

# Contents

Preface V

## CHAPTER 1

### Introduction to Microbes and Their Building Blocks 2

**CASE FILE** The Subject Is You! 3

1.1 Microbes: Tiny but Mighty 4

**Medical Moment** Medications from Microbes 6

1.2 Microbes in History 10

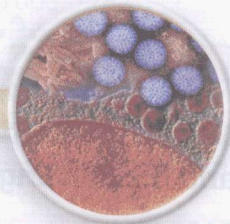
1.3 Macromolecules: Superstructures of Life 15

**Medical Moment** Delivering Essential Nutrients 16

1.4 Naming, Classifying, and Identifying Microorganisms 26

**Case File Wrap-Up** 31

**The Microbiome** Meet Your Microbiome 32



## CHAPTER 2

### Tools of the Laboratory: Methods for the Culturing and Microscopic Analysis of Microorganisms 36

**CASE FILE** Treating the Unknown 37

**Medical Moment** The Making of the Flu Vaccine: An Example of a Live Growth Medium 38

2.1 How to Culture Microorganisms 38

2.2 The Microscope 48

**Medical Moment** Gram-Positive Versus Gram-Negative Bacteria 56

**Case File Wrap-Up** 58

**The Microbiome** Diabetic Wounds and Their Microbiome as Seen by Microscopy 59



## CHAPTER 3

### Bacteria and Archaea 64

**CASE FILE** Extreme Endospores 65

3.1 Form and Function of Bacteria and Archaea 66

3.2 External Structures 70

**Medical Moment** Healthcare-Associated Infections 73

3.3 The Cell Envelope: The Wall and Membrane(s) 74

**Medical Moment** Collecting Sputum 78

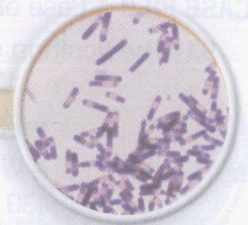
3.4 Bacterial Internal Structure 80

3.5 The Archaea: The Other "Prokaryotes" 83

3.6 Classification Systems for Bacteria and Archaea 84

**Case File Wrap-Up** 86

**The Microbiome** A Sticky Situation 87



## CHAPTER 4

### Eukaryotic Cells and Microorganisms 92

**CASE FILE** Puzzle in the Valley 93

4.1 Overview of the Eukaryotes 94

4.2 Structures of the Eukaryotic Cell 94

4.3 The Fungi 105

**Medical Moment** Vaginal Candidiasis 108

**Medical Moment** Opportunistic Fungal Infection 109

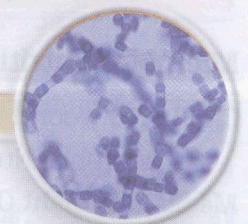
4.4 The Protozoa 110

4.5 The Helminths 113

**Medical Moment** Neglected Parasitic Infections 116

**Case File Wrap-Up** 117

**The Microbiome** Are Eukaryotic Microorganisms Part of Our Microbiome? 118





## CHAPTER

## 5

**Viral Structure and Multiplication 122****CASE FILE** A Case of Croup 123

5.1 The Position of Viruses in the Biological Spectrum 124

5.2 The General Structure of Viruses 126

**Medical Moment** Why Antibiotics Are Ineffective Against Viruses 130

5.3 Modes of Viral Multiplication 132

5.4 Techniques in Cultivating and Identifying Animal Viruses 140

**Medical Moment** Differentiating Between Bacterial and Viral Infections 142

5.5 Other Noncellular Infectious Agents 142

5.6 Viruses and Human Health 142

**Case File Wrap-Up** 144**The Microbiome** Are Viruses Part of the Microbiome? 145

## CHAPTER

## 6

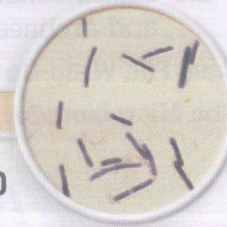
**Microbial Nutrition and Growth 150****CASE FILE** Wound Care 151

6.1 Microbial Nutrition 152

**Medical Moment** Osmosis and IV Fluids 156

6.2 Environmental Factors That Influence Microbes 159

6.3 The Study of Bacterial Growth 166

**Medical Moment** MRSA: PCR Over Culture 171**Case File Wrap-Up** 172**The Microbiome** The Great Oxidation Event and Earth's Microbiome 173

## CHAPTER

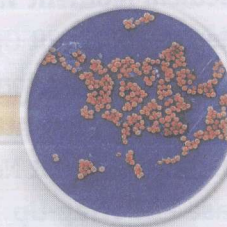
## 7

**Microbial Metabolism 178****CASE FILE** Surviving Sepsis 179

7.1 Metabolism and the Role of Enzymes 180

7.2 The Pursuit and Utilization of Energy 187

7.3 Catabolism 190

**Medical Moment** Facultative Anaerobes 194

7.4 Anabolism and the Crossing Pathways of Metabolism 197

**Medical Moment** Amino Acids: Essential, Nonessential, and Conditionally Essential Amino Acids 198**Case File Wrap-Up** 199**The Microbiome** Electricity Eaters 200

