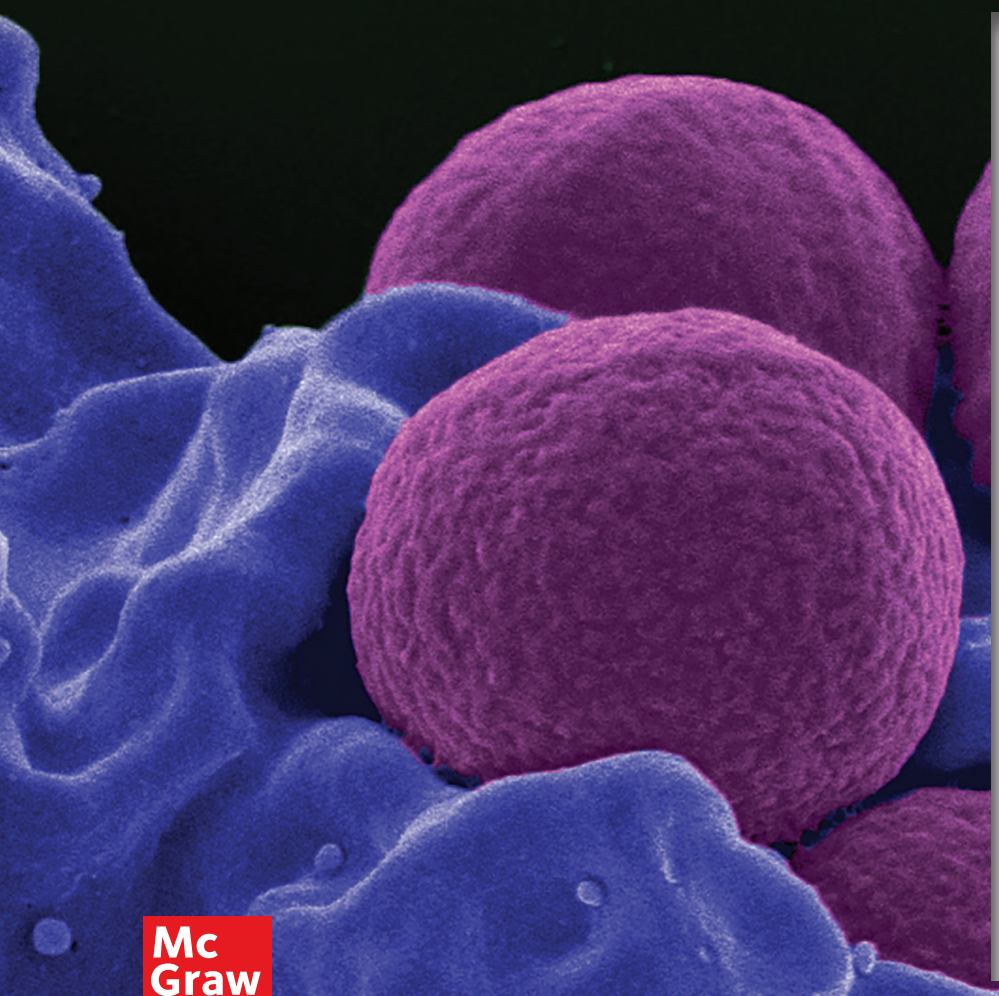
2024 RELEASE

Nester's Microbiology

A HUMAN PERSPECTIVE

Denise Anderson | Sarah Salm | Mira Beins | Ann Auman | Jennifer Walker



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Brief Contents

About the Authors

The Nester Team:

Different Perspectives, One Vision, One Voice

The authors of this edition may be a set of individuals with different insights and unique experiences, but their cooperative relationship defines the word "team." What drives them is a single shared goal: to create the most learning-friendly and up-to-date microbiology textbook available. Each chapter was edited with students in mind, using simpler words where appropriate while maintaining the scientific rigor so important for today's healthcare professionals.

Courtesy of Richard Moore

Denise Anderson

Denise Anderson is a Senior Lecturer Emeritus in the Department of Microbiology at the University of Washington, where for over 30 years she taught a variety of courses, including general microbiology, medical bacteriology laboratory, recombinant DNA techniques, and medical mycology/parasitology laboratory. Equipped with a diverse educational background, including undergraduate work in nutrition and graduate work in food science and in microbiology, she first discovered a passion for teaching when she taught microbiology laboratory courses as part of her graduate training. Her enthusiastic teaching style, fueled by regular doses of Seattle's famous coffee, received high reviews from her students.

Denise now relaxes in the Yorkshire Dales of England, where she lives with her husband, Richard Moore. When not editing textbook chapters, she can usually be found walking scenic footpaths, chatting with friends, fighting weeds in her garden, or enjoying a fermented beverage at the local pub.

Courtesy of Sandy Coetzee

Sarah Salm

Sarah Salm, the digital author, is a Professor at the Borough of Manhattan Community College (BMCC) of the City University of New York, where she primarily teaches microbiology. She earned her undergraduate and doctoral degrees at the University of the Witwatersrand in Johannesburg, South Africa. She moved to New York, where she did postdoctoral work at the NYU Grossman School of Medicine. Her research background is diverse and includes plant virology, prostate cancer, and bacteria in contaminated water. Sarah frequently escapes the busy city to hike with friends and family.

Courtesy of Mira Beins

Mira Beins

Mira Beins is an Associate Teaching Professor in the Department of Microbiology at the University of Washington, where she teaches general microbiology, medical bacteriology, and medical mycology/parasitology. She completed her undergraduate studies in molecular biology and biotechnology at the University of the Philippines before moving to Wisconsin for graduate work in microbiology. Her graduate and postdoctoral research both focused on virology, which solidified her belief that viruses are amazing—although she now begrudgingly admits that bacteria, fungi, and eukaryotic parasites are pretty cool, too.

Mira lives in Seattle with her husband Mike and two kids, Maya and Noah. When she's not busy teaching or driving the kids to their many activities, she enjoys reading books, watching movies, hanging out with friends and family, and planning the next family trip (which Denise hopes will be to the Yorkshire Dales!).

Courtesy of John Froschauer/PLU

Ann Auman

Ann Auman is a Professor of Biology at Pacific Lutheran University (PLU) in Tacoma, WA. After earning her undergraduate degrees in microbiology and molecular and cell biology from the Pennsylvania State University, Ann completed a PhD in microbiology at the University of Washington. There, her thesis research included analyzing microbial communities using culture-independent methods. During her 20+ year teaching career, Ann has primarily taught microbiology and introductory biology courses. As a microbial ecologist, Ann's professional interests focus on understanding microbes' many contributions to global processes as well as the products they make that may be of biotechnological significance.

Ann lives in Kent, WA, with her partner Jeff and is now preparing for an empty nest as her two kids Rebecca and Josh transition into their next phases of life. Away from campus, she enjoys hanging out with her kids, going on walks with her partner and friends, reading and discussing books, and traveling (which Denise hopes will include a visit to the Yorkshire Dales!).

Courtesy of Kate Walker

Jennifer Walker

Jennifer Walker is a Senior Lecturer and the Undergraduate Coordinator for the Microbiology Department at the University of Georgia. Jennifer earned her B.S. in biology at UGA and then fell in love with microbiology after working as a lab technician for a year. She promptly returned to UGA to earn her PhD while studying peptide drug stability motifs and the Gram-negative biotin uptake system as a potential transporter for peptide antimicrobials. While working as a teaching assistant, Jennifer discovered her passion for education and thus combined her love of microbiology with instruction. Along with teaching introductory and upper-level undergraduate microbiology courses, Jennifer works with an amazing team of faculty and staff that mentor and challenge microbiology students to pursue their dreams.

Jennifer lives in Watkinsville with her husband, John, and her four teenage daughters. You can find Jennifer and her family in the fall rooting for the Dawgs at Saturday football games. She also enjoys sewing and working on her yard if she's not attending a pole vault meet, musical performance, volleyball scrimmage, or church event with her family.

Courtesy of Eugene Nester

Eugene Nester

Gene (Eugene) Nester was instrumental in establishing the text's reputation for excellence over the decades. Although no longer an active member of the author team, he wrote the original version of the present text with Evans Roberts and Nancy Pearsall more than 30 years ago. That text, *Microbiology: Molecules, Microbes and Man,* pioneered the organ system approach to the study of infectious disease and was developed specifically for allied health sciences.

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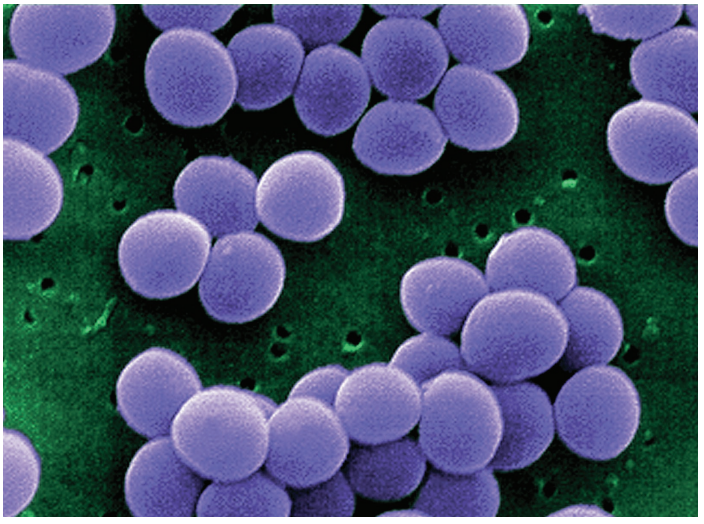

Janice Haney Carr/CDC

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Test Builder allows you to:

- access all test bank content from a particular title.
- easily pinpoint the most relevant content through robust filtering options.
- manipulate the order of questions or scramble questions and/or answers.
- pin questions to a specific location within a test.
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- Including more diverse voices in the development and review of our content.
- Strengthening art guidelines to improve accessibility by ensuring that meaningful text and images are distinguishable and perceivable by users with limited color vision and moderately low vision.

