Guided Tour

A SOUND LEARNING SYSTEM

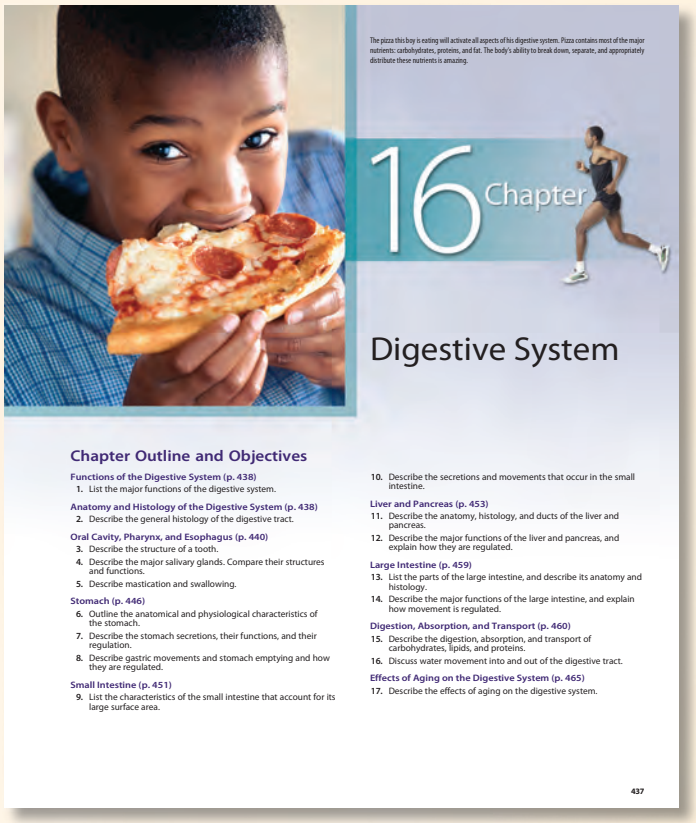
Seeley's Essentials of Anatomy & Physiology is designed to help students learn in a systematic fashion. Simple facts are the building blocks for developing explanations of more complex concepts. The clear and logical text discussion is presented within a supporting framework of learning aids that help organize studying, reinforce learning, and promote problem-solving skills.

"The Seeley Essentials textbook has a logical flow of information—topics build well on each other. Students learn the introductory information first, and then get the details and see how the current information ties into previously presented material. It does a great job of introducing, explaining details, summarizing and "linking" information, and building a great picture of human anatomy and physiology." —Bradley J. Fillmore, *Chadron State College*

"The writing style is unusually 'reader friendly.'"—Claire M. Leonard, *William Paterson University*

Chapter Outline and Objectives

An outline that combines chapter topics with their associated learning outcomes is presented at the beginning of each chapter to introduce key concepts students will encounter in their reading.



The pizza this boy is eating will activate all aspects of his digestive system. Pizza contains most of the major nutrients: carbohydrates, proteins, and fat. The body's ability to break down, separate, and appropriately distribute these nutrients is amazing.

16 Chapter

Digestive System

Chapter Outline and Objectives

Functions of the Digestive System (p. 438)
1. List the major functions of the digestive system.

Anatomy and Histology of the Digestive System (p. 438)
2. Describe the general histology of the digestive tract.

Oral Cavity, Pharynx, and Esophagus (p. 440)
3. Describe the structure of a tooth.
4. Describe the major salivary glands. Compare their structures and functions.
5. Describe mastication and swallowing.

Stomach (p. 446)
6. Outline the anatomical and physiological characteristics of the stomach.
7. Describe the stomach secretions, their functions, and their regulation.
8. Describe gastric movements and stomach emptying and how they are regulated.

Small Intestine (p. 451)
9. List the characteristics of the small intestine that account for its large surface area.
10. Describe the secretions and movements that occur in the small intestine.

