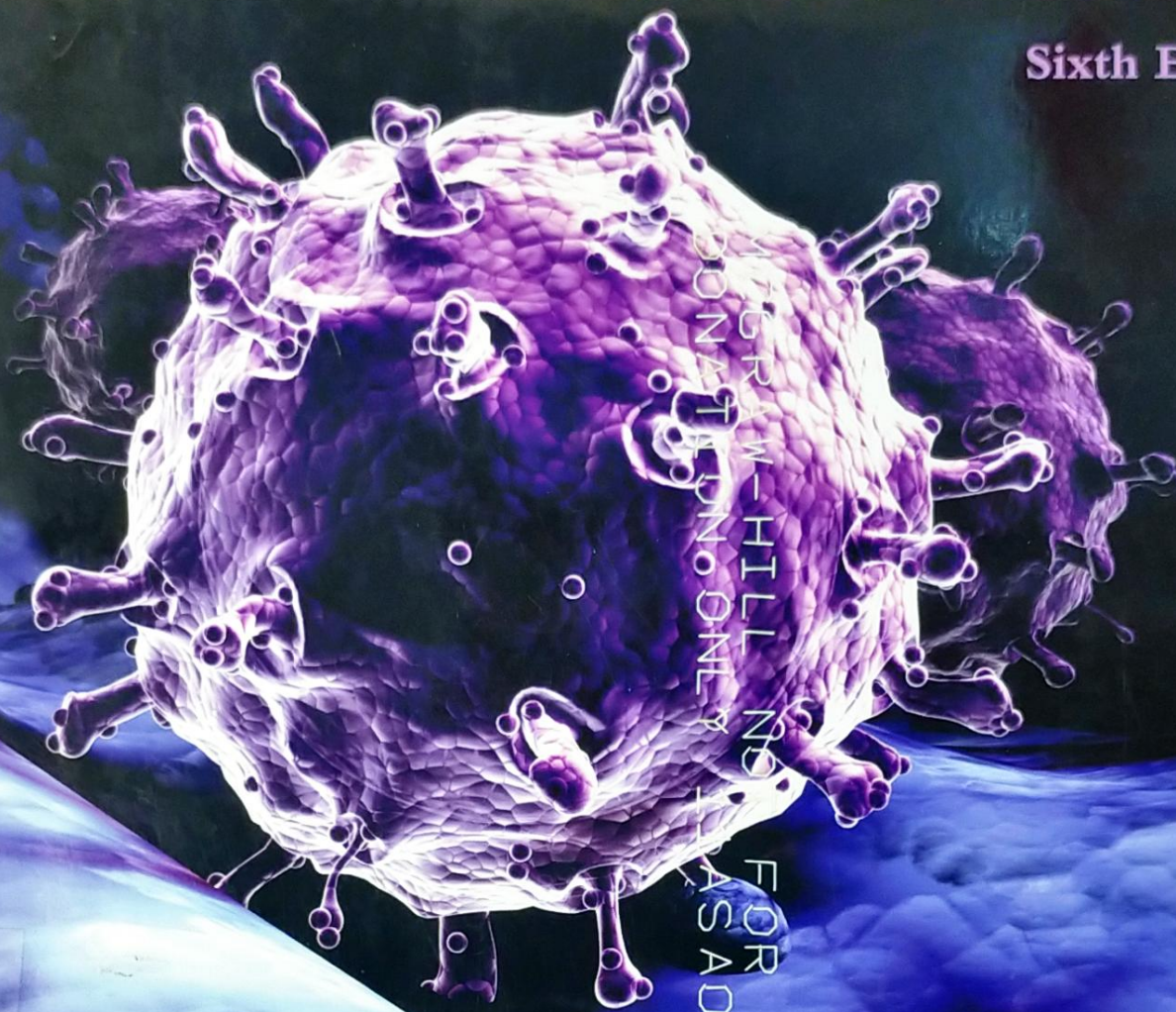


FOUNDATIONS IN  
**Microbiology**  
BASIC PRINCIPLES

Sixth Edition



Kathleen Park Talaro



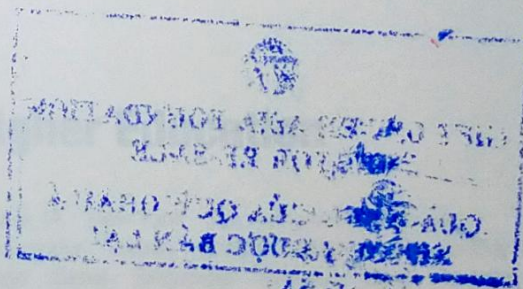
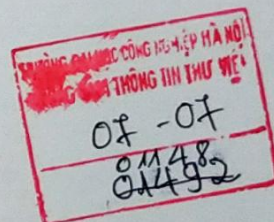
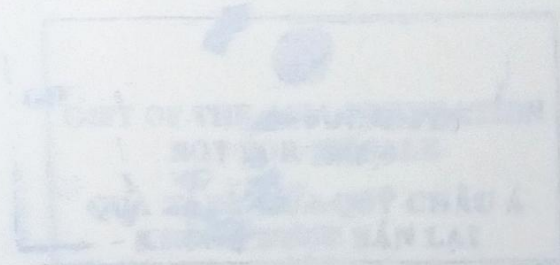
FOUNDATIONS IN

# Microbiology

BASIC PRINCIPLES

Sixth Edition

Northern Park Talara  
Hanoi City College



FOUNDATIONS IN  
**Microbiology**  
BASIC PRINCIPLES

Sixth Edition

**Kathleen Park Talaro**

*Pasadena City College*



**Higher Education**

Boston Burr Ridge, IL Dubuque, IA New York San Francisco St. Louis  
Bangkok Bogotá Caracas Kuala Lumpur Lisbon London Madrid Mexico City  
Milan Montreal New Delhi Santiago Seoul Singapore Sydney Taipei Toronto



FOUNDATIONS IN MICROBIOLOGY: BASIC PRINCIPLES, SIXTH EDITION

Published by McGraw-Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020. Copyright © 2008 by The McGraw-Hill Companies, Inc. All rights reserved. No part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written consent of The McGraw-Hill Companies, Inc., including, but not limited to, in any network or other electronic storage or transmission, or broadcast for distance learning.

Some ancillaries, including electronic and print components, may not be available to customers outside the United States.

This book is printed on acid-free paper.

3 4 5 6 7 8 9 0 QPD/QPD 0 9 8 7

ISBN 978-0-07-299495-7

MHID 0-07-299495-9

Publisher: *Janice Roerig-Blong*  
Developmental Editor: *Darlene M. Schueller*  
Marketing Manager: *Tami Petsche*  
Project Manager: *Lora Kalb*  
Senior Production Supervisor: *Laura Fuller*  
Senior Media Project Manager: *Jodi Banowetz*  