FOCUS ON UNDERSTANDING . . .

Student-Friendly Illustrations

Introduce the "big picture"

Focus figures provide an overview or highlight a key concept.

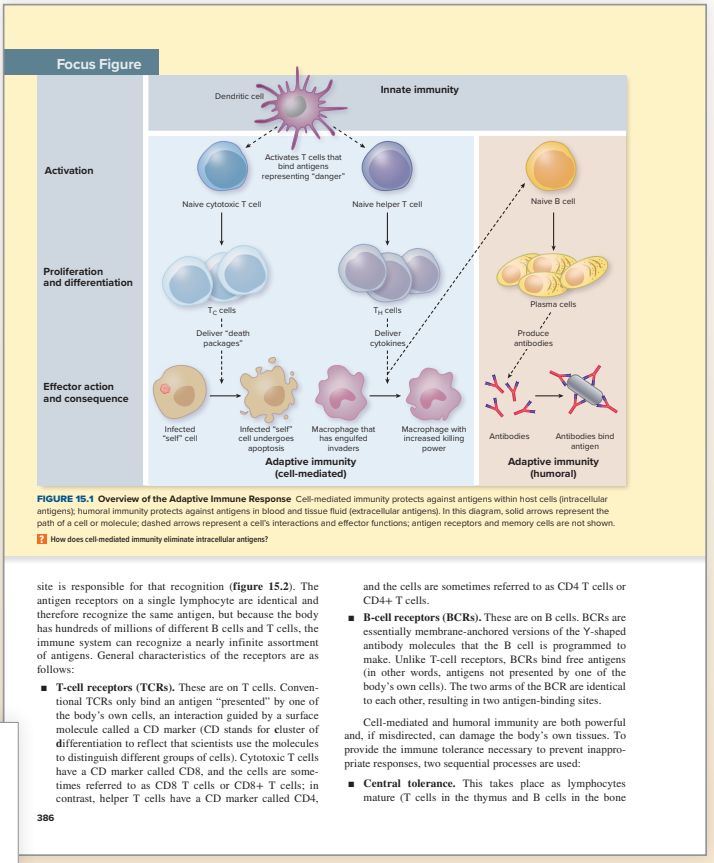

FIGURE 15.1 Overview of the Adaptive Immune Response Cell-mediated immunity protects against antigens within host cells (intracellular antigens); humoral immunity protects against antigens in blood and tissue fluid (extracellular antigens). In this diagram, solid arrows represent the path of a cell or molecule; dashed arrows represent a cell's interactions and effector functions; antigen receptors and memory cells are not shown.

? How does cell-mediated immunity eliminate intracellular antigens?

site is responsible for that recognition (**figure 15.2**). The antigen receptors on a single lymphocyte are identical and therefore recognize the same antigen, but because the body has hundreds of millions of different B cells and T cells, the immune system can recognize a nearly infinite assortment of antigens. General characteristics of the receptors are as follows:

- **T-cell receptors (TCRs).** These are on T cells. Conventional TCRs only bind an antigen "presented" by one of the body's own cells, an interaction guided by a surface molecule called a CD marker (CD stands for **c**luster of **d**ifferentiation to reflect that scientists use the molecules to distinguish different groups of cells). Cytotoxic T cells have a CD marker called CD8, and the cells are sometimes referred to as CD8 T cells or CD8+ T cells; in contrast, helper T cells have a CD marker called CD4, and the cells are sometimes referred to as CD4 T cells or CD4+ T cells.
- **B-cell receptors (BCRs).** These are on B cells. BCRs are essentially membrane-anchored versions of the Y-shaped antibody molecules that the B cell is programmed to make. Unlike T-cell receptors, BCRs bind free antigens (in other words, antigens not presented by one of the body's own cells). The two arms of the BCR are identical to each other, resulting in two antigen-binding sites.

Cell-mediated and humoral immunity are both powerful and, if misdirected, can damage the body's own tissues. To provide the immune tolerance necessary to prevent inappropriate responses, two sequential processes are used:

- **Central tolerance.** This takes place as lymphocytes mature (T cells in the thymus and B cells in the bone

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Keep the big picture in focus

A highlighted mini-version of the overview figure is often incorporated into the upper left corner of subsequent figures, helping students see how those figures fit into the big picture.

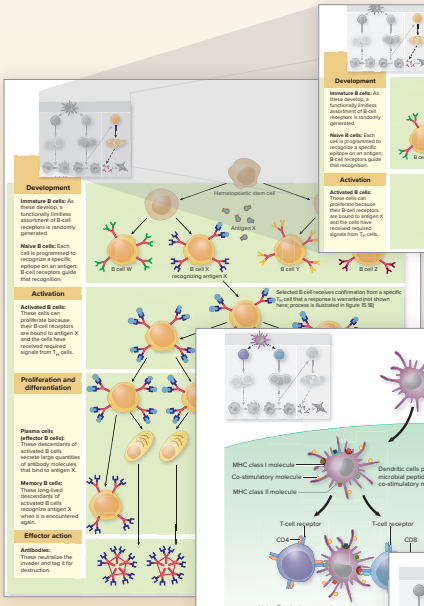


FIGURE 15.10

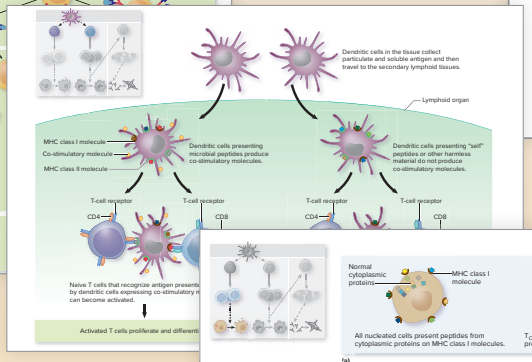


FIGURE 15.13

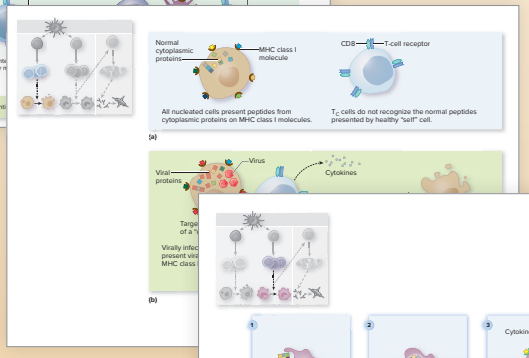


FIGURE 15.14

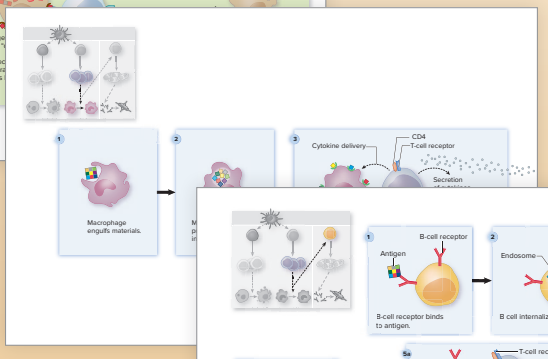


FIGURE 15.16

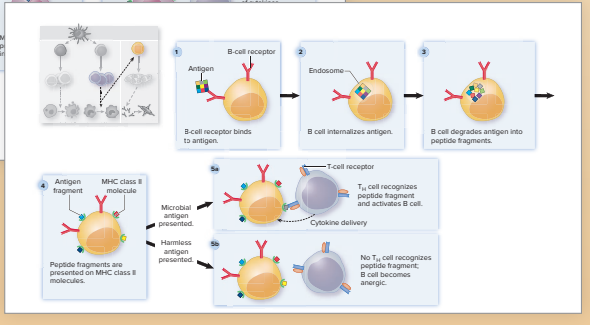


FIGURE 15.18

"Provides a logical unfolding conceptual framework that fosters better understanding."

—Jamal Bittar, University of Toledo

FOCUS ON UNDERSTANDING . . .

Walk through the processes

Step-by-step figures direct the student using numbered icons, often with corresponding icons in the text.

