Preface

Students:

Welcome to the microbial world! I think you will find it fascinating to understand how microbes interact with us, and with our environment. The interesting thing is that each of you has already had a lot of experience with microbiology. For one thing, you are thoroughly populated with microbes right now, and much of your own genetic material actually came from viruses and other microbes. And while you have probably had some bad experiences with quite a few microbes in the form of diseases, you have certainly been greatly benefited by them as well.

This book is suited for all kinds of students and doesn't require any prerequisite knowledge of biology or chemistry. If you are interested in entering the health care profession in some way, this book will give you a strong background in the biology of microorganisms, without overwhelming you with unnecessary details. Don't worry if you're not in the health professions. A grasp of this topic is important for everyone—and can be attained with this book.

—Kelly Cowan

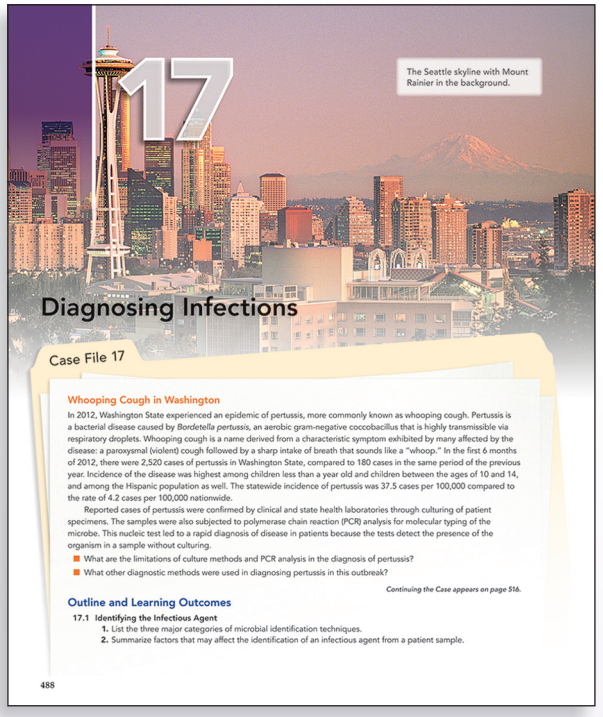
I dedicate this book to all public health workers who devote their lives to bringing the advances and medicines enjoyed by the industrialized world to *all* humans.

Connecting Students to Their Future Careers

Many students taking this course will be entering the health care field in some way, and it is absolutely critical that they have a good background in the biology of microorganisms. Author Kelly Cowan has made it her goal to help all students make the connections between microbiology and the world they see around them. Her textbooks have become known for their engaging writing style, instructional art program, and focus on active learning. The "building blocks" approach establishes the big picture first and then gradually layers concepts onto this foundation. This logical structure helps students build knowledge and ***connect*** important concepts.

"Diagnosing Infections" Chapter

Chapter 17 brings together in one place the current methods used to diagnose infectious diseases. The chapter starts with collecting samples from the patient and details the biochemical, serological, and molecular methods used to identify causative microbes.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The Seattle skyline with Mount Rainier in the background.

Diagnosing Infections

Case File 17

Whooping Cough in Washington

In 2012, Washington State experienced an epidemic of pertussis, more commonly known as whooping cough. Pertussis is a bacterial disease caused by *Bordetella pertussis*, an aerobic gram-negative coccobacillus that is highly transmissible via respiratory droplets. Whooping cough is a name derived from a characteristic symptom exhibited by many affected by the disease: a paroxysmal (violent) cough followed by a sharp intake of breath that sounds like a "whoop." In the first 6 months of 2012, there were 2,520 cases of pertussis in Washington State, compared to 180 cases in the same period of the previous year. Incidence of the disease was highest among children less than a year old and children between the ages of 10 and 14, and among the Hispanic population as well. The statewide incidence of pertussis was 37.5 cases per 100,000 compared to the rate of 4.2 cases per 100,000 nationwide.

Reported cases of pertussis were confirmed by clinical and state health laboratories through culturing of patient specimens. The samples were also subjected to polymerase chain reaction (PCR) analysis for molecular typing of the microbe. This nucleic test led to a rapid diagnosis of disease in patients because the tests detect the presence of the organism in a sample without culturing.

- What are the limitations of culture methods and PCR analysis in the diagnosis of pertussis?
- What other diagnostic methods were used in diagnosing pertussis in this outbreak?

Continuing the Case appears on page 516.

Outline and Learning Outcomes

17.1 Identifying the Infectious Agent

1. List the three major categories of microbial identification techniques.
2. Summarize factors that may affect the identification of an infectious agent from a patient sample.

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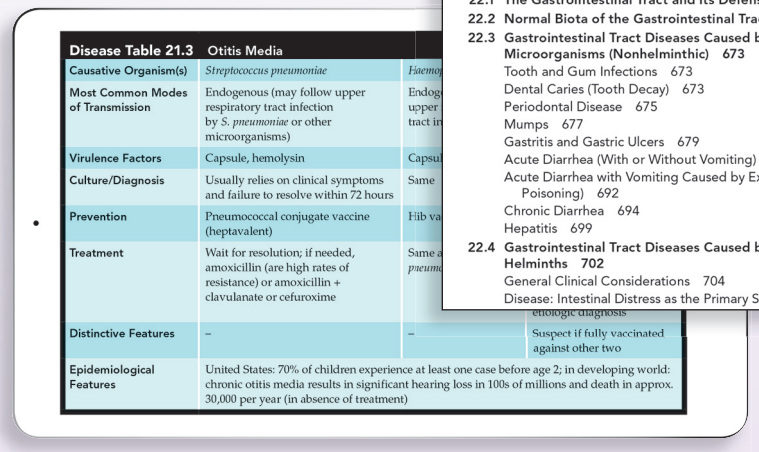
Systematic Presentation of Disease-Causing Organisms

Microbiology: A Systems Approach takes a unique approach to diseases by organizing microbial agents under the heading of the disease condition they cause. After all of them are covered the agents are summarized in a comparative table. Every condition gets a table, whether there is one possible cause or a dozen. Through this approach, students study how diseases affect patients—the way future health care professionals will encounter them in their jobs. A summary table follows the textual discussion of each disease and summarizes the characteristics of agents that can cause that disease. New to this edition: **Every disease table now contains national and worldwide epidemiological information for each causative agent.**

This approach is logical, systematic, and intuitive, as it encourages clinical and critical thinking in students—the type of thinking they will be using if their eventual careers are in health care. Students learn to examine multiple possibilities for a given condition and grow accustomed to looking for commonalities and differences among the various organisms that cause a given condition.


