

Brief Contents

CHAPTER 1	The Main Themes of Microbiology	1
CHAPTER 2	From Atoms to Cells: A Chemical Connection	25
CHAPTER 3	Tools of the Laboratory: The Methods for Studying Microorganisms	57
CHAPTER 4	Prokaryotic Profiles: The Bacteria and Archaea	87
CHAPTER 5	Eucaryotic Cells and Microorganisms	123
CHAPTER 6	An Introduction to the Viruses	159
CHAPTER 7	Elements of Microbial Nutrition, Ecology, and Growth	187
CHAPTER 8	Microbial Metabolism: The Chemical Crossroads of Life	217
CHAPTER 9	Microbial Genetics	253
CHAPTER 10	Genetic Engineering: A Revolution in Molecular Biology	289
CHAPTER 11	Physical and Chemical Control of Microbes	319
CHAPTER 12	Drugs, Microbes, Host—The Elements of Chemotherapy	349
CHAPTER 13	Microbe-Human Interactions: Infection and Disease	383
CHAPTER 14	The Nature of Host Defenses	415
CHAPTER 15	The Acquisition of Specific Immunity and Its Applications	445
CHAPTER 16	Immunization and Immune Assays	475
CHAPTER 17	Disorders in Immunity	497

Contents

Preface xx

Foundations for Success xxvi

CHAPTER 1 The Main Themes of Microbiology 1

The Scope of Microbiology 2

The Impact of Microbes on Earth: Small Organisms with a Giant Effect 2

Microbial Involvement in Energy and Nutrient Flow 3

Human Use of Microorganisms 4

Infectious Diseases and the Human Condition 5

The General Characteristics of Microorganisms 7

Cellular Organization 7

A Note on Viruses 7

Microbial Dimensions: How Small Is Small? 7

Life-styles of Microorganisms 7

The Historical Foundations of Microbiology 8

The Development of the Microscope: "Seeing Is Believing" 8

The Establishment of the Scientific Method 10

The Development of Medical Microbiology 14

Taxonomy: Organizing, Classifying, and Naming Microorganisms 16

The Levels of Classification 17

Assigning Specific Names 18

The Origin and Evolution of Microorganisms 18

Systems of Presenting a Universal Tree of Life 20

HISTORICAL HIGHLIGHTS 1.1

The Fall of Mysticism and the Rise of Microbiology 12

MEDICAL MICROFILE 1.2

The Serendipity of the Scientific Method: Discovering Drugs 16

Chapter Capsule with Key Terms 21

Multiple-Choice Questions 22

Concept Questions 22

Critical-Thinking Questions 23

Internet Search Topics 23

CHAPTER 2 From Atoms to Cells: A Chemical Connection 25

Atoms, Bonds, and Molecules: Fundamental Building Blocks 25

Different Types of Atoms: Elements and Their Properties 26

The Major Elements of Life and Their Primary Characteristics 26

Bonds and Molecules 29

Covalent Bonds and Polarity: Molecules with Shared Electrons 29

Ionic Bonds: Electron Transfer Among Atoms 31

Solutions: Homogeneous Mixtures of Molecules 34

Acidity, Alkalinity, and the pH Scale 35

The Chemistry of Carbon and Organic Compounds 36

Functional Groups of Organic Compounds 37

Macromolecules: Superstructures of Life 38

Carbohydrates: Sugars and Polysaccharides 38

Lipids: Fats, Phospholipids, and Waxes 40

Proteins: Shapers of Life 42

The Nucleic Acids: A Cell Computer and Its Programs 47

Cells: Where Chemicals Come to Life 50

Fundamental Characteristics of Cells 50

Processes That Define Life 50

SPOTLIGHT ON MICROBIOLOGY 2.1

Searching for Ancient Life with Isotopes 28

MICROBITS 2.2

Redox: Electron Transfer and Oxidation-Reduction Reactions 32

MICROBITS 2.3

Membranes: Cellular Skins 45

Chapter Capsule with Key Terms 52

Multiple-Choice Questions 54

Concept Questions 55

Critical-Thinking Questions 55

Internet Search Topic 56

CHAPTER 3 Tools of the Laboratory: The Methods for Studying Microorganisms 57

Methods of Culturing Microorganisms—The Five I's 58

- Inoculation: Producing a Culture 60
- Isolation: Separating One Species from Another 60
- Media: Providing Nutrients in the Laboratory 62
- Incubation, Inspection, and Identification 68