Media Producer: *Eric A. Weber*  
Senior Coordinator of Freelance Design: *Michelle D. Whitaker*  
Cover Designer: *Maureen McCutcheon*  
(USE) Cover Image: ©3D4Medical.com/Getty Images  
Lead Photo Research Coordinator: *Carrie K. Burger*  
Photo Research: *Karen Pugliano*  
Supplement Producer: *Tracy L. Konrardy*  
Compositor: *TechBooks*  
Typeface: *10/12 Times New Roman*  
Printer: *Quebecor World Dubuque, IA*

The credits section for this book begins on page CR-1 and is considered an extension of the copyright page.

**Library of Congress Cataloging-in-Publication Data**

Talaro, Kathleen P.

Foundations in microbiology : basic principles / Kathleen Park Talaro.—6th ed.  
p. cm.

Includes index.

ISBN 978-0-07-299495-7 — ISBN 0-07-299495-9 (hard copy : alk. paper)

1. Microbiology. 2. Medical microbiology. I. Title.

QR41.2.T35 2008

616.9'041—dc22

2006016117

CIP



# Brief Contents

CHAPTER 1	The Main Themes of Microbiology	1
CHAPTER 2	The Chemistry of Biology	27
CHAPTER 3	Tools of the Laboratory: The Methods for Studying Microorganisms	59
CHAPTER 4	An Introduction to Cell and Prokaryotic Cell Structure and Function	89
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	219
CHAPTER 9	Microbial Genetics	255
CHAPTER 10	Genetic Engineering	291
CHAPTER 11	Physical and Chemical Agents for Microbial Control	315
CHAPTER 12	Drugs, Microbes, Host—The Elements of Chemotherapy	345
CHAPTER 13	Microbe–Human Interactions	381
CHAPTER 14	Nonspecific Host Defenses	419
CHAPTER 15	Adaptive, Specific Immunity and Immunization	447
CHAPTER 16	Disorders in Immunity	481
CHAPTER 17	Diagnosing Infections	513