Disease Table 21.3 Otitis Media

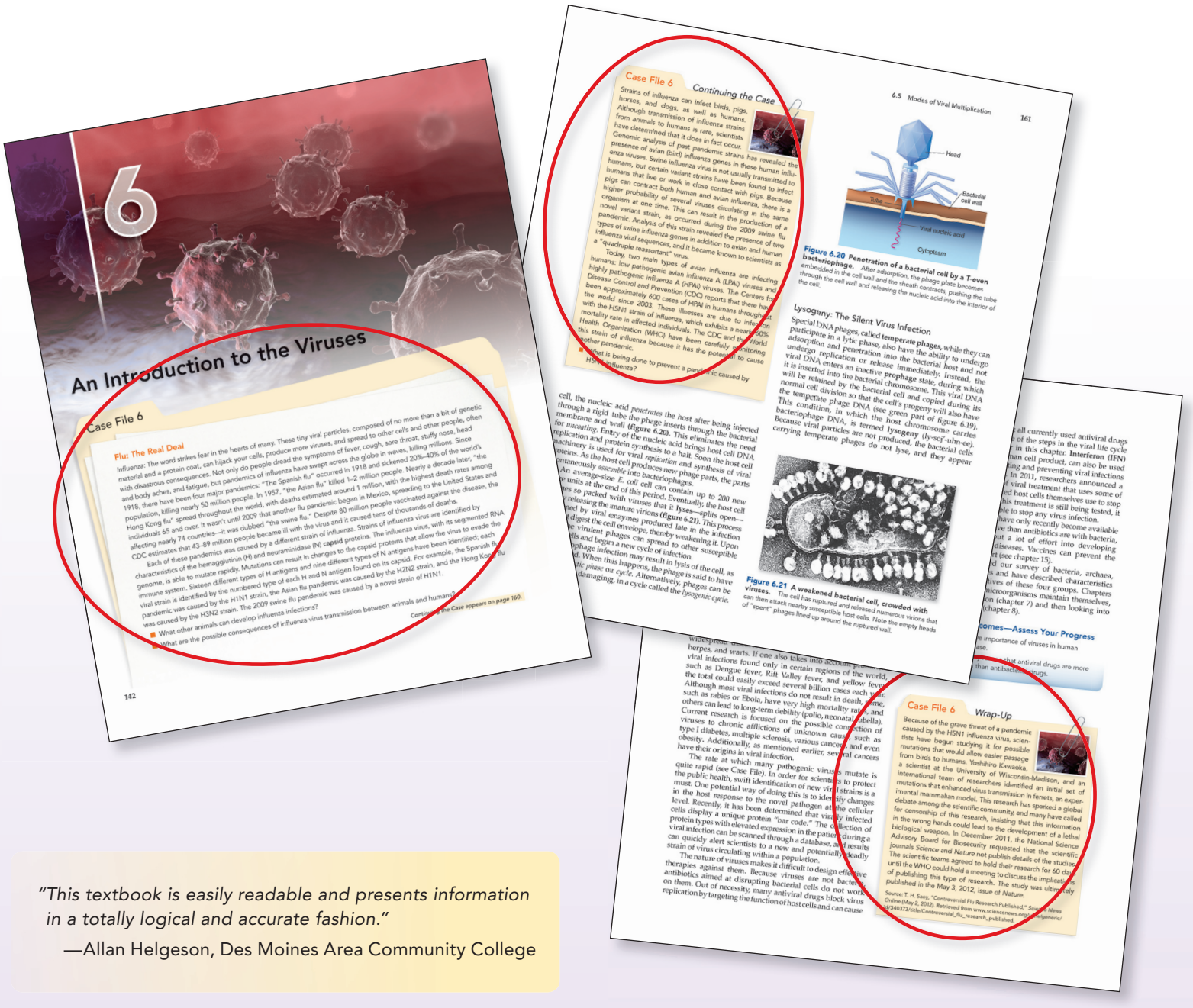
Causative Organism(s)	*Streptococcus pneumoniae*	*Haemop*	
Most Common Modes of Transmission	Endogenous (may follow upper respiratory tract infection by *S. pneumoniae* or other microorganisms)	Endog upper tract in	
Virulence Factors	Capsule, hemolysin	Capsu	
Culture/Diagnosis	Usually relies on clinical symptoms and failure to resolve within 72 hours	Same	
Prevention	Pneumococcal conjugate vaccine (heptavalent)	Hib va	
Treatment	Wait for resolution; if needed, amoxicillin (are high rates of resistance) or amoxicillin + clavulanate or cefuroxime	Same a *pneum*	
Distinctive Features	–	–	Suspect if fully vaccinated against other two
Epidemiological Features	United States: 70% of children experience at least one case before age 2; in developing world: chronic otitis media results in significant hearing loss in 100s of millions and death in approx. 30,000 per year (in absence of treatment)		

CHAPTER 22

Infectious Diseases Affecting the Gastrointestinal Tract 670

Chapter Opening Case Files!

Each chapter opens with a Case File, which helps students grasp the relevance of the material they're about to learn. The questions that directly follow the Case File challenge students to begin to think critically about what they are going to read, expecting that they'll be able to answer them once they've worked through the chapter. The Continuing the Case feature appears within the chapter where relevant, to help students follow the real-world application of the case. The Case File Wrap-Up summarizes the case at the end of the chapter, pulling together the applicable content and the chapter's topics. All of the case files are new in the fourth edition, including hot microbiological topics that are making news headlines today.