## CHAPTER

## 8

**Microbial Genetics and Genetic Engineering 204****CASE FILE** Factors to Consider 205

8.1 Introduction to Genetics and Genes 206

8.2 Transcription and Translation 211

8.3 Genetic Regulation of Protein Synthesis 220

8.4 DNA Recombination Events 223

8.5 Mutations: Changes in the Genetic Code 229

**Medical Moment** Gene Mutations 231

8.6 Studying DNA in the Laboratory and Genetic Engineering 232

**Medical Moment** Growing Hormones 239**Case File Wrap-Up** 243**The Microbiome** Host Genetics and the Microbiome 244

## CHAPTER

## 9

**Physical and Chemical Control of Microbes 248****CASE FILE** Control of Microorganisms in the Operating Room 249

9.1 Controlling Microorganisms 250

9.2 Methods of Physical Control 256

9.3 Chemical Agents in Microbial Control 264

**Medical Moment** The Use of Alcohol-Based Hand Cleansers 265**Medical Moment** Zap VAP: The Role of Chlorhexidine 268**Case File Wrap-Up** 269**The Microbiome** Hand Hygiene 270



## CHAPTER

## 10

**Antimicrobial Treatment 274****CASE FILE** Not What We Were Expecting 275

10.1 Principles of Antimicrobial Therapy 276

10.2 Interactions Between Drug and Microbe 282

10.3 Antimicrobial Resistance 290

**Medical Moment** Why Do Antibiotics Cause Diarrhea? 296

10.4 Interactions Between Drug and Host 296

**Case File Wrap-Up** 300**The Microbiome** How Antibiotics Impact the Microbiome 301

## CHAPTER

## 11

**Interactions Between Microbes and Humans 306****CASE FILE** Seizing the Opportunity 307

11.1 The Human Microbiome 308

11.2 When Colonization Leads to Disease 312

**Medical Moment** When the Portal of Entry Is Compromised 313**Medical Moment** A Gene That Protects You from the Flu 321**Medical Moment** Eye on Careers: Infection Control Practitioner 328

