

GLOBAL
EDITION



Microbiology

An Introduction

THIRTEENTH EDITION

Tortora • Funke • Case



Brief Contents

PART ONE Fundamentals of Microbiology

- 1 The Microbial World and You 27
- 2 Chemical Principles 50
- 3 Observing Microorganisms Through a Microscope 77
- 4 Functional Anatomy of Prokaryotic and Eukaryotic Cells 98
- 5 Microbial Metabolism 133
- 6 Microbial Growth 177
- 7 The Control of Microbial Growth 204
- 8 Microbial Genetics 230
- 9 Biotechnology and DNA Technology 268

PART TWO A Survey of the Microbial World

- 10 Classification of Microorganisms 295
- 11 The Prokaryotes: Domains Bacteria and Archaea 321
- 12 The Eukaryotes: Fungi, Algae, Protozoa, and Helminths 349
- 13 Viruses, Viroids, and Prions 387

PART THREE Interaction between Microbe and Host

- 14 Principles of Disease and Epidemiology 419
- 15 Microbial Mechanisms of Pathogenicity 449
- 16 Innate Immunity: Nonspecific Defenses of the Host 471
- 17 Adaptive Immunity: Specific Defenses of the Host 501
- 18 Practical Applications of Immunology 525
- 19 Disorders Associated with the Immune System 550
- 20 Antimicrobial Drugs 584

PART FOUR Microorganisms and Human Disease

- 21 Microbial Diseases of the Skin and Eyes 616
- 22 Microbial Diseases of the Nervous System 645
- 23 Microbial Diseases of the Cardiovascular and Lymphatic Systems 676
- 24 Microbial Diseases of the Respiratory System 714
- 25 Microbial Diseases of the Digestive System 747
- 26 Microbial Diseases of the Urinary and Reproductive Systems 786

PART FIVE Environmental and Applied Microbiology

- 27 Environmental Microbiology 812
- 28 Applied and Industrial Microbiology 835

Exploring the Microbiome

- 1 How Does Your Microbiome Grow? 29
- 2 Feed Our Intestinal Bacteria, Feed Ourselves: A Tale of Two Starches 63
- 3 Obtaining a More Accurate Picture of Our Microbiota 93
- 4 Eukaryotes Are Microbiota, Too 120
- 5 Do Artificial Sweeteners (and the Intestinal Microbiota That Love Them) Promote Diabetes? 158
- 6 Circadian Rhythms and Microbiota Growth Cycles 194
- 7 Antimicrobial Soaps: Doing More Harm Than Good? 217
- 8 Horizontal Gene Transfer and the Unintended Consequences of Antibiotic Usage 256
- 9 Crime Scene Investigation and Your Microbiome 287
- 10 Techniques for Identifying Members of Your Microbiome 317
- 11 Microbiome in Space 346
- 12 The Mycobiome 361
- 13 The Human Virome 390
- 14 Connections between Birth, Microbiome, and Other Health Conditions 421
- 15 Skin Microbiota Interactions and the Making of MRSA 453
- 16 The Microbiome's Shaping of Innate Immunity 478
- 17 The Relationship between Your Immune Cells and Skin Microbiota 517
- 18 Microbiome May Enhance Response to Oral Vaccines 531
- 19 The Link between Blood Type and Composition of the Intestinal Microbiome 558
- 20 Looking to the Microbiome for the Next Great Antibiotic 611
- 21 Normal Skin Microbiota and Our Immune System: Allies in "Skin Wars" 620
- 22 Microbes Impacting the CNS 670
- 23 Is Blood Sterile? 679
- 24 Discovering the Microbiome of the Lungs 717
- 25 Sorting Out Good Neighbors from Bad in the GI Tract 749
- 26 Resident Microbes of the Urinary System 789
- 27 Resident Microbes of Earth's Most Extreme Environments 820
- 28 Using Bacteria to Stop the Spread of Zika Virus 849