# Contents

Preface xix

## CHAPTER 1 The Main Themes of Microbiology 1

- 1.1 The Scope of Microbiology 2
- 1.2 The Impact of Microbes on Earth: Small Organisms with a Giant Effect 2
  - Microbial Involvement in Energy and Nutrient Flow 4
- 1.3 Human Use of Microorganisms 5
- 1.4 Infectious Diseases and the Human Condition 8
- 1.5 The General Characteristics of Microorganisms 9
  - Cellular Organization 9
  - Microbial Dimensions: How Small Is Small? 11
  - Lifestyles of Microorganisms 12
- 1.6 The Historical Foundations of Microbiology 13
  - The Development of the Microscope: "Seeing Is Believing" 13
  - The Establishment of the Scientific Method 14
  - The Development of Medical Microbiology 16
  - The Discovery of Spores and Sterilization 16
- 1.7 Taxonomy: Organizing, Classifying, and Naming Microorganisms 19
  - The Levels of Classification 19
  - Assigning Specific Names 19
  - The Origin and Evolution of Microorganisms 21
  - Systems of Presenting a Universal Tree of Life 21

■ **INSIGHT 1.1: Discovery**  
Martian Microbes and Astrobiology 7

■ **INSIGHT 1.2: Historical**  
The More Things Change . . . 11

■ **INSIGHT 1.3: Historical**  
The Fall of Superstition and the Rise of Microbiology 14

Chapter Summary with Key Terms 24  
Multiple-Choice Questions 24  
Concept Questions 25  
Critical-Thinking Questions 25  
Internet Search Topics 26

## CHAPTER 2 The Chemistry of Biology 27

- 2.1 Atoms, Bonds, and Molecules: Fundamental Building Blocks 28
  - Different Types of Atoms: Elements and Their Properties 29
  - The Major Elements of Life and Their Primary Characteristics 29
  - Bonds and Molecules 31
- 2.2 Macromolecules: Superstructures of Life 41
  - Carbohydrates: Sugars and Polysaccharides 42

Lipids: Fats, Phospholipids, and Waxes 45  
Proteins: Shapers of Life 47  
The Nucleic Acids: A Cell Computer and Its Programs 50  
The Double Helix of DNA 50

■ **INSIGHT 2.1: Microbiology**  
Searching for Ancient Life with Isotopes 29

Chapter Summary with Key Terms 55  
Multiple-Choice Questions 56  
Concept Questions 57  
Critical-Thinking Questions 58  
Internet Search Topics 58

## CHAPTER 3 Tools of the Laboratory: The Methods for Studying Microorganisms 59

- 3.1 Methods of Culturing Microorganisms—The Five "I"s 60
  - Inoculation: Producing a Culture 60
  - Isolation: Separating One Species from Another 60
  - Media: Providing Nutrients in the Laboratory 62
  - Incubation, Inspection, and Identification 71
- 3.2 The Microscope: Window on an Invisible Realm 73
  - Magnification and Microscope Design 73
  - Variations on the Optical Microscope 76
  - Electron Microscopy 79
  - Preparing Specimens for Optical Microscopes 81

■ **INSIGHT 3.1: Discovery**  
The Uncultured 67

■ **INSIGHT 3.2: Medical**  
Animal Inoculation: "Living Media" 71

■ **INSIGHT 3.3: Discovery**  
The Evolution in Resolution: Probing Microscopes 82

Chapter Summary with Key Terms 86  
Multiple-Choice Questions 86  
Concept Questions 87  
Critical-Thinking Questions 88  
Internet Search Topics 88

## CHAPTER 4 An Introduction to Cells and Prokaryotic Cell Structure and Function 89

- 4.1 Characteristics of Cells and Life 90
  - What Is Life? 90
- 4.2 Prokaryotic Profiles: The Bacteria and Archaea 91
  - The Structure of a Generalized Bacterial Cell 91



<b>4.3 External Structures</b>	91
Appendages: Cell Extensions	91
<b>4.4 The Cell Envelope: The Boundary Layer of Bacteria</b>	97
Differences in Cell Envelope Structure	97
Structure of Cell Walls	98
Mycoplasmas and Other Cell-Wall-Deficient Bacteria	102
Cell Membrane Structure	102
<b>4.5 Bacterial Internal Structure</b>	103
Contents of the Cell Cytoplasm	103
Bacterial Endospores: An Extremely Resistant Life Form	105
<b>4.6 Bacterial Shapes, Arrangements, and Sizes</b>	107
<b>4.7 Classification Systems in the Prokaryotae</b>	111
Bacterial Taxonomy Based on <i>Bergey's Manual</i>	112
Survey of Prokaryotic Groups with Unusual Characteristics	113
Free-Living Nonpathogenic Bacteria	113
Unusual Forms of Medically Significant Bacteria	117
<b>4.8 Archaea: The Other Prokaryotes</b>	117
<b>INSIGHT 4.1: Discovery</b>	
Biofilms—The Glue of Life	96
<b>INSIGHT 4.2: Discovery</b>	
The Gram Stain: A Grand Stain	98
<b>INSIGHT 4.3: Discovery</b>	
Redefining Bacterial Size	115
Chapter Summary 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