> *"The text and illustrations are 'tight' and give each other good support."*
>
> —Richard Shipee, Vincennes University

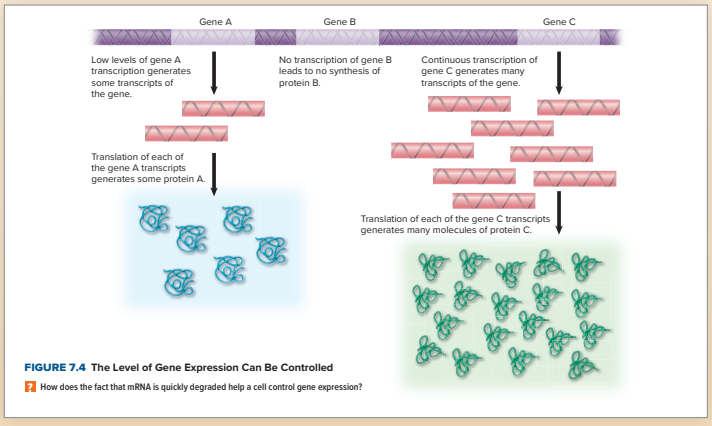
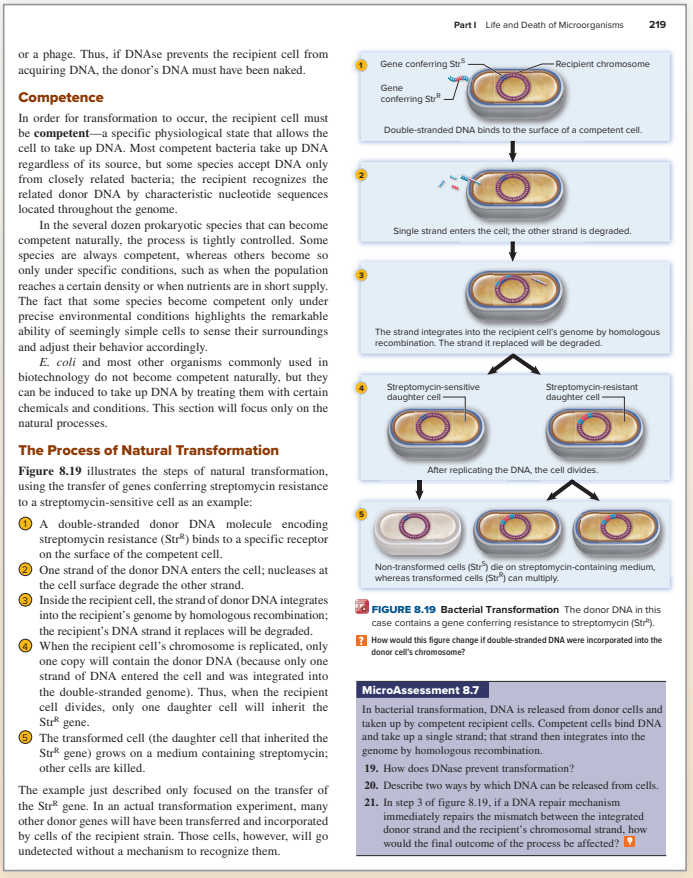


FIGURE 7.4 The Level of Gene Expression Can Be Controlled

How does the fact that mRNA is quickly degraded help a cell control gene expression?

Introduce the body systems

Each disease chapter includes a stunning figure that introduces the students to the anatomy of the body system.



or a phage. Thus, if DNAse prevents the recipient cell from acquiring DNA, the donor's DNA must have been naked.

Competence

In order for transformation to occur, the recipient cell must be **competent**—a specific physiological state that allows the cell to take up DNA. Most competent bacteria take up DNA regardless of its source, but some species accept DNA only from closely related bacteria; the recipient recognizes the related donor DNA by characteristic nucleotide sequences located throughout the genome.

In the several dozen prokaryotic species that can become competent naturally, the process is tightly controlled. Some species are always competent, whereas others become so only under specific conditions, such as when the population reaches a certain density or when nutrients are in short supply. The fact that some species become competent only under precise environmental conditions highlights the remarkable ability of seemingly simple cells to sense their surroundings and adjust their behavior accordingly.

E. coli and most other organisms commonly used in biotechnology do not become competent naturally, but they can be induced to take up DNA by treating them with certain chemicals and conditions. This section will focus only on the natural processes.

The Process of Natural Transformation

Figure 8.19 illustrates the steps of natural transformation, using the transfer of genes conferring streptomycin resistance to a streptomycin-sensitive cell as an example:

1. A double-stranded donor DNA molecule encoding streptomycin resistance (Str^R) binds to a specific receptor on the surface of the competent cell.
2. One strand of the donor DNA enters the cell; nucleases at the cell surface degrade the other strand.
3. Inside the recipient cell, the strand of donor DNA integrates into the recipient's genome by homologous recombination; the recipient's DNA strand it replaces will be degraded.
4. When the recipient cell's chromosome is replicated, only one copy will contain the donor DNA (because only one strand of DNA entered the cell and was integrated into the double-stranded genome). Thus, when the recipient cell divides, only one daughter cell will inherit the Str^R gene.
5. The transformed cell (the daughter cell that inherited the Str^R gene) grows on a medium containing streptomycin; other cells are killed.

The example just described only focused on the transfer of the Str^R gene. In an actual transformation experiment, many other donor genes will have been transferred and incorporated by cells of the recipient strain. Those cells, however, will go undetected without a mechanism to recognize them.

FIGURE 8.19 Bacterial Transformation The donor DNA in this case contains a gene conferring resistance to streptomycin (Str^R).

How would this figure change if double-stranded DNA were incorporated into the donor cell's chromosome?

MicroAssessment 8.7

In bacterial transformation, DNA is released from donor cells and taken up by competent recipient cells. Competent cells bind DNA and take up a single strand; that strand then integrates into the genome by homologous recombination.

19. How does DNase prevent transformation?
20. Describe two ways by which DNA can be released from cells.
21. In step 3 of figure 8.19, if a DNA repair mechanism immediately repairs the mismatch between the integrated donor strand and the recipient's chromosomal strand, how would the final outcome of the process be affected?

Encourage deeper understanding

Figures have accompanying questions that encourage students to think more carefully about the concept illustrated in a figure.

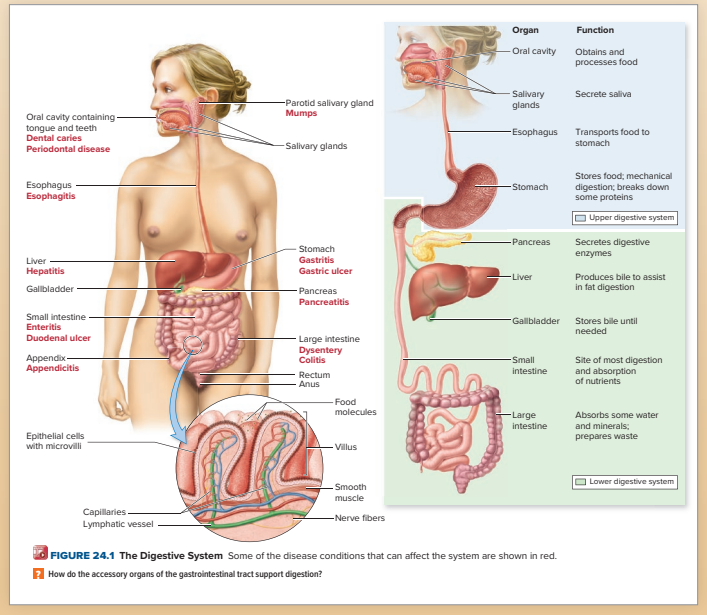


FIGURE 24.1 The Digestive System Some of the disease conditions that can affect the system are shown in red.

How do the accessory organs of the gastrointestinal tract support digestion?

Student-Friendly Chapter Features

Provide the tools for understanding

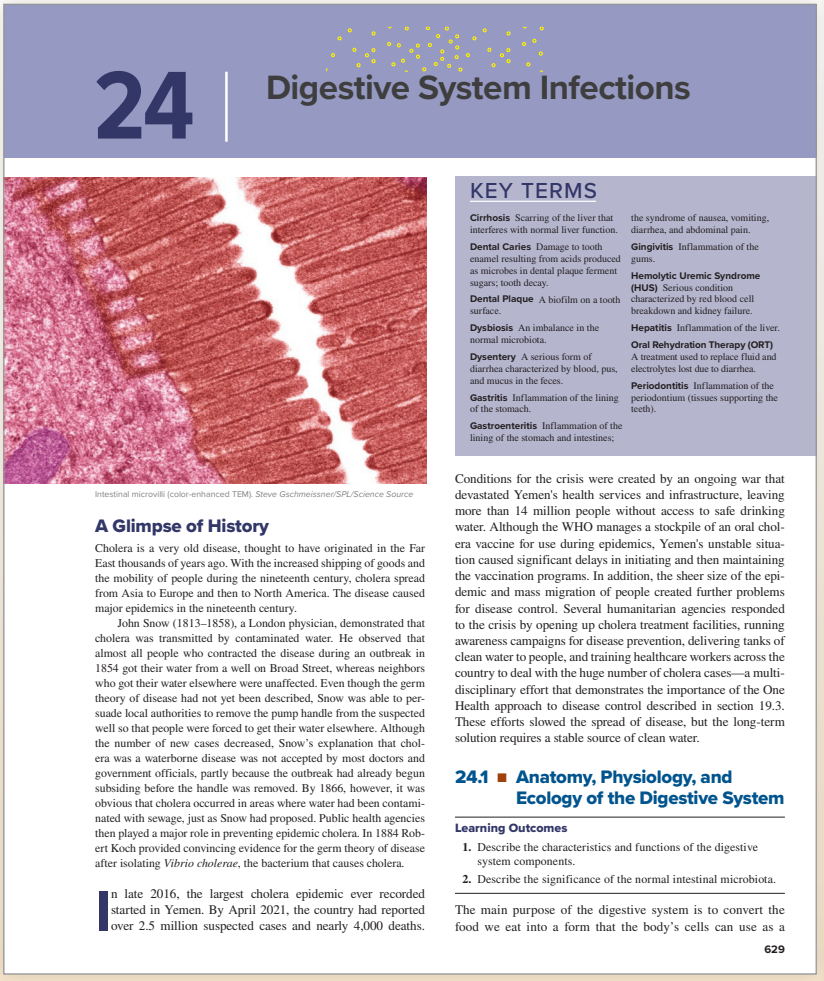
Key Terms for each chapter are defined on the opening page.