The Microscope: Window on an Invisible Realm 70

- Magnification and Microscope Design 70
- Variations on the Optical Microscope 73
- Electron Microscopy 75
- Preparing Specimens for Optical Microscopes 77

MICROBITS 3.1

- Animal Inoculation: "Living Media" 62

MICROBITS 3.2

- An Evolution in Resolution: Probing Microscopes 79

MICROBITS 3.3

- The Chemistry of Dyes and Staining 80

Chapter Capsule with Key Terms 82

Multiple-Choice Questions 83

Concept Questions 84

Critical-Thinking Questions 85

Internet Search Topics 85

CHAPTER 4 Prokaryotic Profiles: The Bacteria and Archaea 87

Prokaryotic Form and Function: External Structure 88

The Structure of a Generalized Prokaryotic Cell 88

- Appendages: Cell Extensions 89
- The Cell Envelope: The Outer Wrapping of Bacteria 92
- Structure of the Cell Wall 95
- Cell Membrane Structure 100

Bacterial Form and Function: Internal Structure 101

- Contents of the Cell Cytoplasm 101
- Bacterial Endospores: An Extremely Resistant Stage 102

Bacterial Shapes, Arrangements, and Sizes 104

Bacterial Identification and Classification Systems 108

- Methods Used in Bacterial Identification 108
- Classification Systems in the Prokaryotae 109

Survey of Prokaryotic Groups with Unusual Characteristics 112

- Unusual Forms of Medically Significant Bacteria 114
- Free-Living Nonpathogenic Bacteria 115
- Archaea: The Other Prokaryotes 117

SPOTLIGHT ON MICROBIOLOGY 4.1

- Biofilms—The Glue of Life 94

HISTORICAL HIGHLIGHTS 4.2

- The Gram Stain: A Grand Stain 97

SPOTLIGHT ON MICROBIOLOGY 4.3

- Redefining Bacterial Size 114

Chapter Capsule with Key Terms 119

Multiple-Choice Questions 120

Concept Questions 121

Critical-Thinking Questions 122

Internet Search Topics 122

CHAPTER 5 Eucaryotic Cells and Microorganisms 123

The Nature of Eucaryotes 123

Form and Function of the Eucaryotic Cell: External Structures 126

- Locomotor Appendages: Cilia and Flagella 126
- Surface Structures: The Glycocalyx 127
- The Cell Wall 127
- The Cell Membrane 127

Form and Function of the Eucaryotic Cell: Internal Structures 128

- The Nucleus: The Control Center 128
- Endoplasmic Reticulum: A Passageway in the Cell 131
- Golgi Apparatus: A Packaging Machine 131
- Mitochondria: Energy Generators of the Cell 133
- Chloroplasts: Photosynthesis Machines 134
- The Cytoskeleton: A Support Network 134
- Ribosomes: Protein Synthesizers 134

Survey of Eucaryotic Microorganisms 135

The Kingdom of the Fungi 135

- Fungal Nutrition 136
- Organization of Microscopic Fungi 137
- Reproductive Strategies and Spore Formation 137
- Fungal Classification 142
- Fungal Identification and Cultivation 143
- The Roles of Fungi in Nature and Industry 143

The Protists 144

- The Algae: Photosynthetic Protists 144
- Biology of the Protozoa 146

The Parasitic Helminths 153

- General Worm Morphology 153
- Life Cycles and Reproduction 153
- A Helminth Cycle: The Pinworm 153
- Helminth Classification and Identification 154
- Distribution and Importance of Parasitic Worms 154