Liver and Pancreas (p. 453)
11. Describe the anatomy, histology, and ducts of the liver and pancreas.
12. Describe the major functions of the liver and pancreas, and explain how they are regulated.

Large Intestine (p. 459)
13. List the parts of the large intestine, and describe its anatomy and histology.
14. Describe the major functions of the large intestine, and explain how movement is regulated.

Digestion, Absorption, and Transport (p. 460)
15. Describe the digestion, absorption, and transport of carbohydrates, lipids, and proteins.
16. Discuss water movement into and out of the digestive tract.

Effects of Aging on the Digestive System (p. 465)
17. Describe the effects of aging on the digestive system.

437

Predict Questions

These innovative critical thinking exercises encourage students to become active learners as they read. Predict Questions challenge readers to use their understanding of new concepts to solve a problem. Answers to Predict Questions are given at the end of the text, allowing students to evaluate their responses and discover the logic used in arriving at the correct answer.

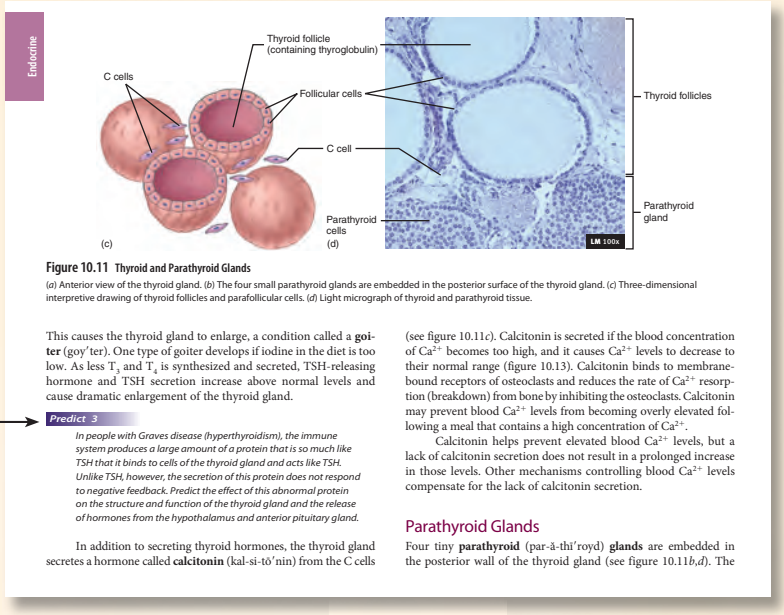


Figure 10.11 Thyroid and Parathyroid Glands

(*a*) Anterior view of the thyroid gland. (*b*) The four small parathyroid glands are embedded in the posterior surface of the thyroid gland. (*c*) Three-dimensional interpretive drawing of thyroid follicles and parafollicular cells. (*d*) Light micrograph of thyroid and parathyroid tissue.

This causes the thyroid gland to enlarge, a condition called a **goiter** (goy′ter). One type of goiter develops if iodine in the diet is too low. As less T_3 and T_4 is synthesized and secreted, TSH-releasing hormone and TSH secretion increase above normal levels and cause dramatic enlargement of the thyroid gland.

Predict 3

In people with Graves disease (hyperthyroidism), the immune system produces a large amount of a protein that is so much like TSH that it binds to cells of the thyroid gland and acts like TSH. Unlike TSH, however, the secretion of this protein does not respond to negative feedback. Predict the effect of this abnormal protein on the structure and function of the thyroid gland and the release of hormones from the hypothalamus and anterior pituitary gland.

In addition to secreting thyroid hormones, the thyroid gland secretes a hormone called **calcitonin** (kal-si-tō′nin) from the C cells (see figure 10.11*c*). Calcitonin is secreted if the blood concentration of Ca^{2+} becomes too high, and it causes Ca^{2+} levels to decrease to their normal range (figure 10.13). Calcitonin binds to membrane-bound receptors of osteoclasts and reduces the rate of Ca^{2+} resorption (breakdown) from bone by inhibiting the osteoclasts. Calcitonin may prevent blood Ca^{2+} levels from becoming overly elevated following a meal that contains a high concentration of Ca^{2+}.