Share the history

A **Glimpse of History** opens each chapter, featuring engaging stories about the people who pioneered the field of microbiology.

Define the expectations

Learning outcomes are found at the beginning of each numbered section, allowing organization, evaluation, and assessment of instruction.



24 Digestive System Infections

Intestinal microvilli (color-enhanced TEM). *Steve Gschmeissner/SPL/Science Source*

A Glimpse of History

Cholera is a very old disease, thought to have originated in the Far East thousands of years ago. With the increased shipping of goods and the mobility of people during the nineteenth century, cholera spread from Asia to Europe and then to North America. The disease caused major epidemics in the nineteenth century.

John Snow (1813–1858), a London physician, demonstrated that cholera was transmitted by contaminated water. He observed that almost all people who contracted the disease during an outbreak in 1854 got their water from a well on Broad Street, whereas neighbors who got their water elsewhere were unaffected. Even though the germ theory of disease had not yet been described, Snow was able to persuade local authorities to remove the pump handle from the suspected well so that people were forced to get their water elsewhere. Although the number of new cases decreased, Snow's explanation that cholera was a waterborne disease was not accepted by most doctors and government officials, partly because the outbreak had already begun subsiding before the handle was removed. By 1866, however, it was obvious that cholera occurred in areas where water had been contaminated with sewage, just as Snow had proposed. Public health agencies then played a major role in preventing epidemic cholera. In 1884 Robert Koch provided convincing evidence for the germ theory of disease after isolating *Vibrio cholerae*, the bacterium that causes cholera.

In late 2016, the largest cholera epidemic ever recorded started in Yemen. By April 2021, the country had reported over 2.5 million suspected cases and nearly 4,000 deaths.

KEY TERMS

Cirrhosis Scarring of the liver that interferes with normal liver function.
Dental Caries Damage to tooth enamel resulting from acids produced as microbes in dental plaque ferment sugars; tooth decay.
Dental Plaque A biofilm on a tooth surface.
Dysbiosis An imbalance in the normal microbiota.
Dysentery A serious form of diarrhea characterized by blood, pus, and mucus in the feces.
Gastritis Inflammation of the lining of the stomach.
Gastroenteritis Inflammation of the lining of the stomach and intestines; the syndrome of nausea, vomiting, diarrhea, and abdominal pain.
Gingivitis Inflammation of the gums.
Hemolytic Uremic Syndrome (HUS) Serious condition characterized by red blood cell breakdown and kidney failure.
Hepatitis Inflammation of the liver.
Oral Rehydration Therapy (ORT) A treatment used to replace fluid and electrolytes lost due to diarrhea.
Periodontitis Inflammation of the periodontium (tissues supporting the teeth).

Conditions for the crisis were created by an ongoing war that devastated Yemen's health services and infrastructure, leaving more than 14 million people without access to safe drinking water. Although the WHO manages a stockpile of an oral cholera vaccine for use during epidemics, Yemen's unstable situation caused significant delays in initiating and then maintaining the vaccination programs. In addition, the sheer size of the epidemic and mass migration of people created further problems for disease control. Several humanitarian agencies responded to the crisis by opening up cholera treatment facilities, running awareness campaigns for disease prevention, delivering tanks of clean water to people, and training healthcare workers across the country to deal with the huge number of cholera cases—a multidisciplinary effort that demonstrates the importance of the One Health approach to disease control described in section 19.3. These efforts slowed the spread of disease, but the long-term solution requires a stable source of clean water.

24.1 ■ Anatomy, Physiology, and Ecology of the Digestive System

Learning Outcomes

1. Describe the characteristics and functions of the digestive system components.
2. Describe the significance of the normal intestinal microbiota.

The main purpose of the digestive system is to convert the food we eat into a form that the body's cells can use as a

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Assess understanding

A **MicroAssessment** at the end of each numbered section summarizes the concepts and includes review questions, usually featuring one that stimulates critical thinking (indicated by a light bulb icon).

MicroAssessment 3.2

Peptidoglycan is a molecule unique to bacteria that provides strength to the cell wall. The Gram-positive cell wall is composed of a relatively thick layer of peptidoglycan as well as teichoic acids. The Gram-negative cell wall has a thin layer of peptidoglycan and a lipopolysaccharide-containing outer membrane. Penicillin and lysozyme interfere with the structural integrity of peptidoglycan. *Mycoplasma* species lack a cell wall. Although archaea have a variety of cell wall types, most have S-layers.

4. What is the significance of lipid A?
5. How does the action of penicillin differ from that of lysozyme?
6. Explain why penicillin kills only actively multiplying cells, whereas lysozyme kills cells in any stage of growth.

Engage the reader

MicroBytes found throughout the chapter provide small "bytes" of information, capturing the reader's attention.

MicroByte

There are more bacteria in one person's mouth than there are people in the world!

FOCUS ON UNDERSTANDING . . .

Highlight the relevance

Focus on a Case boxes describe realistic clinical, veterinary, or environmental situations, along with questions and discussions designed to highlight the relevance of the information.

FOCUS ON A CASE 14.1

A 9-year-old boy with cystic fibrosis—a genetic disease that causes a number of problems, including the buildup of thick, sticky mucus in the lungs—complained of feeling tired, out of breath, and always coughing. When his mother took him to the doctor, she mentioned that his cough was productive, meaning that it contained sputum (pronounced *spew-tum*). She was particularly concerned that the sputum was a blue-green color. His doctor immediately suspected a *Pseudomonas aeruginosa* lung infection—a common complication of cystic fibrosis. A sputum sample was collected and sent to the clinical laboratory.

In the clinical laboratory, the sample was plated onto MacConkey agar and blood agar and incubated. Mucoid colonies surrounded by a bluish-green color grew on both types of agar media. The colonies on MacConkey had no pink coloration, so the medical technologist concluded that the cells did not fer-

The patient was treated with antibiotics, with only limited success. Like most cystic fibrosis patients, he developed a chronic lung infection that required repeated treatments.

1. What role did cystic fibrosis play in the disease process?
2. What is the significance of the mucoid phenotype of the colonies?
3. How would the siderophore (the iron-binding compound) benefit the bacterium?
4. Why would the boy's lung infection make his pre-existing respiratory problems even worse?

Discussion

1. Cystic fibrosis patients often have an accumulation of thick mucus in their

Pseudomonas aeruginosa cells to form biofilms. The biofilm protects the bacterial cells from various components of the immune system, including host defense peptides (antimicrobial peptides) and phagocytes. Bacteria growing within a biofilm are much more difficult for the immune system to destroy.

3. Siderophores help the bacterium obtain iron from the host. Recall that the body's iron-binding proteins (lactoferrin and transferrin) prevent microbes from using the host's iron supply and thereby limit their growth. Microorganisms that make siderophores essentially engage in a "tug-of-war" with the body over iron. That tug-of-war is especially important for *P. aeruginosa* because iron levels influence biofilm formation. When iron is limiting, *P. aeruginosa* cells are motile

FOCUS YOUR PERSPECTIVE 9.1

The COVID-19 Response—The Power of Biotechnology

The COVID-19 response is an excellent illustration of the power of biotechnology. Because of several technologies described in this chapter, the pandemic's global outcome—although devastating—resulted in fewer deaths than feared or predicted.

SARS-CoV-2, the virus that causes COVID-19, has an RNA genome. When the virus was first discovered in China, researchers used the enzyme reverse transcriptase to make a cDNA copy of its genome. That cDNA was then cloned and sequenced, and the information was shared with scientists around the world, initiating a global effort to control the disease.

A major part of any disease control effort is diagnosing patients who have the disease.

CRISPR-Cas-based tests that give results in under an hour. While the first version of this test was authorized for use only in certified laboratories, researchers are also developing instrument-free versions for on-site use.

Data obtained via high-throughput sequencing were used to track the global spread of SARS-CoV-2. The tracking methods rely on detecting spontaneous mutations that inevitably occur as the virus replicates; these mutations serve as evolutionary markers. For example, viral genomes from a cluster of early cases in the Seattle area all shared the same unusual mutation, indicating that they all descended from the same source (see Focus Your Perspective 21.1). Using

addition, the knowledge gained can hopefully be used to prevent a similar pandemic in the future.

The fact that the genome sequence of SARS-CoV-2 was known early on facilitated research aimed at developing targeted antiviral therapies as well as vaccines, as described in Focus on the Future 20.1. By analyzing the viral genome, scientists determined the amino acid sequences of key proteins essential for viral replication. Relatively soon thereafter, the three-dimensional structures of three of those proteins were determined—one that the virus uses to attach to and then enter host cells (its spike protein), one it uses to replicate its genome (its

FOCUS ON PNEUMONIA

Pneumonia is a disease of the lower respiratory tract caused by bacterial, viral, or fungal infection of the lungs; the infection elicits an inflammatory response, resulting in the alveoli (air sacs) filling with fluids such as pus and blood. Pneumonia is the leading cause of death due to infectious disease in the United States.

Signs and Symptoms

The signs and symptoms of pneumonia generally include cough, chills, shortness of breath, fever, and chest pain. In severe cases, the patient may develop cyanosis (bluish skin color) due to poor blood oxygenation. Pneumonia ranges from mild to life-threatening, depending largely on the causative agent but also on any underlying health problems of the patient. It is often accompanied by a productive cough, meaning that a pus- and mucus-containing fluid called **sputum** comes up from the lungs.