SPOTLIGHT ON MICROBIOLOGY 5.1

The Extraordinary Emergence of Eucaryotic Cells 125

SPOTLIGHT ON MICROBIOLOGY 5.2

The Many Faces of Fungi 139

Chapter Capsule with Key Terms 155

Multiple-Choice Questions 156

Concept Questions 156

Critical-Thinking Questions 157

Internet Search Topics 157

**CHAPTER 6 An Introduction
to the Viruses 159****The Search for the Elusive Viruses 160****The Position of Viruses in the Biological Spectrum 160****The General Structure of Viruses 161**

Size Range 161

Unique Viral Constituents: Capsids, Nucleic Acids, and
Envelopes 162**How Viruses Are Classified and Named 167****Modes of Viral Multiplication 167**

The Multiplication Cycle in Bacteriophages 170

Multiplication Cycles in Animal Viruses 173

**Techniques in Cultivating and Identifying Animal
Viruses 177**

Using Live Animal Inoculation 177

Using Bird Embryos 177

Using Cell (Tissue) Culture Techniques 178

Medical Importance of Viruses 180

Other Noncellular Infectious Agents 180

Detection and Control of Viral Infections 180

Treatment of Animal Viral Infections 180

MEDICAL MICROFILE 6.1

A Positive View of Viruses 182

Chapter Capsule with Key Terms 183

Multiple-Choice Questions 183

Concept Questions 184

Critical-Thinking Questions 185

Internet Search Topics 185

**CHAPTER 7 Elements of Microbial Nutrition,
Ecology, and Growth 187****Microbial Nutrition 188**

Chemical Analysis of Microbial Cytoplasm 188

Sources of Essential Nutrients 189

How Microbes Feed: Nutritional Types 192

Transport Mechanisms for Nutrient Absorption 195

Environmental Factors That Influence Microbes 201

Temperature Adaptations 201

Gas Requirements 203

Effects of pH 203

Osmotic Pressure 204

Miscellaneous Environmental Factors 204

Ecological Associations Among Microorganisms 205

Interrelationships Between Microbes and Humans 206

The Study of Microbial Growth 207

The Basis of Population Growth: Binary Fission 207

The Rate of Population Growth 207

The Population Growth Curve 209

Stages in the Normal Growth Curve 209

Other Methods of Analyzing Population Growth 210

SPOTLIGHT ON MICROBIOLOGY 7.1

Life in the Extremes 190

MICROBITS 7.2

Dining with an Ameba 191

MICROBITS 7.3

Light-Driven Organic Synthesis 197

SPOTLIGHT ON MICROBIOLOGY 7.4

Cashing in on "Hot" Microbes 202

SPOTLIGHT ON MICROBIOLOGY 7.5

Life Together: Mutualism 206

MICROBITS 7.6

Steps in a Viable Plate Count—Batch Culture Method 211

Chapter Capsule with Key Terms 213

Multiple-Choice Questions 214

Concept Questions 215

Critical-Thinking Questions 216

Internet Search Topics 216

CHAPTER 8 Microbial Metabolism: The Chemical Crossroads of Life 217

- The Metabolism of Microbes 218
 - Enzymes: Catalyzing the Chemical Reactions of Life 218
 - Regulation of Enzymatic Activity and Metabolic Pathways 226

- The Pursuit and Utilization of Energy 228
 - Cell Energetics 229
 - A Closer Look at Biological Oxidation and Reduction 230
 - Adenosine Triphosphate: Metabolic Money 230

- Pathways of Bioenergetics 232
 - Catabolism: An Overview of Nutrient Breakdown and Energy Release 232
 - Energy Strategies in Microorganisms 233
 - Pyruvic Acid—A Central Metabolite 237
 - The Tricarboxylic Acid Cycle—A Carbon and Energy Wheel 237
 - The Respiratory Chain: Electron Transport and Oxidative Phosphorylation 239
 - Summary of Aerobic Respiration 242
 - Anaerobic Respiration 243
 - The Importance of Fermentation 243