"This textbook is easily readable and presents information in a totally logical and accurate fashion."

—Allan Helgeson, Des Moines Area Community College

Connecting Students to the Content with Truly Instructional Art

Effective science illustrations not only look pretty, but help students visualize complex concepts and processes and paints a conceptual picture for them. The art combines vivid colors, multi-dimensionality, and self-contained narrative to help students study the challenging concepts of microbiology from a visual perspective. Drawings are often paired with photographs or micrographs to enhance comprehension.

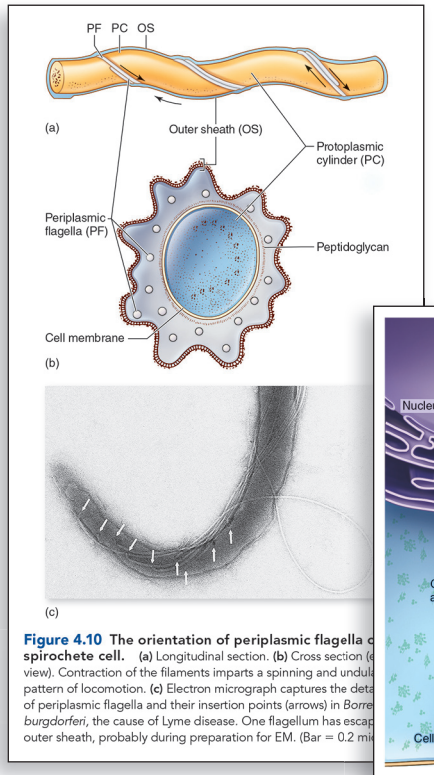


Figure 4.10 The orientation of periplasmic flagella c spirochete cell. **(a)** Longitudinal section. **(b)** Cross section (e view). Contraction of the filaments imparts a spinning and undul pattern of locomotion. **(c)** Electron micrograph captures the deta of periplasmic flagella and their insertion points (arrows) in *Borre burgdorferi*, the cause of Lyme disease. One flagellum has escap outer sheath, probably during preparation for EM. (Bar = 0.2 mi

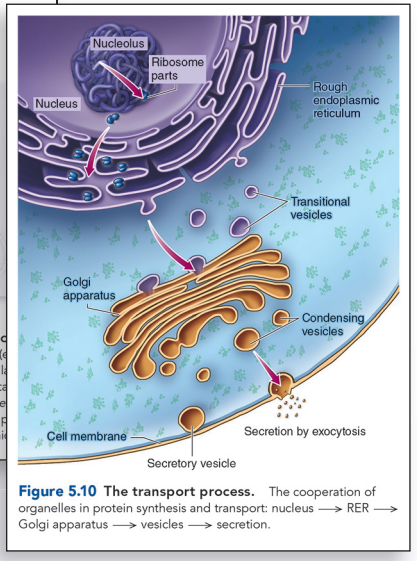
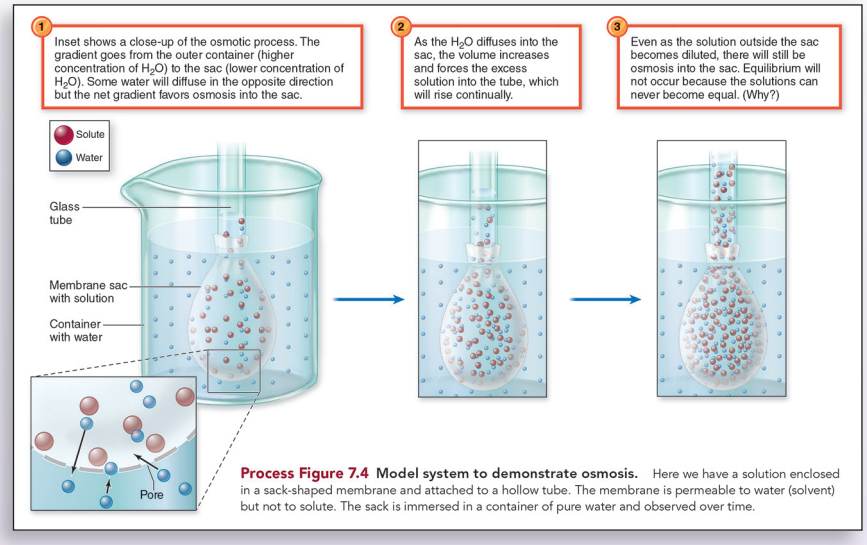


Figure 5.10 The transport process. The cooperation of organelles in protein synthesis and transport: nucleus ⟶ RER ⟶ Golgi apparatus ⟶ vesicles ⟶ secretion.

"The readabililty makes this text a winner. Excellent text!"

—Kimberly Harding, Colorado Mountain College



Process Figure 7.4 Model system to demonstrate osmosis. Here we have a solution enclosed in a sack-shaped membrane and attached to a hollow tube. The membrane is permeable to water (solvent) but not to solute. The sack is immersed in a container of pure water and observed over time.

Process Figures

Many difficult microbiological concepts are best portrayed by breaking them down into stages. These Process Figures show each step clearly marked with an orange, numbered circle and correlated to accompanying narrative to benefit all types of learners. Process Figures are clearly marked next to the figure number. The accompanying legend provides additional explanation.

Connecting Students to Microbiology with Relevant Examples

Real Clinical Photos Help Students Visualize Diseases

Clinical Photos

Color photos of individuals affected by disease provide students with a real life, clinical view of how microorganisms manifest themselves in the human body.

Combination Figures

Line drawings combined with photos give students two perspectives: the realism of photos and the explanatory clarity of illustrations. The authors chose this method of presentation often to help students comprehend difficult concepts.