Some pathogens cause what are referred to as atypical pneumonias, not because the diseases are uncommon, but because the symptoms or the treatments are slightly different than those of the more established types. "Walking pneumonia" is a term often used to describe some atypical pneumonias because of the milder symptoms observed.

To diagnose pneumonia, a physician uses a stethoscope to listen for a characteristic crackling or bubbling sound that occurs in the lungs as air passes by fluid in the alveoli. A chest X ray will likely be done to determine which parts of the lung are infected; areas of infection usually appear as white shadows. The patient may also be asked to give a sputum sample, which can be examined microscopically and inoculated onto appropriate laboratory media as part of the process to identify a bacterial or fungal cause of pneumonia.

Pathogenesis

Various bacteria, viruses, and fungi can all cause pneumonia, but typically only when the respiratory tract defenses are not func-

The damage from pneumonia is largely a result of the inflammatory response. As the capillaries become leaky during inflammation, fluids collect in the alveoli and interfere with O_2 and CO_2 exchange. In addition, phagocytes and other leukocytes are recruited to the site of infection, and mucus production increases. In severe cases, accumulating leukocytes and mucus create a thick substance that may clog the alveoli, a condition called consolidation. The inflammatory response seen in severe pneumonia often affects nerve endings in the pleura, causing pain. Fatal respiratory failure occurs when the lungs can no longer adequately oxygenate the blood or expel CO_2.

Epidemiology

Pneumonias are often categorized as either community-acquired, meaning they develop in members of the general public, or healthcare-associated, meaning they develop in hospitalized patients or other people within the healthcare system. Some types of community-acquired pneumonia (CAP) are contagious. Most, however, originate from the patient's own upper respiratory microbiota. These organisms may gain access to the lungs when a person inadvertently inhales his or her own throat secretions. As with CAPs, healthcare-associated pneumonias (HCAPs) often occur when the patient inhales his or her own upper respiratory microbiota. Patients at particular risk are those on mechanical ventilators used to help breathing, because the ventilator tube provides a portal for microbes to enter the lower airways. Pneumonias that develop this way are further classified as ventilator-associated pneumonias (VAPs).

Treatment and Prevention

Bacterial and fungal pneumonias are treated with antimicrobial medications, chosen according to the susceptibility of the causative agent. Unfortunately, bacteria that cause healthcare-associated

Provide perspective

Focus Your Perspective boxes show how microorganisms and their products influence our lives in many different ways.

Introduce the concepts

Focus on a Disease boxes introduce a general category of disease (pneumonia, diarrheal disease, meningitis, sexually transmitted infections), giving students a framework for understanding specific diseases.

- **Summary** briefly reviews the key points.
- **Short Answer** questions review major chapter concepts.
- **Multiple Choice** questions allow self-testing; answers are provided in Appendix IV.
- **Application** questions provide an opportunity to use knowledge of microbiology to solve real-world problems.
- **Critical Thinking** questions encourage practice in analysis and problem solving that can be used by the student in any subject.

Review the information

End-of-chapter review encourages students to revisit the information.

Build the story

Logical chapter order helps students understand and connect the concepts.

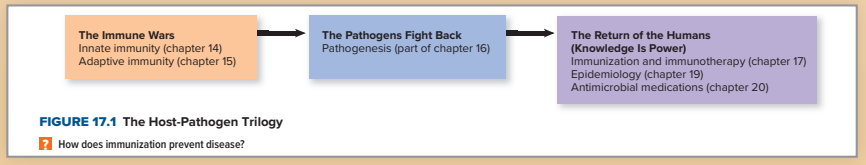

FIGURE 17.1 The Host-Pathogen Trilogy

? How does immunization prevent disease?

Student-Friendly Descriptions

Include analogies

WHY? Analogies provide students a comfortable framework for making sense of difficult topics. Here's an example from chapter 14.

> **Innate Immunity:** *The innate immune system is easiest to understand by considering it as three general interacting components: first-line defenses, sensor systems, and innate effector actions. As a useful analogy, think of the defense systems of a high-security building or compound: The first-line defenses are the security walls surrounding the property; the sensor systems are the security cameras scattered throughout the property, monitoring the environment for signs of invasion; and the effector actions are the security teams sent to remove any invaders that have been detected, thereby eliminating the threat* ***(figure 14.1a).***

Steve Cole/E+/Getty Images

Image Source

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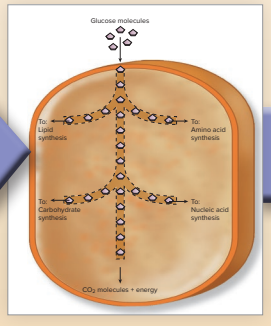
Emphasize the logic

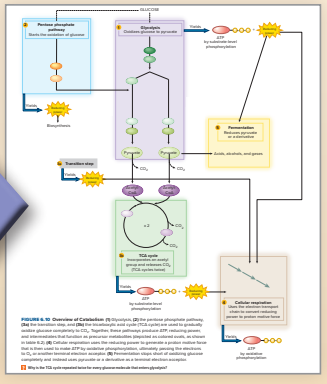
WHY? Descriptions that emphasize the logic of processes make it easier for students to understand and retain the information. Here's an example from chapter 6.

TABLE 6.2 Precursor Metabolites

Precursor Metabolite	Biosynthetic Role (Macromolecules Made From Precursor Metabolite)	Pathway (or Step) Generated
Glucose-6-phosphate	Lipopolysaccharide	Glycolysis
Fructose-6-phosphate	Peptidoglycan	Glycolysis
Dihydroxyacetone phosphate	Lipids (glycerol component)	Glycolysis
3-Phosphoglycerate	Proteins (the amino acids cysteine, glycine, and serine)	Glycolysis
Phosphoenolpyruvate	Proteins (the amino acids phenylalanine, tryptophan, and tyrosine)	Glycolysis
Pyruvate	Proteins (the amino acids alanine, leucine, and valine)	Glycolysis
Ribose-5-phosphate	Nucleic acids and proteins (the amino acid histidine)	Pentose phosphate cycle
Erythrose-4-phosphate	Proteins (the amino acids phenylalanine, tryptophan, and tyrosine)	Pentose phosphate cycle
Acetyl-CoA	Lipids (fatty acids)	Transition step
α-Ketoglutarate	Proteins (the amino acids arginine, glutamate, glutamine, and proline)	TCA cycle
Oxaloacetate	Proteins (the amino acids aspartate, asparagine, isoleucine, lysine, methionine, and threonine)	TCA cycle

Note: The colored icons in the table are used in figures throughout the chapter to represent the respective precursor metabolites.





Introduce the players: *Certain intermediates of catabolic pathways can be used in anabolic pathways, linking these two types of pathways. These intermediates—****precursor metabolites****—serve as carbon skeletons from which subunits of macromolecules can be made* ***(table 6.2).***

Reinforce the concept: *A cell's metabolic pathways make it easy for that cell to use a single type of substrate like glucose for multiple purposes. Think of the cells as extensive biological recycling centers that routinely process millions of glucose molecules* ***(figure 6.9).*** *Molecules that remain on the central deconstruction line are oxidized completely to CO_2, releasing the maximum amount of energy. Some breakdown intermediates, however, can exit that line to be used in biosynthesis.*

Put the pieces together: *Three key metabolic pathways—****the central metabolic pathways****—gradually oxidize glucose to CO_2, summarized as follows:*

$$C_6H_{12}O_6 + 6\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O$$

(glucose) (oxygen) (carbon dioxide) (water)

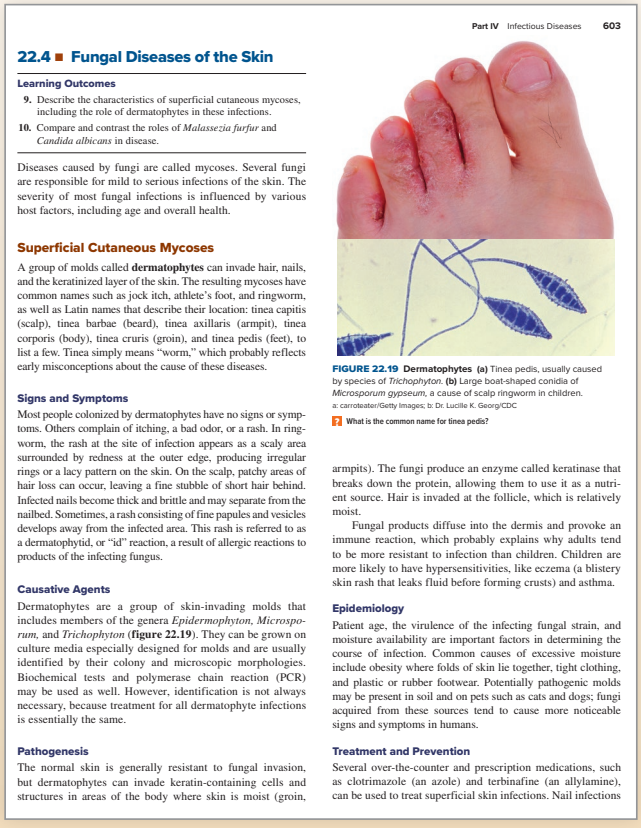
The pathways are catabolic, but the precursor metabolites and reducing power they generate can also be diverted for use in biosynthesis.

FOCUS ON UNDERSTANDING . . .