- Biosynthesis and the Crossing Pathways of Metabolism 244
 - The Frugality of the Cell—Waste Not, Want Not 245

- MICROBITS 8.1**
 - Enzymes as Biochemical Levers 219
- MICROBITS 8.2**
 - Unconventional Enzymes 224
- MICROBITS 8.3**
 - The Enzyme Name Game 225
- HISTORICAL HIGHLIGHTS 8.4**
 - Pasteur and the Wine-to-Vinegar Connection 245
- MICROBITS 8.5**
 - Fermentation and Biochemical Testing 246

- Chapter Capsule with Key Terms 248
- Multiple-Choice Questions 249
- Concept Questions 250
- Critical-Thinking Questions 251
- Internet Search Topics 251

CHAPTER 9 Microbial Genetics 253

- Introduction to Genetics and Genes: Unlocking the Secrets of Heredity 253

- The Nature of the Genetic Material 255
- The DNA Code: A Simple Yet Profound Message 256
- The Significance of DNA Structure 256
- DNA Replication: Preserving the Code and Passing It On 257

- Applications of the DNA Code: Transcription and Translation 262

- The Gene-Protein Connection 262
- The Major Participants in Transcription and Translation 263
- Transcription: The First Stage of Gene Expression 265
- Translation: The Second Stage of Gene Expression 266
- Eucaryotic Transcription and Translation: Similar Yet Different 268
- The Genetics of Animal Viruses 270

- Genetic Regulation of Protein Synthesis and Metabolism 273

- The Lactose Operon: A Model for Inducible Gene Regulation in Bacteria 273
- A Repressible Operon 275
- Antibiotics That Affect Transcription and Translation 276

- Mutations: Changes in the Genetic Code 276

- Causes of Mutations 276
- Categories of Mutations 277
- Repair of Mutations 278
- The Ames Test 278
- Positive and Negative Effects of Mutations 280

- DNA Recombination Events 280

- Transmission of Genetic Material in Bacteria 280

- HISTORICAL HIGHLIGHTS 9.1**
 - Deciphering the Structure of DNA 254

- MICROBITS 9.2**
 - The Packaging of DNA: Winding, Twisting, and Coiling 259

- MICROBITS 9.3**
 - Small RNAs: An Old Dog Shows Off Some New (?) Tricks 266

- Chapter Capsule with Key Terms 286
- Multiple-Choice Questions 286
- Concept Questions 287
- Critical-Thinking Questions 288
- Internet Search Topics 288

CHAPTER 10 Genetic Engineering: A Revolution in Molecular Biology 289

Basic Elements and Applications of Genetic Engineering 290

I. Tools and Techniques of Genetic Engineering 290

DNA: An Amazing Molecule 290

II. Methods in Recombinant DNA Technology: How to Imitate Nature 297

Technical Aspects of Recombinant DNA and Gene Cloning 298

Construction of a Recombinant, Insertion into a Cloning Host, and Genetic Expression 301