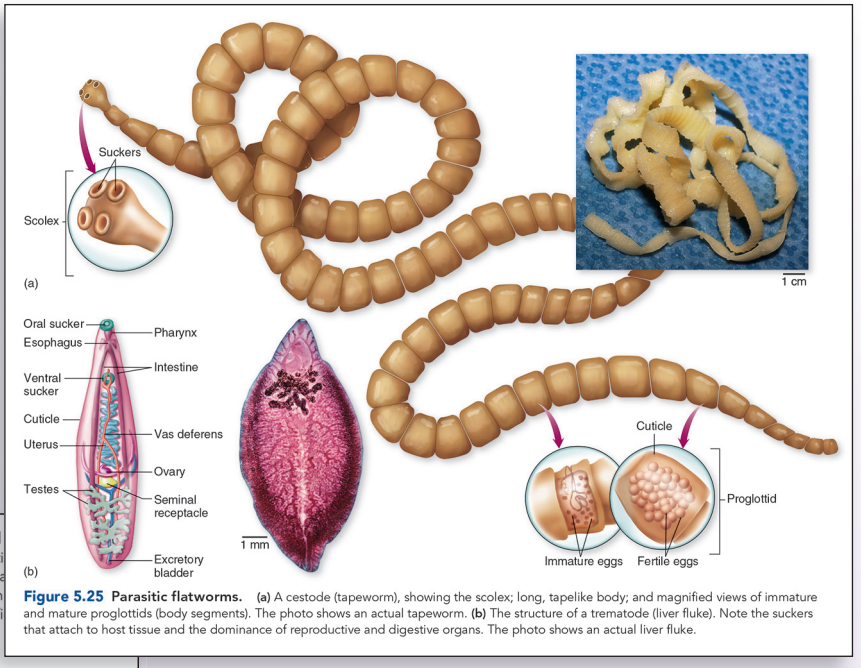


Figure 5.25 Parasitic flatworms. **(a)** A cestode (tapeworm), showing the scolex; long, tapelike body; and magnified views of immature and mature proglottids (body segments). The photo shows an actual tapeworm. **(b)** The structure of a trematode (liver fluke). Note the suckers that attach to host tissue and the dominance of reproductive and digestive organs. The photo shows an actual liver fluke.

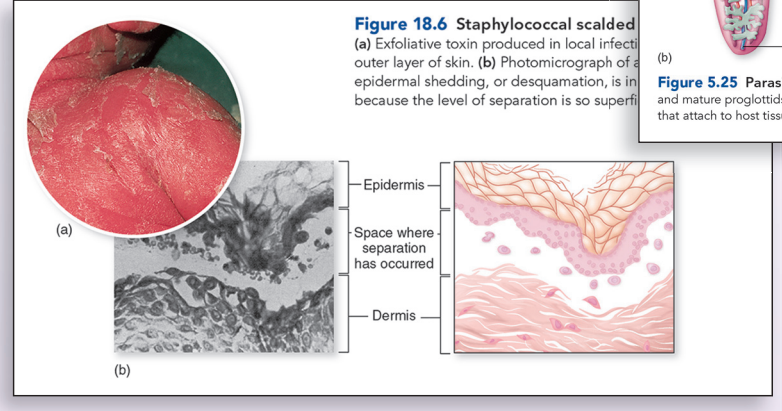


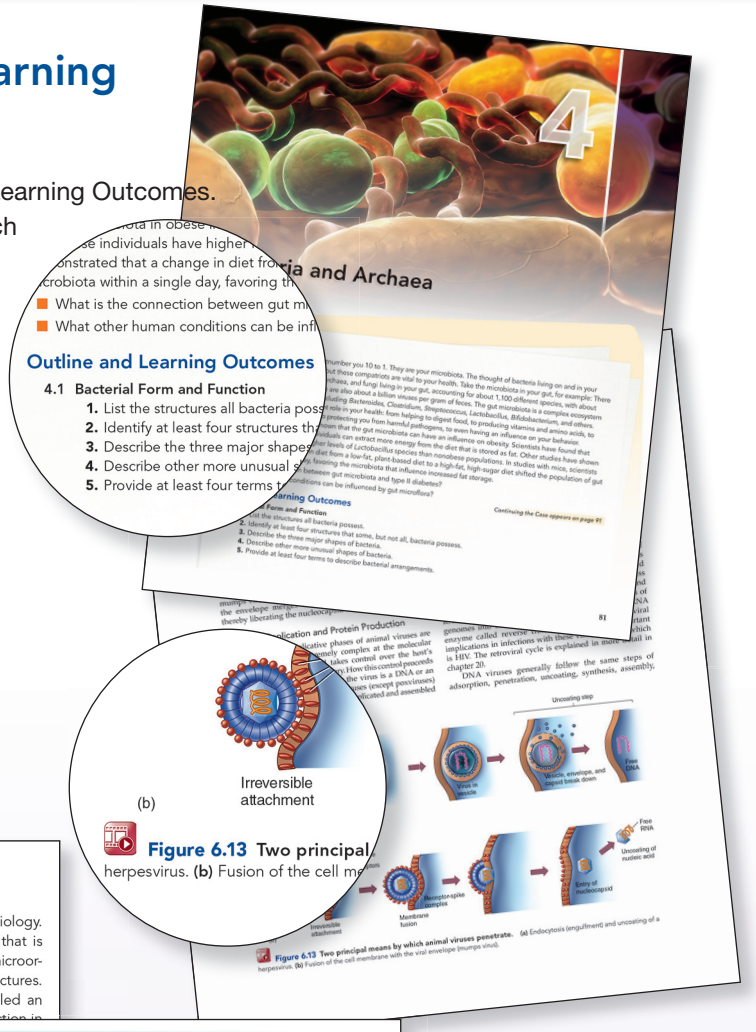
Figure 18.6 Staphylococcal scalded
(a) Exfoliative toxin produced in local infecti
outer layer of skin. **(b)** Photomicrograph of a
epidermal shedding, or desquamation, is in
because the level of separation is so superfi

Connecting Students to Microbiology Through Student-Centered Pedagogy

Pedagogy Created to Promote Active Learning

Learning Outcomes and Assess Your Progress Questions

Every chapter in the book now opens with an outline—which is a list of Learning Outcomes. Assess Your Progress with the learning outcome questions conclude each major section of the text. The Learning Outcomes are tightly correlated to digital material. Instructors can easily measure student learning in relation to the specific Learning Outcomes used in their course.