Calcitonin helps prevent elevated blood Ca^{2+} levels, but a lack of calcitonin secretion does not result in a prolonged increase in those levels. Other mechanisms controlling blood Ca^{2+} levels compensate for the lack of calcitonin secretion.

Parathyroid Glands

Four tiny **parathyroid** (par-ă-thī′royd) **glands** are embedded in the posterior wall of the thyroid gland (see figure 10.11*b*,*d*). The

produced in one part of a cell, such as the cell membrane, and then travel to another part of the same cell, where they bind to receptors in either the cytoplasm or the nucleus. **Intercellular chemical signals** are released from one cell and carried in the intercellular fluid; they bind to receptors that are found in some cells, but usually not in all cells, of the body. Intercellular chemical signals can be categorized into six types, depending on the source of the chemical signals or their targets (table 10.1).

Autocrine (aw′tō-krin; *autos*, self) **chemical signals** are released by cells and have a local effect on the same cell type from which they are released. Examples include chemicals such as the eicosanoids (*eicosa*, refers to 20-carbon atoms) that are released from smooth muscle cells and from platelets in response to inflammation. These chemicals cause the relaxation of blood vessel smooth muscle cells and the aggregation of platelets. As a result, the blood vessels dilate, and blood clots.

Paracrine (par′ă-krin; *para*, alongside) **chemical signals** are released by cells that produce effects on other cell types near the cells from which they are released, without being transported in blood. For example, cells in the pancreas release a peptide called somatostatin, which functions locally to inhibit the secretion of insulin from other cells of the pancreas.

Hormones (hōr′mōnz) and **neurohormones** are intercellular chemical signals secreted into the circulatory system (see "Hormones" later in this chapter). They are carried in the blood to the organs they control, where they bind to receptor molecules and produce a response.

Neurotransmitters and **neuromodulators** are intercellular chemical signals, secreted by nerve cells, that play important roles in nervous system function (see chapter 8).

Vocabulary Aids

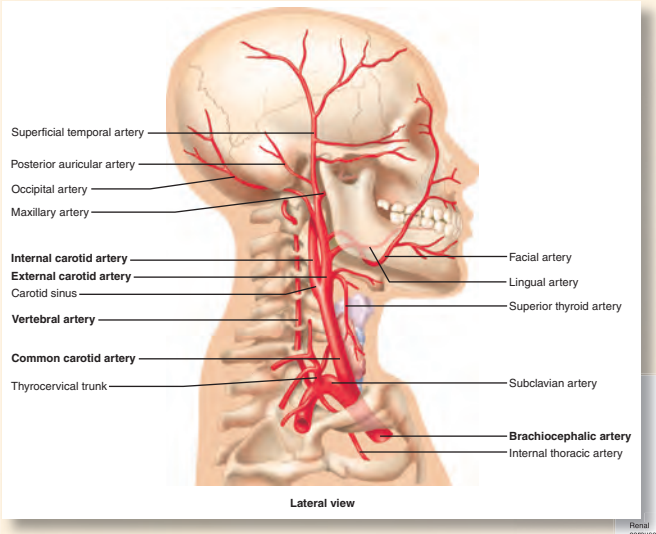
Learning anatomy and physiology, is, in many ways, like learning a new language. Mastering the terminology is vital to building a knowledge base. Key terms are set in boldface where they are defined in the chapter (with acceptable alternate terms in italics), and most terms are included in the glossary at the end of the book. Pronunciation guides are included for difficult words.

Because knowing the origin of a term can enhance understanding and retention, the meanings of the words or root words that form a term are given when they are relevant. Furthermore, a handy list of prefixes, suffixes, and combining forms is printed on the inside of the back cover as a quick reference to help students identify commonly used root words.