11.3 Epidemiology: The Study of Disease in Populations 331

**Case File Wrap-Up** 337**The Microbiome** Fecal Transplants 338

## CHAPTER

## 12

**Host Defenses I: Overview and Nonspecific Defenses 342****CASE FILE** Bacteria Cause That? 343

12.1 Defense Mechanisms of the Host: An Overview 344

**Medical Moment** Examining Lymph Nodes 347**Medical Moment** The Tonsils 349

12.2 The First Line of Defense 352

12.3 The Second Line of Defense 355

**Case File Wrap-Up** 366**The Microbiome** Are We Treating Autoimmune Diseases Incorrectly? 367

## CHAPTER

## 13

**Host Defenses II: Specific Immunity and Immunization 372****CASE FILE** When More Immune Response Is Not Better 373

13.1 Specific Immunity: The Third and Final Line of Defense 374

**Medical Moment** The Thymus 378

13.2 Stage I: The Development of Lymphocyte Diversity 378

**Medical Moment** Blood Exposure in Neonates 380

13.3 Stage II: Presentation of Antigens 382

13.4 Stages III and IV: T-Cell Response 384

13.5 Stages III and IV: B-Cell Response 387

13.6 Specific Immunity and Vaccination 392

**Case File Wrap-Up** 399**The Microbiome** Gut Bacteria Cause Blindness? 400

## CHAPTER

## 14

**Disorders in Immunity 404****CASE FILE** A Body Attacking Itself 405

14.1 The Immune Response: A Two-Sided Coin 406

14.2 Type I Allergic Reactions: Atopy and Anaphylaxis 407

14.3 Type II Hypersensitivities: Reactions That Lyse Foreign Cells 417

14.4 Type III Hypersensitivities: Immune Complex Reactions 419

**Medical Moment** Patch Testing 420

14.5 Type IV Hypersensitivities: Cell-Mediated (Delayed) Reactions 420

14.6 An Inappropriate Response to Self: Autoimmunity 423

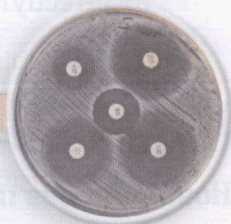


- 14.7 Immunodeficiency Diseases: Hyposensitivity of the Immune System 427

**Medical Moment** Hand Washing 427

**Case File Wrap-Up** 430

**The Microbiome** Asthma and the Airway—and Gut—Microbiome 431



CHAPTER 15

**Diagnosing Infections 436**

**CASE FILE** Tracing the Cause 437

15.1 Preparation for the Survey of Microbial Diseases 438

15.2 First Steps: Specimen Collection 440

15.3 Phenotypic Methods 443

**Medical Moment** Qualitative Versus Quantitative Diagnosis 443

15.4 Immunologic Methods 447

**Medical Moment** Understanding Lab Results 451

15.5 Genotypic Methods 453

**Medical Moment** Detecting and Treating TB 453

15.6 Additional Diagnostic Technologies 456

**Case File Wrap-Up** 459

**The Microbiome** The Human Microbiome Project and Diagnosis of Noninfectious Disease 460



CHAPTER 16

**Infectious Diseases Affecting the Skin and Eyes 464**

**CASE FILE** A Rash of Symptoms 465

16.1 The Skin and Its Defenses 466

16.2 Normal Biota of the Skin 467

16.3 Skin Diseases Caused by Microorganisms 468

**Medical Moment** Scabies 474

**Medical Moment** Scrum Pox: Herpes Gladiatorum 476

16.4 The Surface of the Eye and Its Defenses 484

16.5 Normal Biota of the Eye 485

16.6 Eye Diseases Caused by Microorganisms 486

**Case File Wrap-Up** 488

**The Microbiome** C-Section Babies Have a Different Microbiome than Those Delivered Vaginally 490

CHAPTER 17

**Infectious Diseases Affecting the Nervous System 496**

**CASE FILE** Time Is of the Essence 497

17.1 The Nervous System and Its Defenses 498

17.2 Normal Biota of the Nervous System 499

17.3 Nervous System Diseases Caused by Microorganisms 500

**Medical Moment** Acute Flaccid Myelitis 509

**Case File Wrap-Up** 524

**The Microbiome** The Gut and the Brain 526



CHAPTER 18

**Infectious Diseases Affecting the Cardiovascular and Lymphatic Systems 532**

**CASE FILE** Bitten by a Tick 533

18.1 The Cardiovascular and Lymphatic Systems and Their Defenses 534

18.2 Normal Biota of the Cardiovascular and Lymphatic Systems 536

18.3 Cardiovascular and Lymphatic System Diseases Caused by Microorganisms 537

**Medical Moment** Postexposure Prophylaxis 545

**Medical Moment** Where Does the Fluid Go? 552

**Medical Moment** Ebola Epidemic 556

**Case File Wrap-Up** 564

**The Microbiome** Does Our Gut Microbiome Train Our Immune System Not to Attack HIV? 565



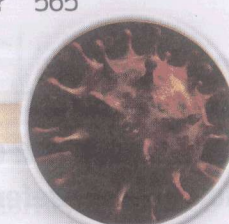
CHAPTER 19

**Infectious Diseases Affecting the Respiratory Systems 570**

**CASE FILE** Very Sick, Very Fast 571

**Medical Moment** Epiglottitis 572

19.1 The Respiratory Tract and Its Defenses 572





**19.2** Normal Biota of the Respiratory Tract 572

**19.3** Upper Respiratory Tract Diseases Caused by Microorganisms 574

**19.4** Diseases Caused by Microorganisms Affecting Both the Upper and Lower Respiratory Tract 580

**19.5** Lower Respiratory Tract Diseases Caused by Microorganisms 586

**Medical Moment** Tuberculosis—A Lesson in Inadequate Treatment 589

**Case File Wrap-Up** 595

**The Microbiome** Gut Bacteria Involved in Deadly Lung Disease? 596

**21.3** Urinary Tract Diseases Caused by Microorganisms 649

**Medical Moment** Cranberry versus UTI 650

**21.4** Reproductive Tract Diseases Caused by Microorganisms 652

**Medical Moment** Crabs 666

**Case File Wrap-Up** 670

**The Microbiome** Save the World with the Vaginal Microbiome 671

## CHAPTER

## 20

## Infectious Diseases Affecting the Gastrointestinal Tract 602

**CASE FILE** "Blood and Guts" 603

**20.1** The Gastrointestinal Tract and Its Defenses 604

**20.2** Normal Biota of the Gastrointestinal Tract 605

**Medical Moment** Dehydration 606

**20.3** Gastrointestinal Tract Diseases Caused by Microorganisms (Nonhelminthic) 606

**Medical Moment** Assessing Jaundice 626

**20.4** Gastrointestinal Tract Diseases Caused by Helminths 631

**Case File Wrap-Up** 637

**The Microbiome** Crohn's Disease and the Gut Microbiome 639

## CHAPTER

## 21

## Infectious Diseases Affecting the Genitourinary System 644

**CASE FILE** It's All in the Walk 645

**21.1** The Genitourinary Tract and Its Defenses 646

**21.2** Normal Biota of the Genitourinary Tract 648

## CHAPTER

## 22

## One Health: The Interconnected Health of the Environment, Humans, and Other Animals By Ronald M. Atlas, University of Louisville, and Marjorie Kelly Cowan 678

**CASE FILE** Ebola in the Hospital 679

**22.1** One Health 680

**22.2** Animals and Infectious Disease: Zoonoses 681

**22.3** The Environment and Infectious Disease 684

**Medical Moment** Plastic Bottles for Clean Water 685

**Medical Moment** *Cryptosporidium* in Your Tap Water? 686

**22.4** Microbes to the Rescue 689

**Case File Wrap-Up** 693

**The Microbiome** Thanks to the Sponge, and Its Microbiome, for Letting Us Breathe 694

**APPENDIX A** Answers to Multiple-Choice Questions in SmartGrid A-1

**APPENDIX B** Answers to the Medical Moments and NCLEX® Questions A-2

**Glossary** G-1

**Index** I-1