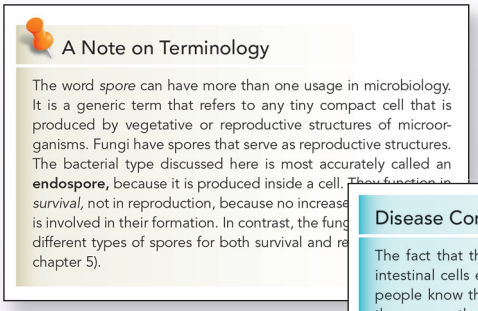


Animated Learning Modules

Certain topics need help to come to life off the page. Animations, video, audio and text all combine to help students understand complex processes. Key topics have an Animated Learning Module assignable through Connect. An icon in the text indicates when these learning modules are available.

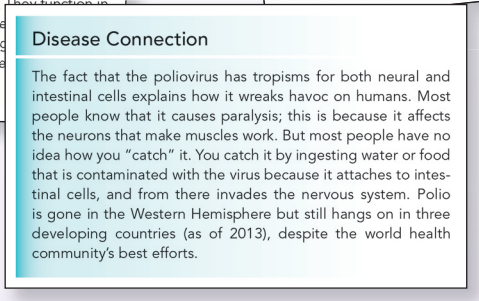
Notes

Notes appear, where appropriate, throughout the text. They give students helpful information about various terminologies, exceptions to the rule, or important clarifications.



Disease Connection

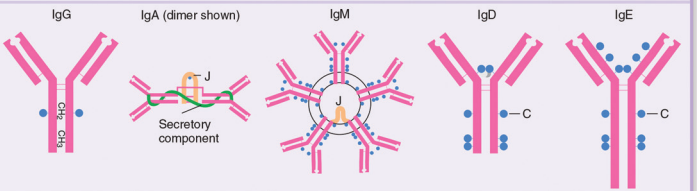
Sometimes it is difficult for students to see the relevance of basic concepts to their chosen professions. So in this edition the basic science chapters contain Disease Connections, very short boxes that relate esoteric topics such as pH and growth phase to clinical situations (*H. pylori* and *M. tuberculosis,* for these examples).



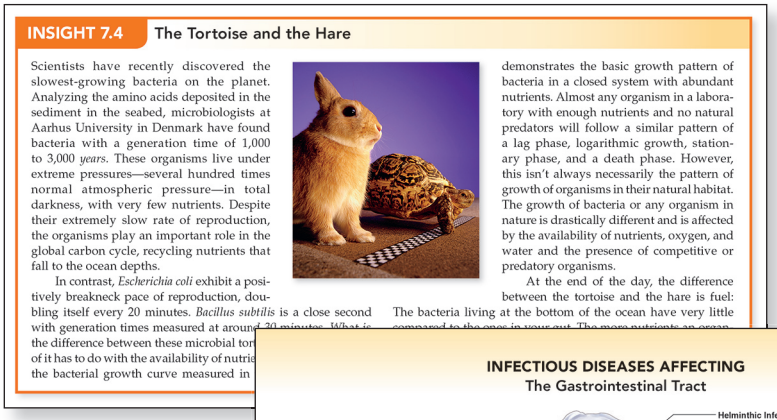
Tables

This edition contains numerous illustrated tables. Horizontal contrasting lines set off each entry, making it easy to read.

Table 15.3 Characteristics of the Immunoglobulin (Ig) Classes

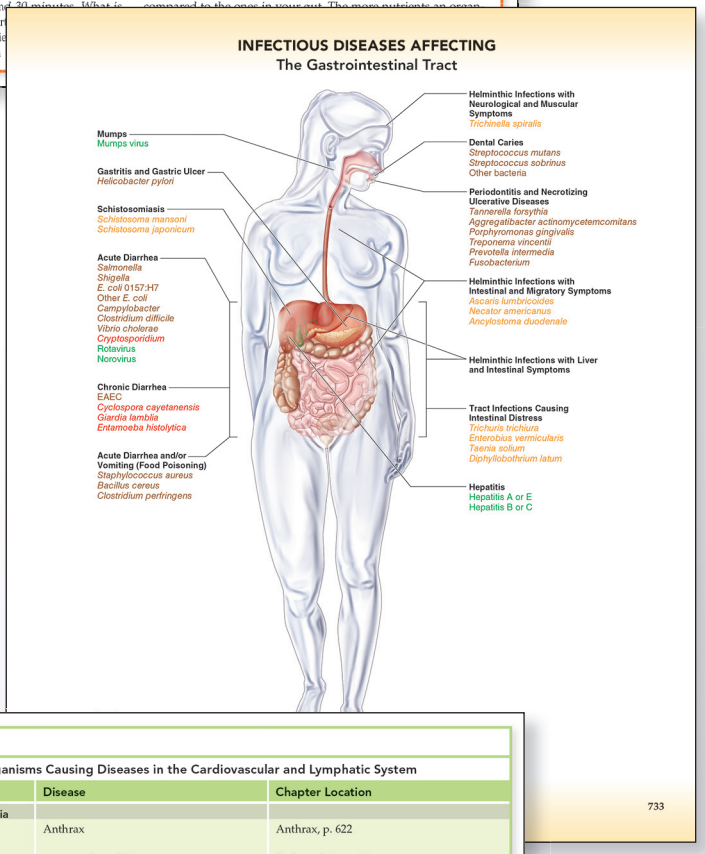


	Monomer	Dimer, Monomer	Pentamer	Monomer	Monomer
Number of Antigen Binding Sites	2	4, 2	10	2	2
Molecular Weight	150,000	170,000-385,000	900,000	180,000	200,000