Guided Tour

INSTRUCTIVE ARTWORK MAKES THE DIFFERENCE

A picture is worth a thousand words—especially when learning anatomy and physiology. Because words alone cannot convey the nuances of anatomy or the intricacies of physiology, the seventh edition of *Seeley's Essentials of Anatomy and Physiology* employs a dynamic program of full-color illustrations and photographs that support and further clarify the text explanations. Brilliantly rendered and carefully reviewed for accuracy and consistency, the precisely labeled illustrations and photos provide concrete, visual reinforcement of the topics discussed throughout the text.

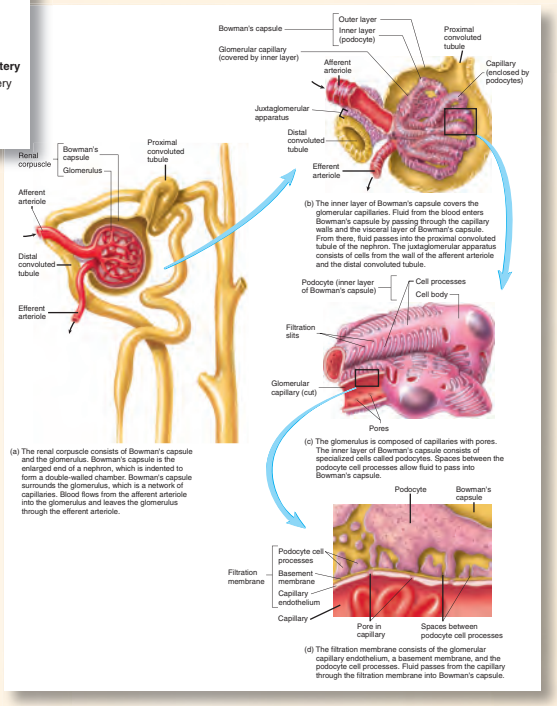


Realistic Anatomical Art

The anatomical figures in Seeley's Essentials of Anatomy and Physiology *have been carefully rendered to convey realistic, three-dimensional detail. Richly textured bones and artfully shaded muscles and vessels lend a sense of realism to the figures which helps readers envision the appearance of actual structures within the body.*

The colors used to represent various anatomical structures have been applied consistently throughout the book. This reliable color pattern promotes continuity between figures and allows students to identify the structures in each illustration.

Reference diagrams orient students to the perspective of important or complex illustrations.



Multi-level Perspective

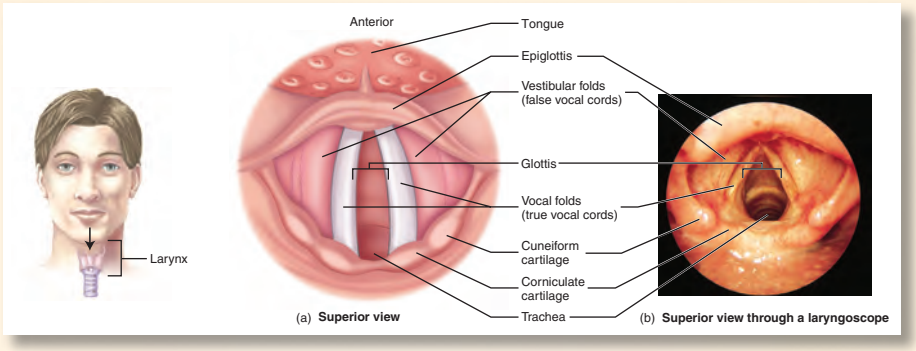
Illustrations depicting complex structures or processes combine macroscopic and microscopic views to help students see the relationships between increasingly detailed drawings.

"As soon as I received a copy of this book, I requested to change the text that I was using to Seeley for the following academic year. This book discusses all topics in an interesting style, and addresses all learning methods. The feedback from my students can be summarized in one phrase 'easy on the eyes.'"—Nahel W. Awadallah, *Sampson Community College*

Guided Tour

Combination Art

Drawings are often paired with photographs to enhance the visualization of structures.