Student-Friendly Disease Presentations

Help students think like experts

Within each body system chapter, diseases are separated by major taxonomic category (bacteria, viruses, fungi, protozoa). This organization reflects a major consideration with respect to treatment options, an important consideration for students going into healthcare-related fields.



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22.4 ■ Fungal Diseases of the Skin

Learning Outcomes

9. Describe the characteristics of superficial cutaneous mycoses, including the role of dermatophytes in these infections.
10. Compare and contrast the roles of *Malassezia furfur* and *Candida albicans* in disease.

Diseases caused by fungi are called mycoses. Several fungi are responsible for mild to serious infections of the skin. The severity of most fungal infections is influenced by various host factors, including age and overall health.

Superficial Cutaneous Mycoses

A group of molds called **dermatophytes** can invade hair, nails, and the keratinized layer of the skin. The resulting mycoses have common names such as jock itch, athlete's foot, and ringworm, as well as Latin names that describe their location: tinea capitis (scalp), tinea barbae (beard), tinea axillaris (armpit), tinea corporis (body), tinea cruris (groin), and tinea pedis (feet), to list a few. Tinea simply means "worm," which probably reflects early misconceptions about the cause of these diseases.

Signs and Symptoms

Most people colonized by dermatophytes have no signs or symptoms. Others complain of itching, a bad odor, or a rash. In ringworm, the rash at the site of infection appears as a scaly area surrounded by redness at the outer edge, producing irregular rings or a lacy pattern on the skin. On the scalp, patchy areas of hair loss can occur, leaving a fine stubble of short hair behind. Infected nails become thick and brittle and may separate from the nailbed. Sometimes, a rash consisting of fine papules and vesicles develops away from the infected area. This rash is referred to as a dermatophytid, or "id" reaction, a result of allergic reactions to products of the infecting fungus.

Causative Agents

Dermatophytes are a group of skin-invading molds that includes members of the genera *Epidermophyton, Microsporum,* and *Trichophyton* (**figure 22.19**). They can be grown on culture media especially designed for molds and are usually identified by their colony and microscopic morphologies. Biochemical tests and polymerase chain reaction (PCR) may be used as well. However, identification is not always necessary, because treatment for all dermatophyte infections is essentially the same.

Pathogenesis

The normal skin is generally resistant to fungal invasion, but dermatophytes can invade keratin-containing cells and structures in areas of the body where skin is moist (groin, armpits). The fungi produce an enzyme called keratinase that breaks down the protein, allowing them to use it as a nutrient source. Hair is invaded at the follicle, which is relatively moist.

Fungal products diffuse into the dermis and provoke an immune reaction, which probably explains why adults tend to be more resistant to infection than children. Children are more likely to have hypersensitivities, like eczema (a blistery skin rash that leaks fluid before forming crusts) and asthma.

Epidemiology

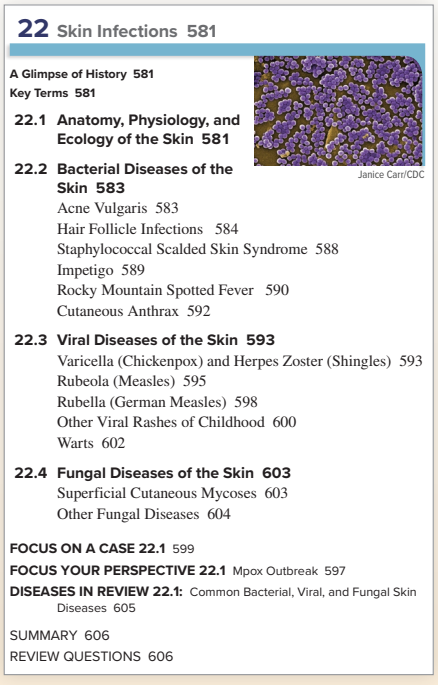
Patient age, the virulence of the infecting fungal strain, and moisture availability are important factors in determining the course of infection. Common causes of excessive moisture include obesity where folds of skin lie together, tight clothing, and plastic or rubber footwear. Potentially pathogenic molds may be present in soil and on pets such as cats and dogs; fungi acquired from these sources tend to cause more noticeable signs and symptoms in humans.

Treatment and Prevention

Several over-the-counter and prescription medications, such as clotrimazole (an azole) and terbinafine (an allylamine), can be used to treat superficial skin infections. Nail infections

FIGURE 22.19 Dermatophytes (a) Tinea pedis, usually caused by species of *Trichophyton*. **(b)** Large boat-shaped conidia of *Microsporum gypseum*, a cause of scalp ringworm in children.
a: carroteater/Getty Images; b: Dr. Lucille K. Georg/CDC

? What is the common name for tinea pedis?



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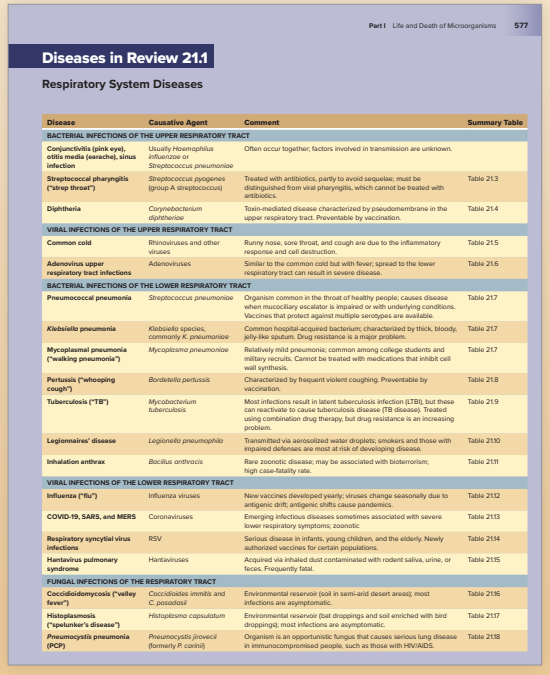
Janice Carr/CDC

Provide a consistent conceptual framework

Disease discussions are separated into consistent subsections, providing a conceptual framework and breaking the material into "bite-sized" pieces.



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Diseases in Review 21.1

Respiratory System Diseases

Disease	Causative Agent	Comment	Summary Table
BACTERIAL INFECTIONS OF THE UPPER RESPIRATORY TRACT			
Conjunctivitis (pink eye), otitis media (earache), sinus infection	Usually *Haemophilus influenzae* or *Streptococcus pneumoniae*	Often occur together; factors involved in transmission are unknown.	
Streptococcal pharyngitis ("strep throat")	*Streptococcus pyogenes* (group A streptococcus)	Treated with antibiotics, partly to avoid sequelae; must be distinguished from viral pharyngitis, which cannot be treated with antibiotics.	Table 21.3
Diphtheria	*Corynebacterium diphtheriae*	Toxin-mediated disease characterized by pseudomembrane in the upper respiratory tract. Preventable by vaccination.	Table 21.4
VIRAL INFECTIONS OF THE UPPER RESPIRATORY TRACT			
Common cold	Rhinoviruses and other viruses	Runny nose, sore throat, and cough are due to the inflammatory response and cell destruction.	Table 21.5
Adenovirus upper respiratory tract infections	Adenoviruses	Similar to the common cold but with fever; spread to the lower respiratory tract can result in severe disease.	Table 21.6
BACTERIAL INFECTIONS OF THE LOWER RESPIRATORY TRACT			
Pneumococcal pneumonia	*Streptococcus pneumoniae*	Organism common in the throat of healthy people; causes disease when mucociliary escalator is impaired or with underlying conditions. Vaccines that protect against multiple serotypes are available.	Table 21.7
***Klebsiella* pneumonia**	*Klebsiella* species, commonly *K. pneumoniae*	Common hospital-acquired bacterium; characterized by thick, bloody, jelly-like sputum. Drug resistance is a major problem.	Table 21.7
Mycoplasmal pneumonia ("walking pneumonia")	*Mycoplasma pneumoniae*	Relatively mild pneumonia; common among college students and military recruits. Cannot be treated with medications that inhibit cell wall synthesis.	Table 21.7
Pertussis ("whooping cough")	*Bordetella pertussis*	Characterized by frequent violent coughing. Preventable by vaccination.	Table 21.8
Tuberculosis ("TB")	*Mycobacterium tuberculosis*	Most infections result in latent tuberculosis infection (LTBI), but these can reactivate to cause tuberculosis disease (TB disease). Treated using combination drug therapy, but drug resistance is an increasing problem.	Table 21.9
Legionnaires' disease	*Legionella pneumophila*	Transmitted via aerosolized water droplets; smokers and those with impaired defenses are most at risk of developing disease.	Table 21.10
Inhalation anthrax	*Bacillus anthracis*	Rare zoonotic disease; may be associated with bioterrorism; high case-fatality rate.	Table 21.11
VIRAL INFECTIONS OF THE LOWER RESPIRATORY TRACT			
Influenza ("flu")	Influenza viruses	New vaccines developed yearly; viruses change seasonally due to antigenic drift; antigenic shifts cause pandemics.	Table 21.12
COVID-19, SARS, and MERS	Coronaviruses	Emerging infectious diseases sometimes associated with severe lower respiratory symptoms; zoonotic	Table 21.13
Respiratory syncytial virus infections	RSV	Serious disease in infants, young children, and the elderly. Newly authorized vaccines for certain populations.	Table 21.14
Hantavirus pulmonary syndrome	Hantaviruses	Acquired via inhaled dust contaminated with rodent saliva, urine, or feces. Frequently fatal.	Table 21.15
FUNGAL INFECTIONS OF THE RESPIRATORY TRACT			
Coccidioidomycosis ("valley fever")	*Coccidioides immitis* and *C. posadasii*	Environmental reservoir (soil in semi-arid desert areas); most infections are asymptomatic.	Table 21.16
Histoplasmosis ("spelunker's disease")	*Histoplasma capsulatum*	Environmental reservoir (bat droppings and soil enriched with bird droppings); most infections are asymptomatic.	Table 21.17
***Pneumocystis* pneumonia (PCP)**	*Pneumocystis jirovecii* (formerly *P. carinii*)	Organism is an opportunistic fungus that causes serious lung disease in immunocompromised people, such as those with HIV/AIDS.	Table 21.18

Summarize each disease's characteristics

Summary tables serve as brief reminders of the important features of each disease. Major diseases are represented with an enhanced summary table that includes an outline of the disease process keyed to a human figure, showing the entry and exit of the pathogen.