III. Biochemical Products of Recombinant DNA Technology 302

IV. Genetically Modified Organisms 303

Recombinant Microbes: Modified Bacteria and Viruses 303

Transgenic Plants: Improving Crops and Foods 303

Transgenic Animals: Engineering Embryos 303

V. Genetic Treatments: Introducing DNA into the Body 305

Gene Therapy 305

Antisense and Triplex DNA Technology: Genetic Medicines 307

VI. Genome Analysis: Maps, Fingerprints, and Family Trees 308

Genome Mapping and Screening: An Atlas of the Genome 309

DNA Fingerprinting: A Unique Picture of a Genome 311

■ MICROBITS 10.1

Okay, the Genome's Sequenced—What's Next? 294

■ SPOTLIGHT ON MICROBIOLOGY 10.2

A Moment to Think 310

■ MICROBITS 10.3

Better Bioterrorism Through Biotechnology? 314

Chapter Capsule with Key Terms 315

Multiple-Choice Questions 316

Concept Questions 317

Critical-Thinking Questions 317

Internet Search Topics 318

CHAPTER 11 Physical and Chemical Control of Microbes 319

Controlling Microorganisms 319

General Considerations in Microbial Control 320

Relative Resistance of Microbial Forms 320

Terminology and Methods of Microbial Control 321

What Is Microbial Death? 323

How Antimicrobial Agents Work: Their Modes of Action 324

Methods of Physical Control 326

Heat As an Agent of Microbial Control 326

The Effects of Cold and Desiccation 330

Radiation As a Microbial Control Agent 330

Sound Waves in Microbial Control 333

Sterilization by Filtration: Techniques for Removing Microbes 333

Chemical Agents in Microbial Control 334

Choosing a Microbicidal Chemical 334

Factors That Affect the Germicidal Activity of Chemicals 335

Germicidal Categories According to Chemical Group 336

■ HISTORICAL HIGHLIGHTS 11.1

Microbial Control in Ancient Times 320

■ SPOTLIGHT ON MICROBIOLOGY 11.2

Pathogen Paranoia: "The Only Good Microbe Is a Dead Microbe" 335

■ HISTORICAL HIGHLIGHTS 11.3

The Quest for Sterile Skin 343

■ SPOTLIGHT ON MICROBIOLOGY 11.4

Decontaminating Congress 345

Chapter Capsule with Key Terms 346

Multiple-Choice Questions 347

Concept Questions 347

Critical-Thinking Questions 348

Internet Search Topics 348

SPOTLIGHT ON MICROBIOLOGY 11.5

MEDICAL MICROBIOLOGY 11.5

Chapter Capsule with Key Terms 349

Multiple-Choice Questions 349

Concept Questions 349

Critical-Thinking Questions 349

Internet Search Topics 349

CHAPTER 12 Drugs, Microbes, Host—The Elements of Chemotherapy 349

- Principles of Antimicrobial Therapy 349
 - The Origins of Antimicrobial Drugs 351
- Interactions Between Drug and Microbe 351
 - Mechanisms of Drug Action 353
- Survey of Major Antimicrobial Drug Groups 357
 - Antibacterial Drugs 357
 - Synthetic Antibacterial Drugs 362
 - Agents to Treat Fungal Infections 363
 - Antiparasitic Chemotherapy 364
 - Antiviral Chemotherapeutic Agents 364
 - The Acquisition of Drug Resistance 367
- Characteristics of Host-Drug Reactions 372
 - Toxicity to Organs 372
 - Allergic Responses to Drugs 372
 - Suppression and Alteration of the Microflora by Antimicrobics 373
- Considerations in Selecting an Antimicrobial Drug 375
 - Identifying the Agent 375
 - Testing for the Drug Susceptibility of Microorganisms 375
 - The MIC and Therapeutic Index 377
 - An Antimicrobial Drug Dilemma 378
- HISTORICAL HIGHLIGHTS 12.1**
 - From Witchcraft to Wonder Drugs 350
- MICROBITS 12.2**
 - A Modern Quest for Designer Drugs 352
- MICROBITS 12.3**
 - Household Remedies—From Apples to Zinc 367
- SPOTLIGHT ON MICROBIOLOGY 12.4**
 - The Rise of Drug Resistance 370
- Chapter Capsule with Key Terms 379
- Multiple-Choice Questions 381
- Concept Questions 381
- Critical-Thinking Questions 382
- Internet Search Topics 382