Histology Micrographs

Light micrographs, as well as scanning and transmission electron micrographs, are used in conjunction with illustrations to present a true picture of anatomy and physiology from the cellular level.

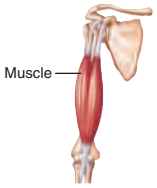
TABLE 4.11 Muscle Tissue

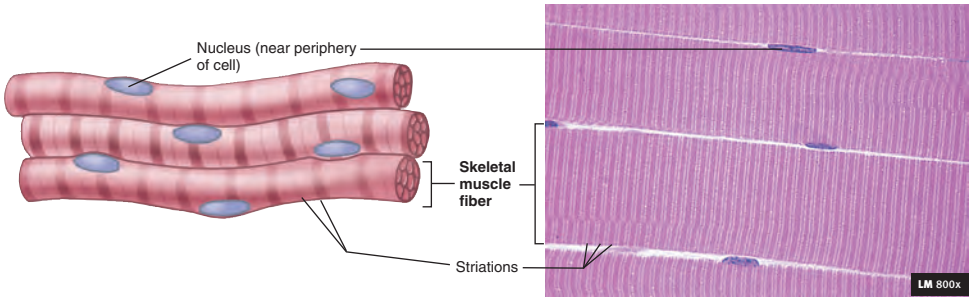
(a) Skeletal Muscle

Structure: Skeletal muscle cells or fibers appear striated (banded); cells are large, long, and cylindrical, with many nuclei

Function: Movement of the body; under voluntary control

Location: Attached to bone or other connective tissue





Guided Tour

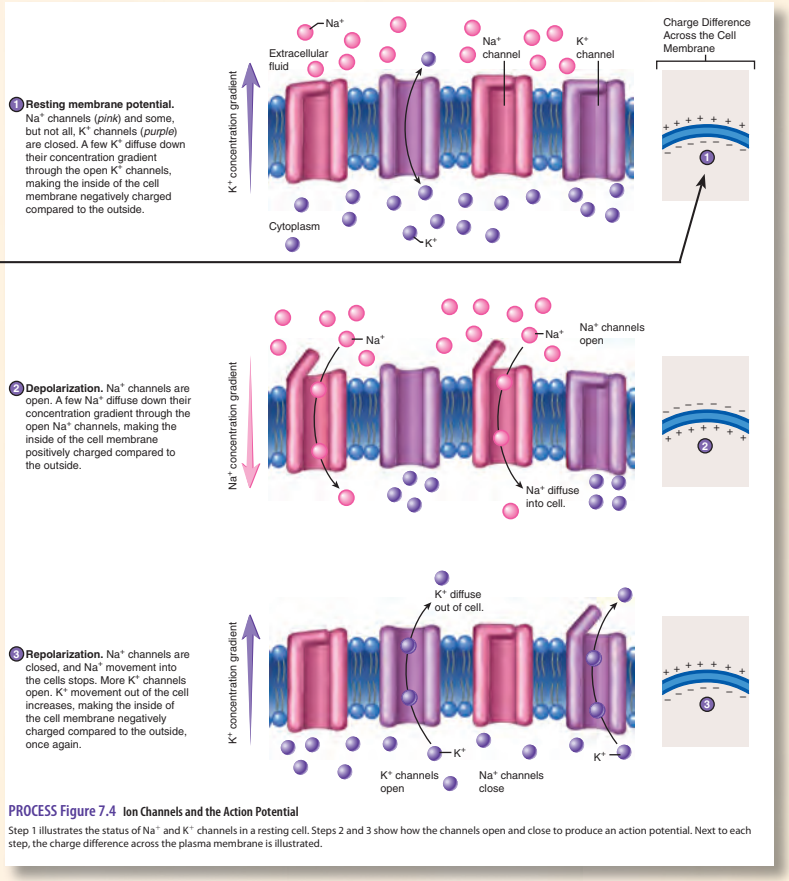
SPECIALIZED FIGURES CLARIFY TOUGH CONCEPTS

Studying anatomy and physiology does not have to be an intimidating task mired in memorization. *Seeley's Essentials of Anatomy and Physiology* uses two special types of illustrations to help students not only learn the steps involved in specific processes, but also apply the knowledge as they predict outcomes in similar situations. Process Figures organize the key occurrences of physiological processes in an easy-to-follow format. Homeostasis figures summarize the mechanisms of homeostasis by diagramming how a given system regulates a parameter within a narrow range of values.