Review the diseases as a group

Each disease chapter ends with a table that summarizes the key features of the diseases discussed in that chapter.

UPDATES—Maintaining the Cutting Edge

Evergreen

Content and technology are ever-changing, and keeping your course up to date with the latest information and assessments is important. That is why we want to deliver the most current and relevant content for your course, hassle-free.

Microbiology, A Human Perspective is moving to an Evergreen delivery model, which means it has content, tools, and technology that is updated and relevant, with updates delivered directly to your existing McGraw Hill Connect® course. Engage students and freshen up assignments with up-to-date coverage of select topics and assessments, all without having to switch editions or build a new course.

Global Changes in This Release

- Updated the disease statistics, vaccine recommendations, treatments, and terminology
- Increased the focus on worldwide effects of infectious diseases
- Aligned the descriptions of diseases that have similar symptoms or epidemiology so that comparisons can be made more easily
- Emphasized that cytokine release and the inflammatory response can lead to signs and symptoms of certain diseases
- Decreased the level of detail about non-specific disease treatments
- Deleted the Focus on the Future boxes, often moving the information into the narrative or using it to create new Focus Your Perspective boxes
- Modified the figures for increased accessibility
- Continued "wordsmithing" to improve the clarity and readability of the descriptions

Key Changes in Individual Chapters

Chapter 1 – Humans and the Microbial World

- Added mpox to the list of emerging infectious diseases and updated the COVID-19 death statistics; updated the information about wheat blast and African swine fever; added information about the recent spread of a novel avian influenza virus (section 1.2)
- Added *Thiomargarita magnifica* to Focus Your Perspective 1.1 (section 1.3)

Chapter 2 – The Molecules of Life

- Changed the name and narrowed the focus of the subsection now called *Triglycerides (Fats)* (was *Simple Lipids*); changed the heading and narrowed the focus of the subsection now called *Phospholipids* (was *Compound Lipids*); moved the information about *trans* fatty acids from a MicroByte into the main narrative; modified a MicroByte to emphasize the importance of artificial intelligence tools in predicting protein shapes based on DNA sequences (section 2.4)

Chapter 3 – Cells and Methods to Observe Them

- Added the terms *primary active transport* and *secondary active transport* (section 3.1)
- Added the term *haploid*; expanded on the functions of storage granules and encapsulin nanocompartments (section 3.4)
- Moved discussion of vesicles from section 3.5 to section 3.7
- Reorganized the discussion of eukaryotic membrane-bound organelles to separate those involved with the endomembrane system from those that are not, updating table 3.4 accordingly (section 3.7)
- Improved the description that distinguishes between resolving power and resolution; simplified the discussion of transmission electron microscopy sample preparation methods (section 3.8)

Chapter 4 – Dynamics of Microbial Growth

- Updated the description of alpha-hemolysis; added a Focus Your Perspective on Agar Art (section 4.6)

Chapter 5 – Control of Microbial Growth

- Added the terms *antimicrobial* and *biocide* to the list of key terms
- Introduced the term *cold pasteurization* (sections 5.1 and 5.3)
- Removed the description of depth filters; updated the discussion of ultraviolet radiation to include the use of UVC for ultraviolet germicidal irradiation; added the term *pascalization* to describe high pressure treatment (section 5.3)

Chapter 6 – Microbial Metabolism: Fueling Cell Growth

- Added the mention of Marjory Stephenson to the Glimpse of History
- Defined the term *intermediates*; reworded the definition of substrate-level phosphorylation (section 6.1)
- More explicitly compared the Embden-Meyerhof and Entner-Doudoroff glycolytic pathways (section 6.3)
- Added the mention of Jennifer Moyle's role in developing the chemiosmotic theory; reworked the detailed description of aerobic respiration in prokaryotes (section 6.4)
- Added a brief discussion of the different meanings of the term *fermentation* (section 6.5)
- Reduced the coverage of chemolithotrophs, referring the reader to chapter 11 for more information (section 6.7)
- Significantly revised the discussion of photosynthesis for better flow and increased understanding; added a brief description of phototrophy involving rhodopsin pigments (section 6.8)

Chapter 7 – The Blueprint of Life, from DNA to Protein

- Changed the Glimpse of History topic to tell the story of the Tsuneko Okasaki
- Clarified the role of DNA helicase (section 7.2)
- Changed the order of the paragraphs that introduce the components of translation so that tRNA is now described before ribosomes (section 7.3)
- Modified the description of quorum sensing (section 7.5)
- Revised the discussion of gene regulation so that the terms *constitutive*, *inducible*, and *repressible* are applied to genes rather enzymes (section 7.6)

Chapter 8 – Bacterial Genetics

- Replaced the term *base substitution* with *base-pair substitution*; redesigned figure 8.2 to clarify the process that leads to base-pair substitution (section 8.2)
- Replaced the critical thinking question in MicroAssessment 8.3 (section 8.3)
- Converted the descriptions of replica plating and Ames test into bullet lists; deleted the section on penicillin enrichment (section 8.5)
- Updated and added "titles" to the bullets and the accompanying figure that describe CRISPR (section 8.11)

Chapter 9 – Biotechnology

- Added clear descriptions of the terms *in vivo* and *in vitro* (section 9.1)
- Revised the discussions of gel electrophoresis and generating a recombinant DNA molecule (sections 9.1 and 9.2, respectively)
- Added the mention of Nobel Prize winners Jennifer Doudna and Emmanuelle Charpentier (section 9.3)
- Removed the description of RNA-seq (section 9.4)
- Changed the title and focus of the section now called *Considerations of Genetic Engineering* (was *Concerns Regarding Genetic Engineering*); added a discussion of gene therapy (section 9.7)

Chapter 10 – Identifying and Classifying Microorganisms

- Added a mention of point-of-care testing (section 10.1)
- Updated the description of prokaryotic nomenclature by indicating that the name of the phylum ends in the suffix *-ota*; updated table 10.1 and figure 10.1 to reflect the recent changes to bacterial phylum names (section 10.1)
- Added Nextstrain to the list of programs that track genomic changes of pathogens (section 10.4)
- Updated figure 10.14 to reflect the recent changes to bacterial phylum names (section 10.5)

Chapter 11 – The Diversity of Bacteria and Archaea

- Revised the discussion of anoxygenic phototrophs to remove much of the overlap with the improved section 6.8, which covers photosynthesis (section 11.2)
- Added the term *nuisance bloom* (section 11.3)
- Added the potential use of magnetosomes for targeted drug delivery systems; added a mention of *Thiomargarita magnifica* (section 11.7)
- Updated tables 11.1 through 11.3 to include the new bacterial phylum names

Chapter 12 – The Eukaryotic Members of the Microbial World

- Explained the use of the term *binary fission* to describe protozoan cell division, particularly how that division is different from the simple binary fission of prokaryotic cells; expanded the discussion of sexual life cycles

of eukaryotes to include the terms *haploid-dominant*, *diploid-dominant*, and *alternation of generations* (chapter introduction)

- Added the term *harmful algal bloom* (section 12.3)
- Mentioned the association between the bites of certain types of ticks and the development of allergies to meats and animal products (section 12.5)

Chapter 13 – Viruses, Viroids, and Prions

- Updated the taxonomic classification of rubella virus to be under the family Matonaviridae; updated Focus Your Perspective 13.1 by including the term *nucleocytoplasmic large DNA viruses* (section 13.1)
- Updated and emphasized the discussion of phage therapy by creating Focus Your Perspective 13.2, which mentions the involvement of SEA-PHAGES (Science Education Alliance Phage Hunters Advancing Genomics and Evolutionary Science) (section 13.2)
- Streamlined the coverage by creating a new section (*Methods Used to Study Viruses*), which consolidates two previous sections (*Methods Used to Study Bacteriophages* and *Cultivating and Quantitating Animal Viruses*) (section 13.7)

Chapter 14 – The Innate Immune Response

- Updated the term *antimicrobial peptides (AMPs)* to *host defense peptides (HDPs)* (section 14.2)
- Added information about extracellular soluble pattern recognition molecules (section 14.5)
- Modified the description of phagocytosis to indicate that phagolysosome formation is part of phagosome maturation (section 14.7)
- Expanded the discussion of damaging effects of inflammation (section 14.8)

Chapter 15 – The Adaptive Immune Response

- Converted the descriptions of B-cell receptors and T-cell receptors to a bullet list (15.1)