All chapter content is tagged to
ASM Curriculum Guidelines for
Undergraduate Microbiology

Microbiology: An Introduction, Global Edition

Table of Contents

Cover

Brief Contents

Title Page

Copyright Page

About the Authors

Digital Authors

Preface

Acknowledgments

Contents

Features

ASM Recommended Curriculum Guidelines for Undergraduate Microbiology

PART ONE Fundamentals of Microbiology

1 The Microbial World and You

Microbes in Our Lives

The Microbiome

Naming and Classifying Microorganisms

Nomenclature

Types of Microorganisms

Classification of Microorganisms

A Brief History of Microbiology

The First Observations

The Debate over Spontaneous Generation

The First Golden Age of Microbiology

The Second Golden Age of Microbiology

The Third Golden Age of Microbiology

Microbes and Human Welfare

Recycling Vital Elements

Sewage Treatment: Using Microbes to Recycle Water

Bioremediation: Using Microbes to Clean Up Pollutants

Insect Pest Control by Microorganisms

Biotechnology and Recombinant DNA Technology

Microbes and Human Disease

Table of Contents

Biofilms

Infectious Diseases

Emerging Infectious Diseases

Study Outline

Study Questions

2 Chemical Principles

The Structure of Atoms

Chemical Elements

Electronic Configurations

How Atoms Form Molecules: Chemical Bonds

Ionic Bonds

Covalent Bonds

Hydrogen Bonds

Molecular Mass and Moles

Chemical Reactions

Energy in Chemical Reactions

Synthesis Reactions

Decomposition Reactions

Exchange Reactions

The Reversibility of Chemical Reactions

IMPORTANT BIOLOGICAL MOLECULES

Inorganic Compounds

Water

Acids, Bases, and Salts

AcidBase Balance: The Concept of pH

Organic Compounds

Structure and Chemistry

Carbohydrates

Lipids

Proteins

Nucleic Acids

Adenosine Triphosphate (ATP)