Process Figures

Process Figures break down physiological processes into a series of smaller steps, allowing readers to track the key occurrences and learn them as they work through the illustration.

Indicators within the artwork correspond to the numbered steps along the side. These colored circles help students zero in on the site where the action described in each step takes place.



Process Figures and Homeostasis Figures are identified next to the figure number. The accompanying caption provides additional explanation.

PROCESS Figure 7.4 Ion Channels and the Action Potential

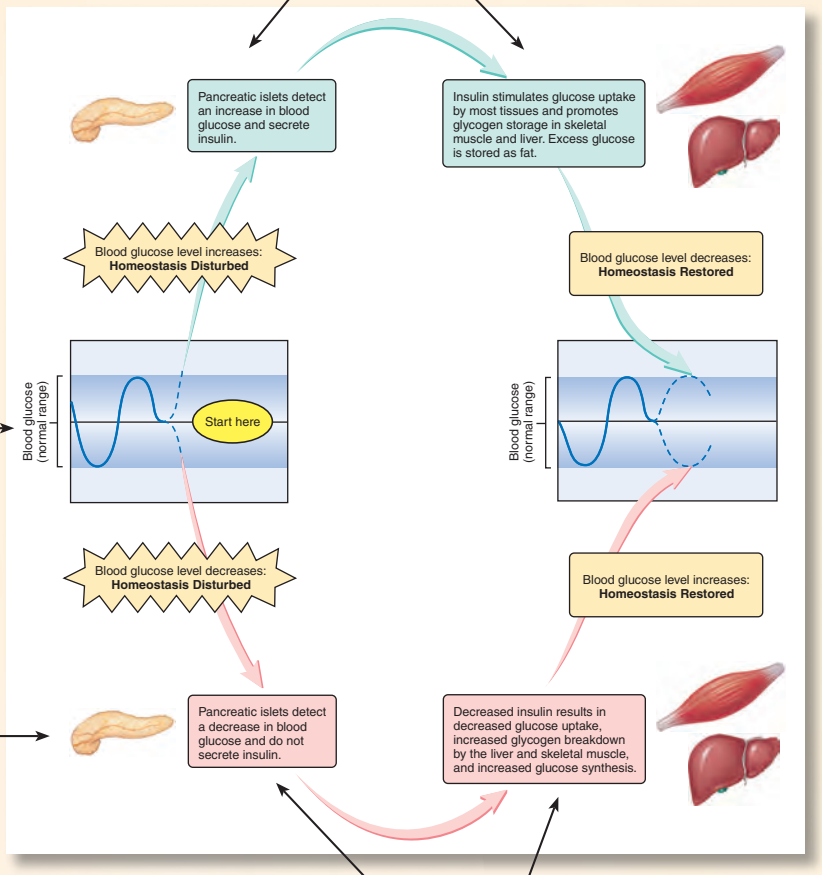
Step 1 illustrates the status of Na^+ and K^+ channels in a resting cell. Steps 2 and 3 show how the channels open and close to produce an action potential. Next to each step, the charge difference across the plasma membrane is illustrated.

Guided Tour

Homeostasis Figures

These specialized flow charts diagram the mechanisms that body systems use to maintain homeostasis. This edition features a new design for these important figures.

Changes caused by an increase of a variable toward the outside of its normal range are shown in the boxes outlined in green.



The normal range for a given value is represented by the graphs in the center of each figure.