<b>5.1 The History of Eucaryotes</b>	124
<b>5.2 Form and Function of the Eucaryotic Cell: External Structures</b>	126
Locomotor Appendages: Cilia and Flagella	126
The Glycocalyx	127
Form and Function of the Eucaryotic Cell: Boundary Structures	128
<b>5.3 Form and Function of the Eucaryotic Cell: Internal Structures</b>	129
The Nucleus: The Control Center	129
Endoplasmic Reticulum: A Passageway in the Cell	130
Golgi Apparatus: A Packaging Machine	130
Mitochondria: Energy Generators of the Cell	132
Chloroplasts: Photosynthesis Machines	133
Ribosomes: Protein Synthesizers	134
The Cytoskeleton: A Support Network	134
Survey of Eucaryotic Microorganisms	135
<b>5.4 The Kingdom of the Fungi</b>	136
Fungal Nutrition	137
Organization of Microscopic Fungi	138

Reproductive Strategies and Spore Formation	140
Fungal Classification	143
Fungal Identification and Cultivation	145
The Roles of Fungi in Nature and Industry	145
<b>5.5 The Protists</b>	146
The Algae: Photosynthetic Protists	146
Biology of the Protozoa	147
<b>5.6 The Parasitic Helminths</b>	153
General Worm Morphology	153
Life Cycles and Reproduction	153
A Helminth Cycle: The Pinworm	154
Helminth Classification and Identification	155
Distribution and Importance of Parasitic Worms	155
<b>INSIGHT 5.1: Historical</b>	
The Extraordinary Emergence of Eucaryotic Cells	125
<b>INSIGHT 5.2: Discovery</b>	
Fungi: A Force of Nature	139
Chapter Summary with Key Terms	156
Multiple-Choice Questions	156
Concept Questions	157
Critical-Thinking Questions	158
Internet Search Topics	158

## CHAPTER 6 An Introduction to the Viruses 159

<b>6.1 The Search for the Elusive Viruses</b>	160
<b>6.2 The Position of Viruses in the Biological Spectrum</b>	160
<b>6.3 The General Structure of Viruses</b>	161
Size Range	161
Viral Components: Capsids, Nucleic Acids, and Envelopes	162
<b>6.4 How Viruses Are Classified and Named</b>	168
<b>6.5 Modes of Viral Multiplication</b>	170
Multiplication Cycles in Animal Viruses	170
The Multiplication Cycle in Bacteriophages	175
<b>6.6 Techniques in Cultivating and Identifying Animal Viruses</b>	178
Using Cell (Tissue) Culture Techniques	178
Using Bird Embryos	179
Using Live Animal Inoculation	180
<b>6.7 Medical Importance of Viruses</b>	180
<b>6.8 Prions and Other Nonviral Infectious Particles</b>	181
<b>6.9 Detection and Treatment of Animal Viral Infections</b>	182
<b>INSIGHT 6.1: Discovery</b>	
An Alternate View of Viruses	161
<b>INSIGHT 6.2: Discovery</b>	
Artificial Viruses Created!	180
<b>INSIGHT 6.3: Medical</b>	
Uncommon Facts About the Common Cold	181
Chapter Summary with Key Terms	183
Multiple-Choice Questions	184
Concept Questions	185
Critical-Thinking Questions	186
Internet Search Topics	186



## CHAPTER 7 Elements of Microbial Nutrition, Ecology, and Growth 187

- 7.1 Microbial Nutrition** 188
  - Chemical Analysis of Microbial Cytoplasm 190
  - Sources of Essential Nutrients 190
  - Transport: Movement of Chemicals Across the Cell Membrane 195
  - The Diffusion of Water: Osmosis 196
  - Endocytosis: Eating and Drinking by Cells 198
- 7.2 Environmental Factors That Influence Microbes** 200
  - Adaptations to Temperature 200
  - Gas Requirements 203
  - Effects of pH 205
  - Osmotic Pressure 205
  - Miscellaneous Environmental Factors 205
  - Ecological Associations Among Microorganisms 206
  - Interrelationships Between Microbes and Humans 208
- 7.3 The Study of Microbial Growth** 209
  - The Basis of Population Growth: Binary Fission 209
  - The Rate of Population Growth 209
  - The Population Growth Curve 211
  - Stages in the Normal Growth Curve 211
  - Other Methods of Analyzing Population Growth 213
- INSIGHT 7.1: Discovery**
  - Dining with an Ameba 189
- INSIGHT 7.2: Discovery**
  - Light-Driven Organic Synthesis 193
- INSIGHT 7.3: Discovery**
  - Life in the Extremes 201
- INSIGHT 7.4: Discovery**
  - Cashing in on "Hot" Microbes 203
- INSIGHT 7.5: Discovery**
  - Mutualism: Merging Life Forms 206
- INSIGHT 7.6: Microbiology**
  - Steps in a Viable Plate Count—Batch Culture Method 212
- Chapter Summary with Key Terms 215
- Multiple-Choice Questions 216
- Concept Questions 216
- Critical-Thinking Questions 217
- Internet Search Topics 218