Study Outline

Study Questions

3 Observing Microorganisms Through a Microscope

Units of Measurement

Microscopy: The Instruments

Light Microscopy

Two-Photon Microscopy

Super-Resolution Light Microscopy

Table of Contents

Scanning Acoustic Microscopy

Electron Microscopy

Scanned-Probe Microscopy

Preparation of Specimens for Light Microscopy

Preparing Smears for Staining

Simple Stains

Differential Stains

Special Stains

Study Outline

Study Questions

4 Functional Anatomy of Prokaryotic and Eukaryotic Cells

Comparing Prokaryotic and Eukaryotic Cells: An Overview

THE PROKARYOTIC CELL

The Size, Shape, and Arrangement of Bacterial Cells

Structures External to the Cell Wall

Glycocalyx

Flagella and Archaeella

Axial Filaments

Fimbriae and Pili

The Cell Wall

Composition and Characteristics

Cell Walls and the Gram Stain Mechanism

Atypical Cell Walls

Damage to the Cell Wall

Structures Internal to the Cell Wall

The Plasma (Cytoplasmic) Membrane

The Movement of Materials across Membranes

Cytoplasm

The Nucleoid

Ribosomes

Inclusions

Endospores

THE EUKARYOTIC CELL

Flagella and Cilia

The Cell Wall and Glycocalyx

The Plasma (Cytoplasmic) Membrane

Cytoplasm

Ribosomes

Organelles

Table of Contents

The Nucleus

Endoplasmic Reticulum

Golgi Complex

Lysosomes

Vacuoles

Mitochondria

Chloroplasts

Peroxisomes

Centrosome

The Evolution of Eukaryotes

Study Outline

Study Questions

5 Microbial Metabolism

Catabolic and Anabolic Reactions

Enzymes

Collision Theory

Enzymes and Chemical Reactions

Enzyme Specificity and Efficiency

Naming Enzymes

Enzyme Components

Factors Influencing Enzymatic Activity

Feedback Inhibition

Ribozymes

Energy Production

Oxidation-Reduction Reactions

The Generation of ATP

Metabolic Pathways of Energy Production

Carbohydrate Catabolism

Glycolysis

Additional Pathways to Glycolysis

Cellular Respiration

Fermentation

Lipid and Protein Catabolism

Biochemical Tests and Bacterial Identification

Photosynthesis

The Light-Dependent Reactions: Photophosphorylation

The Light-Independent Reactions: The Calvin-Benson Cycle

A Summary of Energy Production Mechanisms

Metabolic Diversity among Organisms

Photoautotrophs

Table of Contents

Photoheterotrophs

Chemoautotrophs

Chemoheterotrophs

Metabolic Pathways of Energy Use

Polysaccharide Biosynthesis

Lipid Biosynthesis

Amino Acid and Protein Biosynthesis

Purine and Pyrimidine Biosynthesis

The Integration of Metabolism

Study Outline

Study Questions

6 Microbial Growth

The Requirements for Growth

Physical Requirements

Chemical Requirements

Biofilms

Culture Media

Chemically Defined Media

Complex Media

Anaerobic Growth Media and Methods

Special Culture Techniques

Selective and Differential Media

Enrichment Culture

Obtaining Pure Cultures

Preserving Bacterial Cultures

The Growth of Bacterial Cultures

Bacterial Division

Generation Time

Logarithmic Representation of Bacterial Populations

Phases of Growth

Direct Measurement of Microbial Growth

Estimating Bacterial Numbers by Indirect Methods

Study Outline

Study Questions

7 The Control of Microbial Growth

The Terminology of Microbial Control

The Rate of Microbial Death

Actions of Microbial Control Agents

Alteration of Membrane Permeability

Table of Contents

Damage to Proteins and Nucleic Acids

Physical Methods of Microbial Control

Heat

Filtration

Low Temperatures

High Pressure

Desiccation

Osmotic Pressure

Radiation

Chemical Methods of Microbial Control

Principles of Effective Disinfection

Evaluating a Disinfectant

Types of Disinfectants

Microbial Characteristics and Microbial Control

Study Outline

Study Questions

8 Microbial Genetics

Structure and Function of the Genetic Material

Genotype and Phenotype

DNA and Chromosomes

The Flow of Genetic Information

DNA Replication

RNA and Protein Synthesis

The Regulation of Bacterial Gene Expression

Pre-transcriptional Control

Post-transcriptional Control

Changes in Genetic Material

Mutation

Types of Mutations

Mutagens

The Frequency of Mutation

Identifying Mutants

Identifying Chemical Carcinogens

Genetic Transfer and Recombination

Plasmids and Transposons

Transformation in Bacteria

Conjugation in Bacteria

Transduction in Bacteria

Genes and Evolution

Study Outline

Table of Contents

Study Questions

9 Biotechnology and DNA Technology

Introduction to Biotechnology

Recombinant DNA Technology

An Overview of Recombinant DNA Procedures

Tools of Biotechnology

Selection

Mutation

Restriction Enzymes

Vectors

Polymerase Chain Reaction

Techniques of Genetic Modification

Inserting Foreign DNA into Cells

Obtaining DNA

Selecting a Clone

Making a Gene Product

Applications of DNA Technology

Therapeutic Applications

Genome Projects

Scientific Applications

Agricultural Applications

Safety Issues and the Ethics of Using DNA Technology

Study Outline

Study Questions

PART TWO A Survey of the Microbial World

10 Classification of Microorganisms

The Study of Phylogenetic Relationships

The Three Domains

A Phylogenetic Tree

Classification of Organisms

Scientific Nomenclature

The Taxonomic Hierarchy

Classification of Prokaryotes

Classification of Eukaryotes

Classification of Viruses

Methods of Classifying and Identifying Microorganisms

Morphological Characteristics

Differential Staining

Biochemical Tests

Serology

Table of Contents

- Phage Typing
- Fatty Acid Profiles
- Flow Cytometry
- DNA Sequencing
- DNA Fingerprinting
- Nucleic Acid Hybridization
- Putting Classification Methods Together