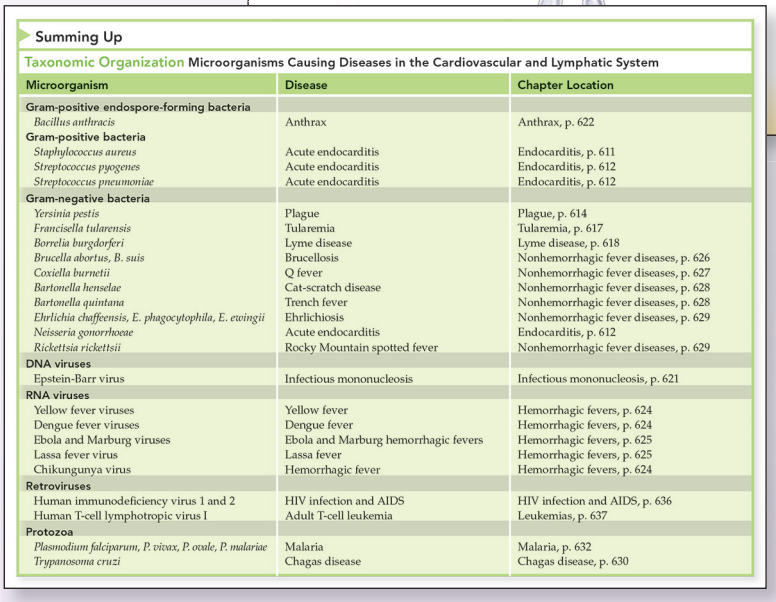
Insight Readings

Found throughout each chapter, current, real-world readings allow students to see an interesting application of the concepts they're studying.



System Summary Figures

"Glass body" figures at the end of each disease chapter highlight the affected organs and list the diseases that were presented in the chapter. In addition, the microbes are color coded by type of microorganism.



Summing Up

Taxonomic Organization Microorganisms Causing Diseases in the Cardiovascular and Lymphatic System

Microorganism	Disease	Chapter Location
Gram-positive endospore-forming bacteria		
Bacillus anthracis	Anthrax	Anthrax, p. 622
Gram-positive bacteria		
Staphylococcus aureus	Acute endocarditis	Endocarditis, p. 611
Streptococcus pyogenes	Acute endocarditis	Endocarditis, p. 612
Streptococcus pneumoniae	Acute endocarditis	Endocarditis, p. 612
Gram-negative bacteria		
Yersinia pestis	Plague	Plague, p. 614
Francisella tularensis	Tularemia	Tularemia, p. 617
Borrelia burgdorferi	Lyme disease	Lyme disease, p. 618
Brucella abortus, B. suis	Brucellosis	Nonhemorrhagic fever diseases, p. 626
Coxiella burnetii	Q fever	Nonhemorrhagic fever diseases, p. 627
Bartonella henselae	Cat-scratch disease	Nonhemorrhagic fever diseases, p. 628
Bartonella quintana	Trench fever	Nonhemorrhagic fever diseases, p. 628
Ehrlichia chaffeensis, E. phagocytophila, E. ewingii	Ehrlichiosis	Nonhemorrhagic fever diseases, p. 629
Neisseria gonorrhoeae	Acute endocarditis	Endocarditis, p. 612
Rickettsia rickettsii	Rocky Mountain spotted fever	Nonhemorrhagic fever diseases, p. 629
DNA viruses		
Epstein-Barr virus	Infectious mononucleosis	Infectious mononucleosis, p. 621
RNA viruses		
Yellow fever viruses	Yellow fever	Hemorrhagic fevers, p. 624
Dengue fever viruses	Dengue fever	Hemorrhagic fevers, p. 624
Ebola and Marburg viruses	Ebola and Marburg hemorrhagic fevers	Hemorrhagic fevers, p. 625
Lassa fever virus	Lassa fever	Hemorrhagic fevers, p. 625
Chikungunya virus	Hemorrhagic fever	Hemorrhagic fevers, p. 624
Retroviruses		
Human immunodeficiency virus 1 and 2	HIV infection and AIDS	HIV infection and AIDS, p. 636
Human T-cell lymphotropic virus I	Adult T-cell leukemia	Leukemias, p. 637
Protozoa		
Plasmodium falciparum, P. vivax, P. ovale, P. malariae	Malaria	Malaria, p. 632
Trypanosoma cruzi	Chagas disease	Chagas disease, p. 630

"I appreciate the organization in the way the topics are broken up so students can easily maintain their focus while reading. The Disease Tables, Insight Readings, and System Summary Figures are a great way for them to review and apply what they have learned."

—Alicia D. Carley, Northwest Technical College

Taxonomic List of Organisms

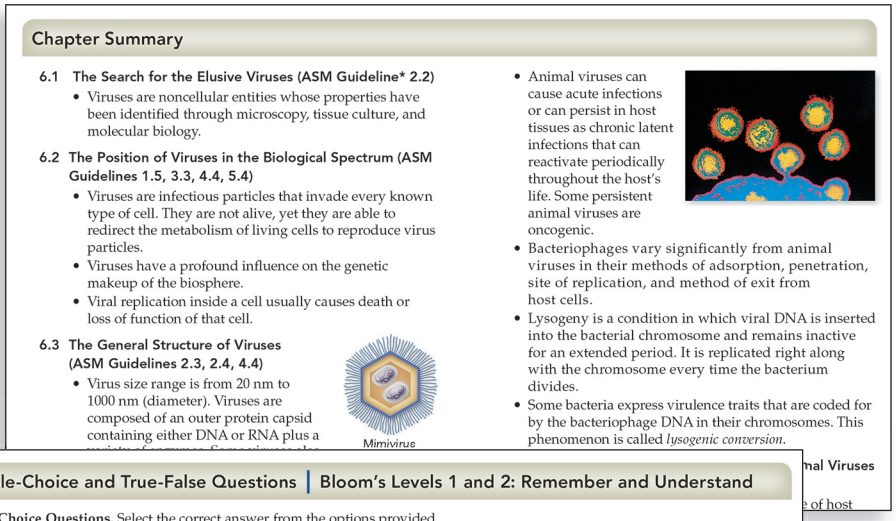
A taxonomic list of organisms is presented at the end of each disease chapter so students can see the taxonomic position of microbes causing diseases in that body system.