Start at the yellow icon and follow the green arrows to learn about the chain of events triggered by an ***increase*** *in the variable, or the red arrows for events resulting from a* ***decrease*** *in the variable.*

Small accompanying illustrations remind students of the organs or structures involved in the process.

Changes caused by a decrease of a variable toward the outside of its normal range are shown in boxes outlined in red.

"The homeostasis figures in Chapters 12 and 13 are fantastic. I always emphasize in my classes that homeostasis is the reason our bodies function the way they do. The advantages of having figures like this is that there is a clear start/stop point and the figures clearly represent the mechanisms responsible for maintaining the feedback necessary for regulating homeostasis."—Melissa Reed, *Pitt Community College*

Guided Tour

CLINICAL CONTENT PUTS KNOWLEDGE INTO PRACTICE

Seeley's Essentials of Anatomy and Physiology provides clinical examples to promote interest and demonstrate relevance, but clinical information is used primarily to illustrate the application of basic knowledge. Exposure to clinical case studies is especially beneficial if students are planning on using their knowledge of anatomy and physiology in a health-related career.

A CASE IN POINT

Venous Thrombosis

Harry Leggs is a 55-year-old college professor who teaches a night class in a small town about 50 miles from his home. One evening, as he walked to his car after teaching the class, Harry became aware of a slight pain in his right leg. By the time he reached home about 90 minutes later, the calf of his right leg was swollen. When he extended his knee and plantar flexed his foot, the pain increased. Harry knew this was a serious condition, so he drove to the emergency room. There, technicians performed a Doppler test to monitor the flow of blood through the blood vessels in Harry's right leg. The test confirmed that a thrombus had formed in one of the deep veins of the leg.

Harry's symptoms stemmed from several events. Small proteins released from fibrinogen during clot formation caused the activation of kinins that stimulate pain receptors (see chapter 14). Also, the blocked vein caused edema and led to tissue ischemia, a decrease in blood flow to tissues, which may resulted in tissue damage and pain. Edema occurred because of the increase in venous pressure inferior to the blocked vein (see figure 13.24).

A major danger associated with a deep venous thrombosis is that portions of the thrombus may form emboli. The emboli are likely to be transported in the blood to the lungs, where they form pulmonary emboli. Pulmonary emboli are life-threatening because they may be large or numerous enough to block blood flow to substantial areas of the lungs.

Harry was admitted to the hospital for a few days. His movements were restricted, and he was given an anticoagulant. Even after his release, he continued taking the anticoagulant for a few weeks until the clot had dissolved.

A Case in Point

These brief case studies explore relevant issues of clinical interest and explain how material just presented in the text can be used to understand important anatomical and physiological concepts, particularly in a clinical setting.

"Overall, the text chapters are clear, easy to read, and very concise. They give the students exactly what they need to know. The case studies are great. I encourage my students to read and apply them to help understand the content of the chapter." —Mahmoud Bishr, *Penn Valley College*

CLINICAL IMPACT

Blood Vessels Used for Coronary Bypass Surgery

The great saphenous vein is often surgically removed and used in coronary bypass surgery. Portions of the saphenous vein are grafted to create a route for blood flow that bypasses blocked portions of the coronary arteries. The circulation interrupted by the removal of the saphenous vein flows through other veins of the lower limb instead. The internal thoracic artery is also used for coronary bypasses. The distal end of the artery is freed and attached to a coronary artery at a point that bypasses the blocked portion. This technique appears to be better because the internal thoracic artery does not become blocked as fast as the saphenous vein. However, due to the length of the saphenous vein and the fact that more than one segment can be removed for use in bypass surgery, surgeons use the saphenous vein.