Study Outline

Study Questions

11 The Prokaryotes: Domains Bacteria and Archaea

The Prokaryotic Groups

DOMAIN BACTERIA

Gram-Negative Bacteria

- Proteobacteria
- The Nonproteobacteria Gram-Negative Bacteria

The Gram-Positive Bacteria

- Firmicutes (Low G + C Gram-Positive Bacteria)
- Tenericutes
- Actinobacteria (High G + C Gram-Positive Bacteria)

DOMAIN ARCHAEA

Diversity within the Archaea

MICROBIAL DIVERSITY

Discoveries Illustrating the Range of Diversity

Study Outline

Study Questions

12 The Eukaryotes: Fungi, Algae, Protozoa, and Helminths

Fungi

- Characteristics of Fungi
- Medically Important Fungi
- Fungal Diseases
- Economic Effects of Fungi

Lichens

Algae

- Characteristics of Algae
- Selected Phyla of Algae
- Roles of Algae in Nature

Protozoa

- Characteristics of Protozoa
- Medically Important Protozoa

Table of Contents

Slime Molds

Helminths

Characteristics of Helminths

Platyhelminths

Nematodes

Arthropods as Vectors

Study Outline

Study Questions

13 Viruses, Viroids, and Prions

General Characteristics of Viruses

Host Range

Viral Size

Viral Structure

Nucleic Acid

Capsid and Envelope

General Morphology

Taxonomy of Viruses

Isolation, Cultivation, and Identification of Viruses

Growing Bacteriophages in the Laboratory

Growing Animal Viruses in the Laboratory

Viral Identification

Viral Multiplication

Multiplication of Bacteriophages

Multiplication of Animal Viruses

Viruses and Cancer

The Transformation of Normal Cells into Tumor Cells

DNA Oncogenic Viruses

RNA Oncogenic Viruses

Viruses to Treat Cancer

Latent Viral Infections

Persistent Viral Infections

Plant Viruses and Viroids

Prions

Study Outline

Study Questions

PART THREE Interaction between Microbe and Host

14 Principles of Disease and Epidemiology

Pathology, Infection, and Disease

Table of Contents

Human Microbiome

- Relationships between the Normal Microbiota and the Host
- Opportunistic Microorganisms
- Cooperation among Microorganisms

The Etiology of Infectious Diseases

- Kochs Postulates
- Exceptions to Koch's Postulates

Classifying Infectious Diseases

- Occurrence of a Disease
- Severity or Duration of a Disease
- Extent of Host Involvement

Patterns of Disease

- Predisposing Factors
- Development of Disease

The Spread of Infection

- Reservoirs of Infection
- Transmission of Disease

Healthcare-Associated Infections (HAIs)

- Microorganisms in the Hospital
- Compromised Host
- Chain of Transmission
- Control of Healthcare-Associated Infections

Emerging Infectious Diseases

Epidemiology

- Descriptive Epidemiology
- Analytical Epidemiology
- Experimental Epidemiology
- Case Reporting
- The Centers for Disease Control and Prevention (CDC)

Study Outline

Study Questions

15 Microbial Mechanisms of Pathogenicity

How Microorganisms Enter a Host

- Portals of Entry
- The Preferred Portal of Entry
- Numbers of Invading Microbes
- Adherence