## CHAPTER 8 Microbial Metabolism 219

- 8.1 The Metabolism of Microbes** 220
  - Enzymes: Catalyzing the Chemical Reactions of Life 220
  - Regulation of Enzymatic Activity and Metabolic Pathways 228
- 8.2 The Pursuit and Utilization of Energy** 230
  - Cell Energetics 230
  - A Closer Look at Biological Oxidation and Reduction 231
  - Adenosine Triphosphate: Metabolic Money 232
- 8.3 Pathways of Bioenergetics** 233
  - Catabolism: An Overview of Nutrient Breakdown and Energy Release 234
  - Energy Strategies in Microorganisms 235

- Pyruvic Acid—A Central Metabolite 238
- The Tricarboxylic Acid Cycle—A Carbon and Energy Wheel 238
- The Respiratory Chain: Electron Transport and Oxidative Phosphorylation 241
- Summary of Aerobic Respiration 244
- Anaerobic Respiration 245
- The Importance of Fermentation 245
- 8.4 Biosynthesis and the Crossing Pathways of Metabolism** 248
  - The Frugality of the Cell—Waste Not, Want Not 248

- INSIGHT 8.1: Discovery**
  - Enzymes as Biochemical Levers 221
- INSIGHT 8.2: Discovery**
  - Unconventional Enzymes 222
- INSIGHT 8.3: Discovery**
  - The Enzyme Name Game 226
- INSIGHT 8.4: Historical**
  - Pasteur and the Wine-to-Vinegar Connection 246
- INSIGHT 8.5: Discovery**
  - Fermentation and Biochemical Testing 247
- Chapter Summary with Key Terms 250
- Multiple-Choice Questions 251
- Concept Questions 252
- Critical-Thinking Questions 253
- Internet Search Topics 254

## CHAPTER 9 Microbial Genetics 255

- 9.1 Introduction to Genetics and Genes:**
  - Unlocking the Secrets of Heredity** 256
    - The Nature of the Genetic Material 256
    - The DNA Code: A Simple Yet Profound Message 258
    - The Significance of DNA Structure 261
    - DNA Replication: Preserving the Code and Passing It On 261
- 9.2 Applications of the DNA Code:**
  - Transcription and Translation** 264
    - The Gene-Protein Connection 264
    - The Major Participants in Transcription and Translation 265
    - Transcription: The First Stage of Gene Expression 267
    - Translation: The Second Stage of Gene Expression 268
    - Eucaryotic Transcription and Translation: Similar Yet Different 272
    - The Genetics of Animal Viruses 273
- 9.3 Genetic Regulation of Protein Synthesis and Metabolism** 274
  - The Lactose Operon: A Model for Inducible Gene Regulation in Bacteria 276
  - A Repressible Operon 277
  - Antibiotics That Affect Transcription and Translation 277



**9.4 Mutations: Changes in the Genetic Code** 278

- Causes of Mutations 279
- Categories of Mutations 279
- Repair of Mutations 280
- The Ames Test 281
- Positive and Negative Effects of Mutations 281

**9.5 DNA Recombination Events** 282

- Transmission of Genetic Material in Bacteria 282

**INSIGHT 9.1: Discovery**

- The Packaging of DNA: Winding, Twisting, and Coiling 257

**INSIGHT 9.2: Historical**

- Deciphering the Structure of DNA 259

**INSIGHT 9.3: Discovery**

- Revising Some Rules of Genetics 266

**INSIGHT 9.4: Medical**

- Replication Strategies in Animal Viruses 274

Chapter Summary with Key Terms 287

Multiple-Choice Questions 288

Concept Questions 289

Critical-Thinking Questions 290

Internet Search Topics 290

**CHAPTER 10 Genetic Engineering** 291

**10.1 Basic Elements and Applications of Genetic Engineering** 292

**10.2 Tools and Techniques of Genetic Engineering** 292

- Practical Properties of DNA 292

**10.3 Methods in Recombinant DNA Technology: How to Imitate Nature** 300

- Technical Aspects of Recombinant DNA and Gene Cloning 300
- Construction of a Recombinant, Insertion into a Cloning Host, and Genetic Expression 302