CHAPTER 13 Microbe-Human Interactions: Infection and Disease 383

- The Human Host 383
 - Contact, Infection, Disease—A Continuum 383
 - Resident Flora: The Human As a Habitat 384
 - Indigenous Flora of Specific Regions 386
- The Progress of an Infection 391
 - The Portal of Entry: Gateway to Infection 391
 - The Size of the Inoculum 393
 - Mechanisms of Invasion and Establishment of the Pathogen 393
 - Signs and Symptoms: Warning Signals of Disease 398
 - The Portal of Exit: Vacating the Host 400
 - The Persistence of Microbes and Pathologic Conditions 400
- Epidemiology: The Study of Disease in Populations 401
 - Who, When, and Where? Tracking Disease in the Population 401
 - Reservoirs: Where Pathogens Persist 403
 - How and Why? The Acquisition and Transmission of Infectious Agents 406
 - Nosocomial Infections: The Hospital As a Source of Disease 408
 - Which Agent Is the Cause? Using Koch's Postulates to Determine Etiology 409
- MICROBITS 13.1**
 - Life Without Flora 390
- MEDICAL MICROFILE 13.2**
 - The Classic Stages of Clinical Infections 398
- MICROBITS 13.3**
 - A Quick Guide to the Terminology of Infection and Disease 399
- HISTORICAL HIGHLIGHTS 13.4**
 - The History of Human Guinea Pigs 411
- Chapter Capsule with Key Terms 411
- Multiple-Choice Questions 412
- Concept Questions 413
- Critical-Thinking Questions 414
- Internet Search Topics 414

CHAPTER 14 The Nature of Host Defenses 415**Defense Mechanisms of the Host in Perspective 415**

Barriers at the Portal of Entry: A First Line of Defense 416

Introducing the Immune System 418**Systems Involved in Immune Defenses 419**

The Communicating Body Compartments 420

Nonspecific Immune Reactions of the Body's Compartments 429

The Inflammatory Response: A Complex Concert of Reactions to Injury 429

The Stages of Inflammation 429

Phagocytes: The Ever-Present Busybodies of Inflammation and Specific Immunity 434

Contributors to the Body's Chemical Immunity 436

Specific Immunities: The Third and Final Line of Defense 439**MEDICAL MICROFILE 14.1**

When Inflammation Gets Out of Hand 432

MEDICAL MICROFILE 14.2

The Dynamics of the Inflammatory Mediators 433

MEDICAL MICROFILE 14.3

Some Facts About Fever 434

MICROBITS 14.4

How Complement Works 441

Chapter Capsule with Key Terms 441

Multiple-Choice Questions 442

Concept Questions 442

Critical-Thinking Questions 443

Internet Search Topics 443

CHAPTER 15 The Acquisition of Specific Immunity and Its Applications 445**Further Explorations into the Immune System 445****The Dual Nature of Specific Immune Responses 446**

I. Development of the Dual Lymphocyte System 446

II. Entrance and Presentation of Antigens and Clonal Selection 446

III. B and III. T Activation of Lymphocytes and Clonal Expansion 446

IV. Products of B Lymphocytes: Antibody Structure and Functions 446

V. How T Cells Respond to Antigen: Cell-Mediated Immunity (CMI) 446

Essential Preliminary Concepts for Understanding Immune Reactions of Sections I–V 448