How Bacterial Pathogens Penetrate Host Defenses

- Capsules
- Cell Wall Components

Table of Contents

Enzymes

Antigenic Variation

Penetration into the Host

Biofilms

How Bacterial Pathogens Damage Host Cells

Using the Host's Nutrients: Siderophores

Direct Damage

Production of Toxins

Plasmids, Lysogeny, and Pathogenicity

Pathogenic Properties of Viruses

Viral Mechanisms for Evading Host Defenses

Cytopathic Effects of Viruses

Pathogenic Properties of Fungi, Protozoa, Helminths, and Algae

Fungi

Protozoa

Helminths

Algae

Portals of Exit

Study Outline

Study Questions

16 Innate Immunity: Nonspecific Defenses of the Host

The Concept of Immunity

FIRST LINE OF DEFENSE: SKIN AND MUCOUS MEMBRANES

Physical Factors

Chemical Factors

Normal Microbiota and Innate Immunity

SECOND LINE OF DEFENSE

Formed Elements in Blood

The Lymphatic System

Phagocytes

Actions of Phagocytic Cells

The Mechanism of Phagocytosis

Inflammation

Vasodilation and Increased Permeability of Blood Vessels

Phagocyte Migration and Phagocytosis

Tissue Repair

Fever

Antimicrobial Substances

The Complement System

Table of Contents

Interferons

Iron-Binding Proteins

Antimicrobial Peptides

Other Factors

Study Outline

Study Questions

17 Adaptive Immunity: Specific Defenses of the Host

The Adaptive Immune System

Dual Nature of the Adaptive Immune System

Overview of Humoral Immunity

Overview of Cellular Immunity

Cytokines: Chemical Messengers of Immune Cells

Antigens and Antibodies

Antigens

Humoral Immunity: Antibodies

Humoral Immunity Response Process

Activation and Clonal Expansion of Antibody-Producing Cells

The Diversity of Antibodies

Results of the AntigenAntibody Interaction

Cellular Immunity Response Process

Antigen-Presenting Cells (APCs)

Classes of T Cells

Nonspecific Cells and Extracellular Killing by the Adaptive Immune System

Immunological Memory

Types of Adaptive Immunity

Study Outline

Study Questions

18 Practical Applications of Immunology

Vaccines

Principles and Effects of Vaccination

Types of Vaccines and Their Characteristics

Vaccine Production, Delivery Methods, and Formulations

Diagnostic Immunology

Use of Monoclonal Antibodies

Precipitation Reactions

Agglutination Reactions

Neutralization Reactions

Complement-Fixation Reactions

Fluorescent-Antibody Techniques

Table of Contents

Enzyme-Linked Immunosorbent Assay (ELISA)

Western Blotting (Immunoblotting)

The Future of Diagnostic and Therapeutic Immunology

Study Outline

Study Questions

19 Disorders Associated with the Immune System

Hypersensitivity

Allergies and the Microbiome

Type I (Anaphylactic) Reactions

Type II (Cytotoxic) Reactions

Type III (Immune Complex) Reactions

Type IV (Delayed Cell-Mediated) Reactions

Autoimmune Diseases

Cytotoxic Autoimmune Reactions

Immune Complex Autoimmune Reactions

Cell-Mediated Autoimmune Reactions

Reactions to Transplantation

Immunosuppression to Prevent Transplant Rejection

The Immune System and Cancer

Immunotherapy for Cancer

Immunodeficiencies

Congenital Immunodeficiencies

Acquired Immunodeficiencies

Acquired Immunodeficiency Syndrome (AIDS)