**10.4 Biochemical Products of Recombinant DNA Technology** 302

**10.5 Genetically Modified Organisms** 304

- Recombinant Microbes: Modified Bacteria and Viruses 304
- Transgenic Plants 305
- Transgenic Animals: Engineering Embryos 306

**10.6 Genome Analysis: Fingerprints and Genetic Testing** 307

- DNA Fingerprinting: A Unique Picture of a Genome 309

**INSIGHT 10.1: Discovery**

- Okay, the Genome's Sequenced—What's Next? 297

**INSIGHT 10.2: Discovery**

- Of Mice and Men (and Herbicide-Resistant Plants) 306

**INSIGHT 10.3: Microbiology**

- A Moment to Think 309

Chapter Summary with Key Terms 312

Multiple-Choice Questions 313

Concept Questions 313

Critical-Thinking Questions 314

Internet Search Topics 314

**CHAPTER 11 Physical and Chemical Agents for Microbial Control** 315

**11.1 Controlling Microorganisms** 316

- General Considerations in Microbial Control 316
- Relative Resistance of Microbial Forms 316
- Terminology and Methods of Microbial Control 317
- What Is Microbial Death? 319
- How Antimicrobial Agents Work: Their Modes of Action 321

**11.2 Methods of Physical Control** 322

- Heat as an Agent of Microbial Control 322
- The Effects of Cold and Dessication 326
- Radiation as a Microbial Control Agent 326
- Sterilization by Filtration: Techniques for Removing Microbes 328

**11.3 Chemical Agents in Microbial Control** 330

- Choosing a Microbicidal Chemical 330
- Factors That Affect the Germicidal Activity of Chemicals 332
- Germicidal Categories According to Chemical Group 332

**INSIGHT 11.1: Historical**

- Microbial Control in Ancient Times 317

**INSIGHT 11.2: Microbiology**

- Pathogen Paranoia: "The Only Good Microbe Is a Dead Microbe" 330

**INSIGHT 11.3: Medical**

- The Quest for Sterile Skin 336

**INSIGHT 11.4: Microbiology**

- Decontaminating Congress 340

Chapter Summary with Key Terms 341

Multiple-Choice Questions 342

Concept Questions 343

Critical-Thinking Questions 343

Internet Search Topics 344

**CHAPTER 12 Drugs, Microbes, Host—The Elements of Chemotherapy** 345

**12.1 Principles of Antimicrobial Therapy** 346

- The Origins of Antimicrobial Drugs 346

**12.2 Interactions Between Drug and Microbe** 348

- Mechanisms of Drug Action 348

**12.3 Survey of Major Antimicrobial Drug Groups** 354

- Antibacterial Drugs That Act on the Cell Wall 354
- Antibiotics That Damage Bacterial Cell Membranes 357
- Drugs That Act on DNA or RNA 357
- Drugs That Interfere with Protein Synthesis 358
- Drugs That Block Metabolic Pathways 359
- Agents to Treat Fungal Infections 360
- Antiparasitic Chemotherapy 360
- Interactions Between Microbes and Drugs: The Acquisition of Drug Resistance 364
- New Approaches to Antimicrobial Therapy 367



**12.4 Interaction Between Drug and Host 370**

- Toxicity to Organs 370
- Allergic Responses to Drugs 370
- Suppression and Alteration of the Microflora by Antimicrobials 370

**12.5 Considerations in Selecting an Antimicrobial Drug 372**

- Identifying the Agent 372
- Testing for the Drug Susceptibility of Microorganisms 372
- The MIC and Therapeutic Index 373

**INSIGHT 12.1: Historical**

- From Witchcraft to Wonder Drugs 347

**INSIGHT 12.2: Discovery**

- A Modern Quest for Designer Drugs 355

**INSIGHT 12.3: Discovery**

- Household Remedies—From Apples to Zinc 363

**INSIGHT 12.4: Medical**

- The Rise of Drug Resistance 368

Chapter Summary with Key Terms 377

Multiple-Choice Questions 378

Concept Questions 379

Critical-Thinking Questions 379

Internet Search Topics 380

**CHAPTER 13 Microbe–Human Interactions 381****13.1 We Are Not Alone 382**

- Contact, Colonization, Infection, Disease 382
- Resident Flora: The Human as a Habitat 382
- Indigenous Flora of Specific Regions 384
- Flora of the Human Skin 384
- Flora of the Gastrointestinal Tract 386
- Flora of the Respiratory Tract 387
- Flora of the Genitourinary Tract 387