Connecting Learning to Bloom's Taxonomy

The end-of-chapter material is linked to Bloom's Taxonomy. It has been carefully planned to promote active learning and provide review for different learning styles and levels of difficulty. Multiple-Choice and True-False Questions (Remember and Understand) precede the Critical Thinking, Concept Connections, Visual Connections Questions and Concept Mapping Exercises, which take the student through the Apply, Analyze, Evaluate, and Create levels. The consistent layout of each chapter allows students to develop a learning strategy and gain confidence in their ability to master the concepts, leading to success in the class!

Chapter Summary

A brief outline of the main chapter concepts is provided for students with important terms highlighted. Key terms are also included in the glossary at the end of the book. The chapter summary is now tagged with new American Society for Microbiology curricular guidelines.



Chapter Summary

6.1 The Search for the Elusive Viruses (ASM Guideline* 2.2)

- Viruses are noncellular entities whose properties have been identified through microscopy, tissue culture, and molecular biology.

6.2 The Position of Viruses in the Biological Spectrum (ASM Guidelines 1.5, 3.3, 4.4, 5.4)

- Viruses are infectious particles that invade every known type of cell. They are not alive, yet they are able to redirect the metabolism of living cells to reproduce virus particles.
- Viruses have a profound influence on the genetic makeup of the biosphere.
- Viral replication inside a cell usually causes death or loss of function of that cell.

6.3 The General Structure of Viruses (ASM Guidelines 2.3, 2.4, 4.4)

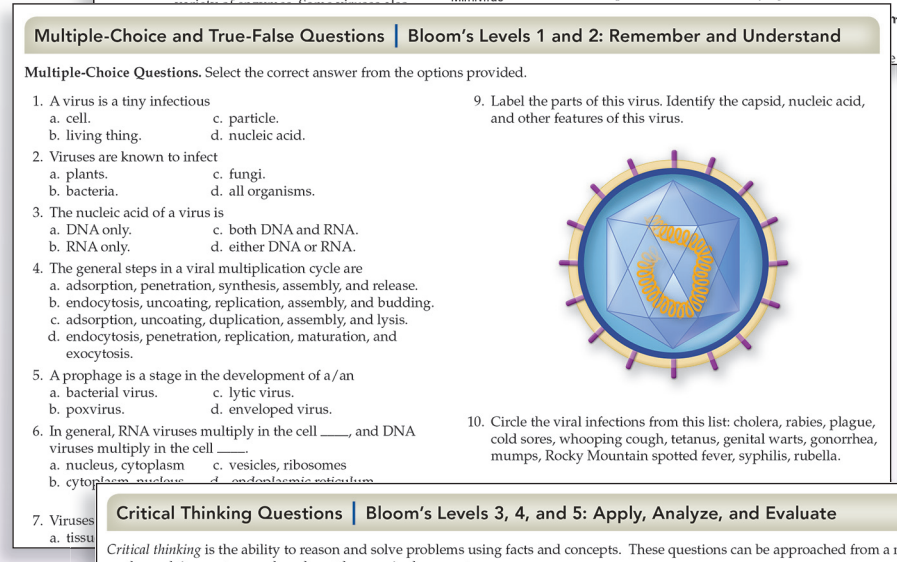
- Virus size range is from 20 nm to 1000 nm (diameter). Viruses are composed of an outer protein capsid containing either DNA or RNA plus a

Mimivirus

- Animal viruses can cause acute infections or can persist in host tissues as chronic latent infections that can reactivate periodically throughout the host's life. Some persistent animal viruses are oncogenic.
- Bacteriophages vary significantly from animal viruses in their methods of adsorption, penetration, site of replication, and method of exit from host cells.
- Lysogeny is a condition in which viral DNA is inserted into the bacterial chromosome and remains inactive for an extended period. It is replicated right along with the chromosome every time the bacterium divides.
- Some bacteria express virulence traits that are coded for by the bacteriophage DNA in their chromosomes. This phenomenon is called *lysogenic conversion*.

Multiple Choice and True-False Questions

Students can assess their knowledge of basic concepts by answering these questions. Other types of questions and activities that follow build on this foundational knowledge. The ConnectPlus eBook allows students to quiz themselves interactively using these questions! Bloom's Levels for all questions are provided.



Multiple-Choice and True-False Questions | Bloom's Levels 1 and 2: Remember and Understand

Multiple-Choice Questions. Select the correct answer from the options provided.

1. A virus is a tiny infectious
   a. cell. c. particle.
   b. living thing. d. nucleic acid.
2. Viruses are known to infect
   a. plants. c. fungi.
   b. bacteria. d. all organisms.
3. The nucleic acid of a virus is
   a. DNA only. c. both DNA and RNA.
   b. RNA only. d. either DNA or RNA.
4. The general steps in a viral multiplication cycle are
   a. adsorption, penetration, synthesis, assembly, and release.
   b. endocytosis, uncoating, replication, assembly, and budding.
   c. adsorption, uncoating, duplication, assembly, and lysis.
   d. endocytosis, penetration, replication, maturation, and exocytosis.
5. A prophage is a stage in the development of a/an
   a. bacterial virus. c. lytic virus.
   b. poxvirus. d. enveloped virus.
6. In general, RNA viruses multiply in the cell ____, and DNA viruses multiply in the cell ____.
   a. nucleus, cytoplasm c. vesicles, ribosomes
   b. cytoplasm, nucleus d. endoplasmic reticulum
7. Viruses
   a. tissu

9. Label the parts of this virus. Identify the capsid, nucleic acid, and other features of this virus.

10. Circle the viral infections from this list: cholera, rabies, plague, cold sores, whooping cough, tetanus, genital warts, gonorrhea, mumps, Rocky Mountain spotted fever, syphilis, rubella.