The Origin of AIDS

HIV Infection

Diagnostic Methods

HIV Transmission

AIDS Worldwide

Preventing and Treating AIDS

Study Outline

Study Questions

20 Antimicrobial Drugs

The History of Chemotherapy

Antibiotic Use and Discovery Today

Spectrum of Antimicrobial Activity

The Action of Antimicrobial Drugs

Inhibiting Cell Wall Synthesis

Inhibiting Protein Synthesis

Injuring the Plasma Membrane

Table of Contents

Inhibiting Nucleic Acid Synthesis

Inhibiting the Synthesis of Essential Metabolites

Common Antimicrobial Drugs

Antibacterial Antibiotics: Inhibitors of Cell Wall Synthesis

Inhibitors of Protein Synthesis

Injury to Membranes

Nucleic Acid Synthesis Inhibitors

Competitive Inhibition of Essential Metabolites

Antifungal Drugs

Antiviral Drugs

Antiprotozoan and Anthelmintic Drugs

Tests to Guide Chemotherapy

The Diffusion Methods

Broth Dilution Tests

Resistance to Antimicrobial Drugs

Mechanisms of Resistance

Antibiotic Misuse

Cost and Prevention of Resistance

Antibiotic Safety

Effects of Combinations of Drugs

Future of Chemotherapeutic Agents

Study Outline

Study Questions

PART FOUR Microorganisms and Human Disease

21 Microbial Diseases of the Skin and Eyes

Structure and Function of the Skin

Mucous Membranes

Normal Microbiota of the Skin

Microbial Diseases of the Skin

Bacterial Diseases of the Skin

Viral Diseases of the Skin

Fungal Diseases of the Skin and Nails

Parasitic Infestation of the Skin

Microbial Diseases of the Eye

Inflammation of the Eye Membranes: Conjunctivitis

Bacterial Diseases of the Eye

Other Infectious Diseases of the Eye

Study Outline

Study Questions

Table of Contents

22 Microbial Diseases of the Nervous System

Structure and Function of the Nervous System

Bacterial Diseases of the Nervous System

Bacterial Meningitis

Tetanus

Botulism

Leprosy

Viral Diseases of the Nervous System

Poliomyelitis

Rabies

Arboviral Encephalitis

Fungal Disease of the Nervous System

Cryptococcus neoformans Meningitis (Cryptococcosis)

Protozoan Diseases of the Nervous System

African Trypanosomiasis

Amebic Meningoencephalitis

Nervous System Diseases Caused by Prions

Bovine Spongiform Encephalopathy and Variant Creutzfeldt-Jakob Disease

Diseases Caused by Unidentified Agents

Study Outline

Study Questions

23 Microbial Diseases of the Cardiovascular and Lymphatic Systems

Structure and Function of the Cardiovascular and Lymphatic Systems

Bacterial Diseases of the Cardiovascular and Lymphatic Systems

Sepsis and Septic Shock

Bacterial Infections of the Heart

Rheumatic Fever

Tularemia

Brucellosis (Undulant Fever)

Anthrax

Gangrene

Systemic Diseases Caused by Bites and Scratches

Vector-Transmitted Diseases

Viral Diseases of the Cardiovascular and Lymphatic Systems

Burkitts Lymphoma

Infectious Mononucleosis

Other Diseases and Epstein-Barr Virus

Cytomegalovirus Infections

Chikungunya

Classic Viral Hemorrhagic Fevers

Table of Contents

Emerging Viral Hemorrhagic Fevers

Protozoan Diseases of the Cardiovascular and Lymphatic Systems

Chagas Disease (American Trypanosomiasis)

Toxoplasmosis

Malaria

Leishmaniasis

Babesiosis

Helminthic Disease of the Cardiovascular and Lymphatic Systems

Schistosomiasis

Disease of Unknown Etiology

Kawasaki Syndrome

Study Outline

Study Questions

24 Microbial Diseases of the Respiratory System

Structure and Function of the Respiratory System

Normal Microbiota of the Respiratory System

MICROBIAL DISEASES OF THE UPPER RESPIRATORY SYSTEM

Bacterial Diseases of the Upper Respiratory System

Streptococcal Pharyngitis (Strep Throat)

Scarlet Fever

Diphtheria

Otitis Media

Viral Disease of the Upper Respiratory System

The Common Cold

MICROBIAL DISEASES OF THE LOWER RESPIRATORY SYSTEM

Bacterial Diseases of the Lower Respiratory System

Pertussis (Whooping Cough)

Tuberculosis

Bacterial Pneumonias

Melioidosis

Viral Diseases of the Lower Respiratory System

Viral Pneumonia

Respiratory Syncytial Virus (RSV)

Influenza (Flu)

Fungal Diseases of the Lower Respiratory System

Histoplasmosis

Coccidioidomycosis

Pneumocystis Pneumonia

Blastomycosis (North American Blastomycosis)