**13.2 Major Factors in the Development of an Infection 388**

- Becoming Established: Step One—Portals of Entry 390
- The Requirement for an Infectious Dose 393
- Becoming Established: Step Two—Attaching to the Host 394
- Becoming Established: Step Three—Surviving Host Defenses 394
- Causing Disease 395
- The Process of Infection and Disease 399
- Signs and Symptoms: Warning Signals of Disease 401
- The Portal of Exit: Vacating the Host 402
- The Persistence of Microbes and Pathologic Conditions 403

**13.3 Sources and Spread of Microbes 403**

- Reservoirs: Where Pathogens Persist 403
- The Acquisition and Transmission of Infectious Agents 406
- Nosocomial Infections: The Hospital as a Source of Disease 408
- Universal Blood and Body Fluid Precautions 409

**13.4 Epidemiology: The Study of Disease in Populations 410**

- Who, When, and Where? Tracking Disease in the Population 410

**INSIGHT 13.1: Discovery**

- Life Without Flora 389

**INSIGHT 13.2: Medical**

- Laboratory Biosafety Levels and Classes of Pathogens 391

**INSIGHT 13.3: Historical**

- Human Guinea Pigs 396

**INSIGHT 13.4: Medical**

- A Quick Guide to the Terminology of Infection and Disease 401

**INSIGHT 13.5: Medical**

- Koch's Postulates: Solving the Puzzle of New Diseases 414

Chapter Summary with Key Terms 415

Multiple-Choice Questions 416

Concept Questions 417

Critical-Thinking Questions 418

Internet Search Topics 418

**CHAPTER 14 Nonspecific Host Defenses 419****14.1 Defense Mechanisms of the Host in Perspective 420**

- Barriers at the Portal of Entry: A First Line of Defense 420

**14.2 Structure and Function of the Organ of Defense and Immunity 422**

- The Communicating Body Compartments 423

**14.3 Actions of the Second Line of Defense 431**

- Recognition: Activation of the Innate Immunological Response 432
- The Inflammatory Response: A Complex Concert of Reactions to Injury 432
- The Stages of Inflammation 433
- Phagocytosis: Partner to Inflammation and Immunity 438
- Interferon: Antiviral Cytokines and Immune Stimulants 439
- Complement: A Versatile Backup System 441
- Overall Stages in the Complement Cascade 441
- Summary of Host Defenses 443

**INSIGHT 14.1: Medical**

- When Inflammation Gets Out of Hand 434

**INSIGHT 14.2: Medical**

- The Dynamics of Inflammatory Mediators 436

**INSIGHT 14.3: Medical**

- Some Facts About Fever 437

Chapter Summary with Key Terms 444

Multiple-Choice Questions 444

Concept Questions 445

Critical-Thinking Questions 446

Internet Search Topics 446



## CHAPTER 15 Adaptive, Specific Immunity and Immunization 447

- 15.1 Specific Immunity: The Adaptive Line of Defense** 448
  - A General Scheme for Classifying Immunities 448
  - An Overview of Specific Immune Responses 450
- 15.2 Development of the Immune Response System** 452
  - Markers on Cell Surfaces Involved in Recognition of Self and Nonself 452
  - The Origin of Diversity and Specificity in the Immune Response 453
- 15.3 Lymphocyte Responses and Antigens** 455
  - Specific Events in B-Cell Maturation 455
  - Specific Events in T-Cell Maturation 456
  - Entrance and Processing of Antigens and Clonal Selection 456
- 15.4 Cooperation in Immune Reactions to Antigens** 457
  - The Role of Antigen Processing and Presentation to Lymphocytes 458
- 15.5 B-Cell Responses** 459
  - Activation of B Lymphocytes: Clonal Expansion and Antibody Production 459
  - Products of B Lymphocytes: Antibody Structure and Functions 459
  - Monoclonal Antibodies: Useful Products from Cancer Cells 463
- 15.6 T-Cell Responses** 464
  - Cell-Mediated Immunity (CMI) 464
- 15.7 Immunization: Methods of Manipulating Immunity for Therapeutic Purposes** 468
  - Passive Immunization 468
  - Artificial Active Immunity: Vaccination 469
  - Development of New Vaccines 469
  - Route of Administration and Side Effects of Vaccines 473
  - To Vaccinate: Why, Whom, and When? 473