Markers on Cell Surfaces Involved in Recognition of Self and Nonself 448

The Origin of Diversity and Specificity in the Immune Response 449

The Lymphocyte Response System in Depth 452

I. Development of the Dual Lymphocyte System: Stages in Origin, Differentiation, and Maturation 453

II. Entrance and Processing of Antigens and Clonal Selection 454

III. B Activation of B Lymphocytes: Clonal Expansion and Antibody Production 457

IV. Products of B Lymphocytes: Antibody Structure and Functions 457

III. T Activation of T Lymphocytes and V. How T Cells Respond to Antigen: Cell-Mediated Immunity (CMI) 463

A Practical Scheme for Classifying Specific Immunities 467

MEDICAL MICROFILE 15.1

Monoclonal Antibodies: Variety Without Limit 466

SPOTLIGHT ON MICROBIOLOGY 15.2

Lymphokines: Chemical Products of T Cells 468

MEDICAL MICROFILE 15.3

Breast Feeding: The Gift of Antibodies 469

Chapter Capsule with Key Terms 470

Multiple-Choice Questions 471

Concept Questions 472

Critical-Thinking Questions 473

Internet Search Topics 473

CHAPTER 16 Immunization and Immune Assays 475

Practical Applications of Immunologic Function 475

Immunization: Methods of Manipulating Immunity for Therapeutic Purposes 476

Serological and Immune Tests: Measuring the Immune Response *in Vitro* 482

HISTORICAL HIGHLIGHTS 16.1

The Lively History of Active Immunization 476

MEDICAL MICROFILE 16.2

When Positive Is Negative: How to Interpret Serological Test Results 484

Chapter Capsule with Key Terms 493

Multiple-Choice Questions 493

Concept Questions 494

Critical-Thinking Questions 495

Internet Search Topics 495

CHAPTER 17 Disorders in Immunity 497

The Immune Response: A Two-Sided Coin 498

Overreactions to Antigens: Allergy/Hypersensitivity 498

Type I Allergic Reactions: Atopy and Anaphylaxis 499

Epidemiology and Modes of Contact with Allergens 499

The Nature of Allergens and Their Portals of Entry 500

Mechanisms of Type I Allergy: Sensitization and Provocation 500

Cytokines, Target Organs, and Allergic Symptoms 502

Specific Diseases Associated with IgE- and Mast Cell-Mediated Allergy 504

Anaphylaxis: An Overpowering Systemic Reaction 505

Diagnosis of Allergy 505

Treatment and Prevention of Allergy 506

Type II Hypersensitivities: Reactions That Lyse Foreign Cells 508

Human Blood Types 508

The Basis of Human ABO Antigens and Blood Types 508

Antibodies Against A and B Antigens 508

The Rh Factor and Its Clinical Importance 510

Other RBC Antigens 512

Type III Hypersensitivities: Immune Complex Reactions 513

Mechanisms of Immune Complex Disease 513

Types of Immune Complex Disease 513

An Inappropriate Response Against Self, or Autoimmunity 514

Type IV Hypersensitivities: Cell-Mediated (Delayed) Reactions 518

Delayed-Type Hypersensitivity 518

T Cells and Their Role in Organ Transplantation 518

Immunodeficiency Diseases: Hyposensitivity of the Immune System 523

Primary Immunodeficiency Diseases 523

Secondary Immunodeficiency Diseases 525

Cancer: Cells Out of Control 526

Characteristics and Classification of Tumors and Cancers 526

The Function of the Immune System in Cancer 531

■ MEDICAL MICROFILE 17.1	
Of What Value Is Allergy?	504
■ MEDICAL MICROFILE 17.2	
Why Doesn't a Mother Reject Her Fetus?	512
■ SPOTLIGHT ON MICROBIOLOGY 17.3	
Pretty, Pesky, Poisonous Plants	520
■ MEDICAL MICROFILE 17.4	
The Mechanics of Bone Marrow Transplantation	522
■ SPOTLIGHT ON MICROBIOLOGY 17.5	
An Answer to the Bubble Boy Mystery	526
■ SPOTLIGHT ON MICROBIOLOGY 17.6	
Hot on the Trail of Cancer Clues	529

Chapter Capsule with Key Terms 532

Multiple-Choice Questions 533

Concept Questions 534

Critical-Thinking Questions 534

Internet Search Topics 535

APPENDIX A: Exponents A-1

APPENDIX B: Significant Events in Microbiology B-1

APPENDIX C: Methods for Testing Sterilization and Germicidal Processes C-1

APPENDIX D: Classification of Major Microbial Disease Agents by System Affected, Site of Infection, and Routes of Transmission D-1

APPENDIX E: Answers to Multiple-Choice Questions and Selected Matching Questions E-1

Glossary G-1

Credits CR-1

Index I-1