Other Fungi Involved in Respiratory Disease

Table of Contents

Study Outline

Study Questions

25 Microbial Diseases of the Digestive System

Structure and Function of the Digestive System

Normal Microbiota of the Digestive System

Bacterial Diseases of the Mouth

Dental Caries (Tooth Decay)

Periodontal Disease

Bacterial Diseases of the Lower Digestive System

Staphylococcal Food Poisoning (Staphylococcal Enterotoxigenesis)

Shigellosis (Bacillary Dysentery)

Salmonellosis (Salmonella Gastroenteritis)

Typhoid Fever

Cholera

Noncholera Vibrios

Escherichia coli Gastroenteritis

Campylobacteriosis (Campylobacter Gastroenteritis)

Helicobacter Peptic Ulcer Disease

Yersinia Gastroenteritis

Clostridium perfringens Gastroenteritis

Clostridium difficileAssociated Diarrhea

Bacillus cereus Gastroenteritis

Viral Diseases of the Digestive System

Mumps

Hepatitis

Viral Gastroenteritis

Fungal Diseases of the Digestive System

Protozoan Diseases of the Digestive System

Giardiasis

Cryptosporidiosis

Cyclosporiasis

Amebic Dysentery (Amebiasis)

Helminthic Diseases of the Digestive System

Tapeworms

Hydatid Disease

Nematodes

Study Outline

Study Questions

26 Microbial Diseases of the Urinary and Reproductive Systems

Structure and Function of the Urinary System

Table of Contents

Structure and Function of the Reproductive Systems

Normal Microbiota of the Urinary and Reproductive Systems

DISEASES OF THE URINARY SYSTEM

Bacterial Diseases of the Urinary System

Cystitis

Pyelonephritis

Leptospirosis

DISEASES OF THE REPRODUCTIVE SYSTEMS

Bacterial Diseases of the Reproductive Systems

Gonorrhea

Nongonococcal Urethritis (NGU)

Pelvic Inflammatory Disease (PID)

Syphilis

Lymphogranuloma Venereum (LGV)

Chancroid (Soft Chancre)

Bacterial Vaginosis

Viral Diseases of the Reproductive Systems

Genital Herpes

Genital Warts

AIDS

Fungal Disease of the Reproductive Systems

Candidiasis

Protozoan Disease of the Reproductive Systems

Trichomoniasis

Study Outline

Study Questions

PART FIVE Environmental and Applied Microbiology

27 Environmental Microbiology

Microbial Diversity and Habitats

Symbiosis

Soil Microbiology and Biogeochemical Cycles

The Carbon Cycle

The Nitrogen Cycle

The Sulfur Cycle

Life without Sunshine

The Phosphorus Cycle

The Degradation of Synthetic Chemicals in Soil and Water

Aquatic Microbiology and Sewage Treatment

Aquatic Microorganisms

The Role of Microorganisms in Water Quality

Table of Contents

Water Treatment

Sewage (Wastewater) Treatment

Study Outline

Study Questions

28 Applied and Industrial Microbiology

Food Microbiology

Foods and Disease

Industrial Food Canning

Aseptic Packaging

Radiation and Industrial Food Preservation

High-Pressure Food Preservation

The Role of Microorganisms in Food Production

Industrial Microbiology and Biotechnology

Fermentation Technology

Industrial Products

Alternative Energy Sources Using Microorganisms

Biofuels

Industrial Microbiology and the Future

Study Outline

Study Questions

Answers to Knowledge and Comprehension Study Questions

Appendix A Metabolic Pathways

Appendix B Exponents, Exponential Notation, Logarithms, and Generation Time

Appendix C Methods for Taking Clinical Samples

Appendix D Pronunciation Rules and Word Roots

Appendix E Classification of Prokaryotes According to Bergeys Manual

Glossary

A

B

C

D

E

F

G

H

I

Table of Contents

K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z

Credits
Trademark Attributions
Index
Back Cover