Critical Thinking Questions

Students use higher-order Bloom's skills (Apply, Analyze, Evaluate) with these questions. There is no single correct answer; this can open doors to discussion and application. New critical thinking questions have been added for the fourth edition.

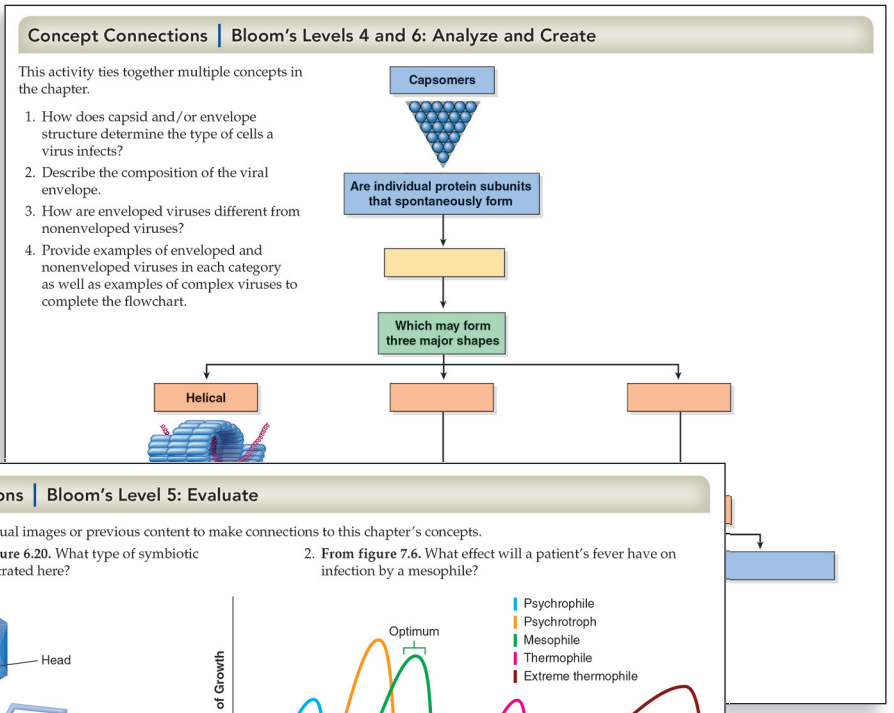
Critical Thinking Questions | Bloom's Levels 3, 4, and 5: Apply, Analyze, and Evaluate

Critical thinking is the ability to reason and solve problems using facts and concepts. These questions can be approached from a number of angles and, in most cases, they do not have a single correct answer.

1. Provide evidence in support of or refuting the following statement: Viruses are simple cellular agents of disease.
2. Summarize the unique properties of viruses and explain which of these characteristics allow them to function as "parasites."
3. a. Sketch the basic structure of both a nonenveloped and an enveloped virus, labeling all parts.
   b. Discuss the validity of the following statement: The viral capsid and envelope only provide functions that enhance the pathogenicity of a virus.
4. a. You identify a novel microbe in your laboratory and find that it possesses two types of nucleic acid. Explain why you immediately rule out the fact that this microbe is a virus.
   b. Describe the nucleic acid configuration of a positive-sense RNA virus and explain why its multiplication cycle is less complex than that of a retrovirus.
5. Define the term *tropism*, and provide at least one example illustrating how viral structure determines this property of a virus.
6. a. Provide one example of an oncogenic virus and explain the unique properties of its multiplication cycle that allow it to trigger the development of cancer.
   b. Compare and contrast the processes of latency and lysogeny, providing examples of latent viruses and lysogenic viruses.
7. Summarize the method used by most companies to manufacture influenza vaccine today, providing one clear advantage and one disadvantage of this process.

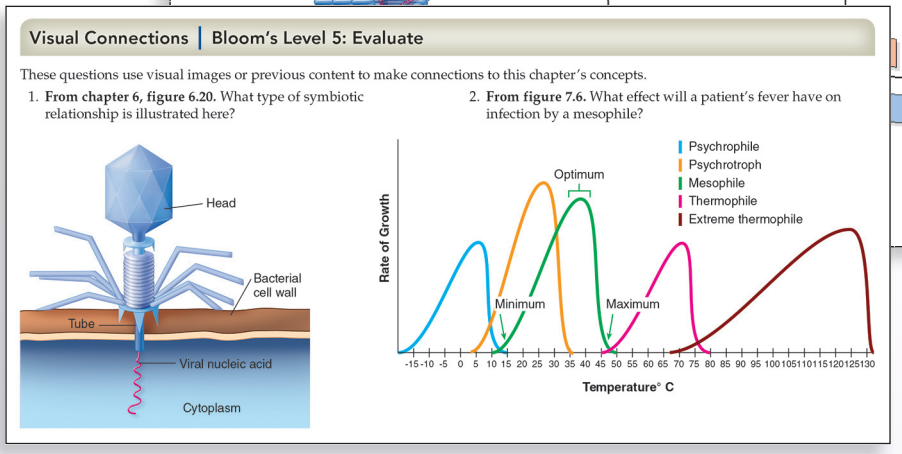
Concept Connections

A new feature that ties together topics in a visual manner, and calls on students' ability to Analyze and Create while connecting material from the chapter.



Visual Connections

Visual Connections questions take images and concepts learned in previous chapters and ask students to apply that knowledge to concepts newly learned in the current chapter. This helps students Evaluate information in new contexts and enhances learning.



Concept Mapping

Every chapter contains a list of terms from which students are asked to construct (Create) a concept map. ConnectPlus expands this activity with interactive concept maps.