**INSIGHT 15.1: Historical**  
Breast Feeding: The Gift of Antibodies 450

**INSIGHT 15.2: Medical**  
Monoclonal Antibodies: Variety Without Limit 465

**INSIGHT 15.3: Historical**  
The Lively History of Active Immunization 472

Chapter Summary with Key Terms 477  
Multiple-Choice Questions 478  
Concept Questions 479  
Critical-Thinking Questions 480  
Internet Search Topics 480

Cytokines, Target Organs, and Allergic Symptoms 486  
Specific Diseases Associated with IgE- and Mast Cell-Mediated Allergy 488  
Anaphylaxis: An Overpowering Systemic Reaction 489  
Diagnosis of Allergy 489  
Treatment and Prevention of Allergy 490

### 16.3 Type II Hypersensitivities: Reactions That Lyse Foreign Cells 492

The Basis of Human ABO Antigens and Blood Types 492  
Antibodies Against A and B Antigens 493  
The Rh Factor and Its Clinical Importance 494  
Other RBC Antigens 495

### 16.4 Type III Hypersensitivities: Immune Complex Reactions 496

Mechanisms of Immune Complex Disease 496  
Types of Immune Complex Disease 496

### 16.5 Immunopathologies Involving T Cells 497

Type IV Delayed-Type Hypersensitivity 497  
T Cells and Their Role in Organ Transplantation 499  
Types of Transplants 501

### 16.6 Autoimmune Diseases—An Attack on Self 502

Genetic and Gender Correlation in Autoimmune Disease 502  
The Origins of Autoimmune Disease 502  
Examples of Autoimmune Disease 503

### 16.7 Immunodeficiency Diseases: Hyposensitivity of the Immune System 505

Primary Immunodeficiency Diseases 506  
Secondary Immunodeficiency Diseases 507

### 16.8 The Function of the Immune System in Cancer 508

**INSIGHT 16.1: Medical**  
Of What Value Is Allergy? 488

**INSIGHT 16.2: Medical**  
Why Doesn't a Mother Reject Her Fetus? 496

**INSIGHT 16.3: Medical**  
Pretty, Pesky, Poisonous Plants 498

**INSIGHT 16.4: Medical**  
The Gift of Life: Bone Marrow Transplantation 501

**INSIGHT 16.5: Discovery**  
An Answer to the Mystery of David 508

Chapter Summary with Key Terms 509  
Multiple-Choice Questions 511  
Concept Questions 511  
Critical-Thinking Questions 512  
Internet Search Topics 512

## CHAPTER 16 Disorders in Immunity 481

- 16.1 The Immune Response: A Two-Sided Coin** 482
  - Overreactions to Antigens: Allergy/Hypersensitivity 483
- 16.2 Type I Allergic Reactions: Atopy and Anaphylaxis** 483
  - Modes of Contact with Allergens 484
  - The Nature of Allergens and Their Portals of Entry 484
  - Mechanisms of Type I Allergy: Sensitization and Provocation 484

## CHAPTER 17 Diagnosing Infections 513

- 17.1 Preparation for the Survey of Microbial Diseases** 514
  - Phenotypic Methods 514
  - Genotypic Methods 514
  - Immunological Methods 514
- 17.2 On the Track of the Infectious Agent: Specimen Collection** 514
  - Overview of Laboratory Techniques 515



<b>17.3 Phenotypic Methods</b>	517
Immediate Direct Examination of Specimen	517
Cultivation of Specimen	517
<b>17.4 Genotypic Methods</b>	520
DNA Analysis Using Genetic Probes	520
Nucleic Acid Sequencing and rRNA Analysis	520
Polymerase Chain Reaction	520
G + C Base Composition	520
<b>17.5 Immunological Methods</b>	520
General Features of Immune Testing	521
Agglutination and Precipitation Reactions	523
The Western Blot for Detecting Proteins	525
Complement Fixation	526
Miscellaneous Serological Tests	527
Fluorescent Antibodies and Immunofluorescence Testing	527
Immunoassays: Tests of Great Sensitivity	527
Tests That Differentiate T Cells and B Cells	529
<i>In Vivo</i> Testing	530
A Viral Example	530

<b>INSIGHT 17.1: Medical</b>	
New Guidelines for Enteric Cultures	518
<b>INSIGHT 17.2: Medical</b>	
When Positive Is Negative: How to Interpret Serological Test Results	523
Chapter Summary with Key Terms	532
Multiple-Choice Questions	533
Concept Questions	533
Critical-Thinking Questions	534
Internet Search Topics	534

<b>APPENDIX A</b>	A-1
<b>APPENDIX B</b>	B-1
<b>APPENDIX C</b>	C-1
<b>APPENDIX D</b>	D-1
<b>APPENDIX E</b>	E-1
Glossary	G-1
Credits	CR-1
Index	I-1