Chapter 16 – Host-Microbe Interactions

- Converted what were headings under *Beneficial Roles of the Human Microbiome* to a bullet list; added a discussion of the gut microbiome–brain connection (section 16.2)
- Replaced the electron micrograph of a type III secretion system in figure 16.4 (section 16.5)
- Modified figure 16.12 to emphasize the involvement of cytokines in the response to superantigens (section 16.8)

Chapter 17 – Applications of Immune Responses

- Added a discussion of mRNA vaccines, viral vector vaccines, and DNA vaccines in a new subsection, *Nucleic Acid–Based Vaccines* changed the name and expanded the focus of the subsection now called *Vaccination Uses and Benefits* (was *Importance of Vaccines*); added information about ring vaccination; added a discussion about the novel oral polio vaccine type 2 (nOPV2) (section 17.2)

Chapter 18 – Immunological Disorders

- Revised the bullet list that describes the events leading to type I hypersensitivity to more closely align with figure 18.1; simplified table 18.2, which compares the major types of hypersensitivity reactions (section 18.1)
- Deleted Focus Your Perspective 18.1 (*The Fetus as an Allograft*)

Chapter 19 – Epidemiology

- Added information about surveillance case definitions, added the term *infection-fatality rate*, and rearranged the order of the other topics in the discussion (section 19.1)
- Updated the information about droplet transmission and airborne transmission to reflect the insights gained from the COVID-19 pandemic (section 19.2)
- Added information about the One Health approach to disease control (sections 19.3 and 19.6)
- Updated the information about nationally notifiable infectious diseases; added information about reportable infectious diseases: added information about the CDC's National Wastewater Surveillance System (NWSS); mentioned WHO's role of drawing attention to neglected tropical diseases (NTDs); added a Focus Your Perspective box on Bioterrorism Surveillance; moved the information on reduction and eradication of disease to section 19.6 (section 19.5)
- Changed the title and expanded the scope of the section now called *Trends in Infectious Diseases* (was *Emerging Infectious Diseases*); added dengue fever to the list of diseases likely to increase as a result of climate change (section 19.6)
- Moved the information about Standard Precautions into the main narrative (section 19.7)

Chapter 20 – Antimicrobial Medications

- Added mentions of the contributions of the "penicillin girls" and Dorothy Hodgkin Crowfoot to penicillin discovery and production; added the mention of the contributions of Albert Schatz and Elizabeth Bugie to the discovery of

streptomycin; added the subsection *Rational Drug Design* (section 20.1)

- Reorganized the discussion of protein synthesis inhibitors, separating the drugs according to the ribosomal subunit they bind; updated the discussion of antimicrobials that act against *Mycobacterium tuberculosis* (section 20.3)
- Added a bullet list that describes the sources of antimicrobial resistance genes; updated the information about resistant strains of *M. tuberculosis* and *Neisseria gonorrhoeae* (section 20.5)
- Expanded the section on antiviral and antifungal drugs to include recent examples (sections 20.6 and 20.7, respectively)
- Added the mention of neglected tropical diseases; added an explanation of why antibacterial drugs can often be used to treat diseases caused by apicomplexan protozoa; updated the drug options listed in table 20.5 (section 20.8)

Chapter 21 – Respiratory System Infections

- Reorganized the anatomy/physiology descriptions to emphasize characteristics in common between the upper respiratory tract and the lower respiratory tract (section 21.1)
- Reorganized the discussion of tuberculosis treatment, using a bullet list to emphasize the two-phase treatment approach (section 21.4)
- Substantially revised and updated the influenza coverage; moved the coverage of COVID-19, SARS, and MERS forward to increase the emphasis; updated the coverage of COVID-19 to include emerging variants, new treatments, and vaccines; added information about the new respiratory syncytial virus (RSV) vaccines (section 21.5)

Chapter 22 – Skin Infections

- Added a discussion of acne as an inflammatory disease of the pilosebaceous unit (sebaceous gland and associated arrector pili), a term now introduced in figure 22.1 (section 22.2)
- Added a new Focus Your Perspective 22.1 on the mpox outbreak (section 22.3)

Chapter 23 – Wound Infections

- Expanded the discussion of gas gangrene to include two forms: traumatic and spontaneous (section 23.3); revised the discussion of bacterial infections of bite wounds (section 23.4)

Chapter 24 – Digestive System Infections

- Changed the headings and modified the coverage of the periodontal disease descriptions to reflect updates in terminology: *Periodontal Disease* is now *Dental Plaque-Induced Periodontal Diseases,* and *Acute Ulcerative Gingivitis* is now *Necrotizing Periodontal Diseases* (section 24.2)
- Revised the signs and symptoms discussion of oral herpes to emphasize the differences between the initial infection and recurrences (section 24.3)
- Rearranged some information in the disease discussions to emphasize similarities among the diseases; added information on XDR *Salmonella* Typhi as well as the new typhoid conjugate vaccine used in countries where typhoid is endemic (section 24.4)
- Added CDC's 2023 recommendation for hepatitis B screening; added the 2023 discovery that HCV uses flavin adenine dinucleotide (FAD) as 5′ cap on its RNA thus preventing its genome from being recognized by pattern recognition receptors in infected cells; moved the graph that compares the incidence of acute hepatitis A, B, and C to the end of the hepatitis coverage (section 24.6)

Chapter 25 – Cardiovascular and Lymphatic System Infections

- Changed the chapter title to emphasize the separate components of the cardiovascular and lymphatic systems; increased the emphasis on the terms *cytokine storm* and *sepsis* by introducing them in the chapter introduction
- Reorganized the anatomy/physiology descriptions to emphasize the separate components of the cardiovascular and lymphatic systems (section 25.1)
- Moved the description of bacterial sepsis forward to increase the emphasis, explained that sepsis can result from any systemic microbial infection (bacterial, viral, or fungal), and revised the bacterial sepsis pathogenesis discussion to include a bullet list; revised the Lyme disease epidemiology discussion, using a bullet format to describe and illustrate the *Ixodes scapularis* life cycle; converted the brucellosis "disease person" table to a standard table (section 25.2)
- Mentioned that viral infections can lead to sepsis; rearranged and aligned the coverage of the arboviral diseases (dengue and severe dengue, chikungunya, Zika virus disease, and yellow fever) to emphasize the similarities; added information about the new dengue vaccine used in countries where dengue is endemic (section 25.3)

- Simplified the description and the illustration of the malaria life cycle, and also added information about the new malaria vaccines; added a section on leishmaniasis (section 25.4)

Chapter 26 – Nervous System Infections

- Simplified the anatomy/physiology discussion (section 26.1)
- Updated the discussion of circulating vaccine-derived poliovirus strains (cVDPV) (section 26.3)
- Added *Mycobacterium lepromatosis* as another causative agent of leprosy; added descriptions of two additional forms of botulism: adult intestinal toxemia botulism and iatrogenic botulism; added mention that certain strains of *C. butyricum* and *C. baratii* produce botulinum toxin (section 26.7)

Chapter 27 – Genitourinary Tract Infections

- Added a description of how glycoprotein in the urine protects against urinary tract infections (section 27.2)
- Modified the coverage of leptospirosis to focus on mild versus severe disease symptoms (section 27.2)
- Distinguished between the terms *sexually transmitted infection (STI)* and *sexually transmitted disease (STD)* in the Focus on a Disease box; increased the emphasis on the importance of pelvic inflammatory disease (PID) (section 27.4)
- Moved the coverage of human papilloma STIs forward; substantially revised the HIV/AIDS coverage and, as part of that, included an updated replication cycle figure and mention of the new capsid inhibitor used for treatment (section 27.5).

Chapter 28 – Microbial Ecology

- Introduced the term *harmful algal bloom* (section 28.3)

Chapter 29 – Environmental Microbiology: Treatment of Water, Wastes, and Polluted Habitats

- Modified the definition of wastewater, and added the definition of sewage; added the terms *nuisance bloom* and *harmful algal bloom* (section 29.1)

Chapter 30 – Food Microbiology

- Modified the description of FoodNet (section 30.4)

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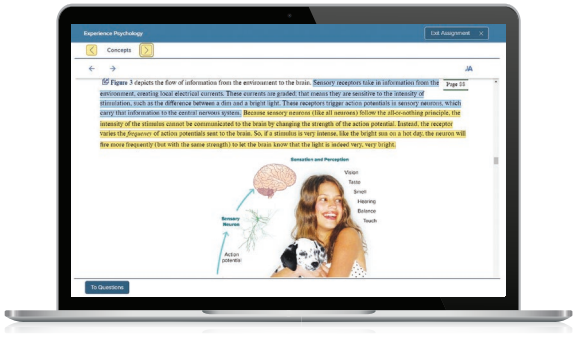

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We hope that this text will be interesting and educational for students and helpful to instructors. Our goal is excellence, so with that in mind we would appreciate any comments and suggestions from our readers.

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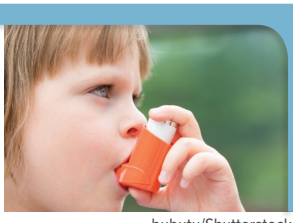
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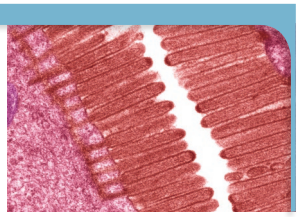
PART IV

Infectious Diseases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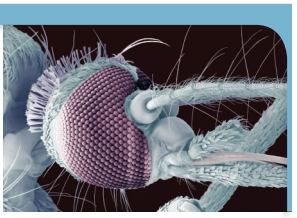
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