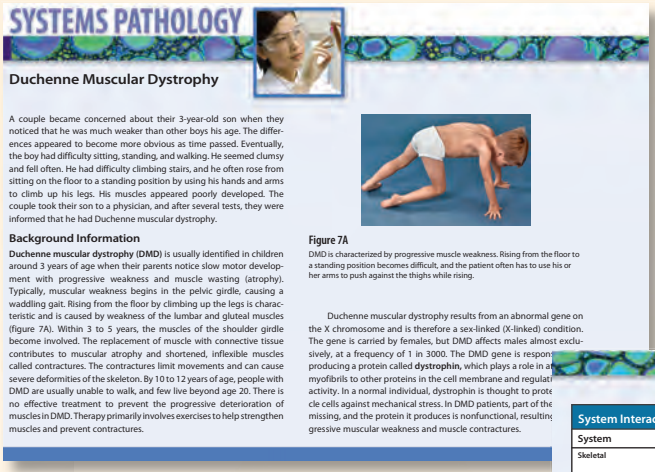
Clinical Impact

The topics of these boxed essays include pathologies, current research, sports medicine, exercise physiology, pharmacology, and various clinical applications.

Guided Tour

Systems Pathology

These in-depth boxes explore a specific disorder or condition related to a particular body system. Presented in a modified case study format, each Systems Pathology box begins with a patient history followed by background information about the featured topic.



SYSTEMS PATHOLOGY

Duchenne Muscular Dystrophy

A couple became concerned about their 3-year-old son when they noticed that he was much weaker than other boys his age. The differences appeared to become more obvious as time passed. Eventually, the boy had difficulty sitting, standing, and walking. He seemed clumsy and fell often. He had difficulty climbing stairs, and he often rose from sitting on the floor to a standing position by using his hands and arms to climb up his legs. His muscles appeared poorly developed. The couple took their son to a physician, and after several tests, they were informed that he had Duchenne muscular dystrophy.

Background Information

Duchenne muscular dystrophy (DMD) is usually identified in children around 3 years of age when their parents notice slow motor development with progressive weakness and muscle wasting (atrophy). Typically, muscular weakness begins in the pelvic girdle, causing a waddling gait. Rising from the floor by climbing up the legs is characteristic and is caused by weakness of the lumbar and gluteal muscles (figure 7A). Within 3 to 5 years, the muscles of the shoulder girdle become involved. The replacement of muscle with connective tissue contributes to muscular atrophy and shortened, inflexible muscles called contractures. The contractures limit movements and can cause severe deformities of the skeleton. By 10 to 12 years of age, people with DMD are usually unable to walk, and few live beyond age 20. There is no effective treatment to prevent the progressive deterioration of muscles in DMD. Therapy primarily involves exercises to help strengthen muscles and prevent contractures.

Figure 7A
DMD is characterized by progressive muscle weakness. Rising from the floor to a standing position becomes difficult, and the patient often has to use his or her arms to push against the thighs while rising.

Duchenne muscular dystrophy results from an abnormal gene on the X chromosome and is therefore a sex-linked (X-linked) condition. The gene is carried by females, but DMD affects males almost exclusively, at a frequency of 1 in 3000. The DMD gene is respons producing a protein called **dystrophin,** which plays a role in a myofibrils to other proteins in the cell membrane and regulat activity. In a normal individual, dystrophin is thought to prote cle cells against mechanical stress. In DMD patients, part of the missing, and the protein it produces is nonfunctional, resultin gressive muscular weakness and muscle contractures.

A System Interactions table at the end of every box summarizes how the condition affects each body system.

System Interactions — **Effects of Duchenne Muscular Dystrophy on Other Systems**

System	Interactions
Skeletal	Shortened, inflexible muscles (contractures) cause severe deformities of the skeletal system. Kyphoscoliosis, severe curvature of the spinal column laterally and anteriorly, can be so severe that normal respiratory movements are impaired. Surgery is sometimes required to prevent contractures from making it impossible for the individual to sit in a wheelchair.
Nervous	Some degree of mental retardation occurs in a large percentage of people with DMD, although the specific cause is unknown. Research suggests that dystrophin is important in the formation of synapses between nerve cells.
Cardiovascular	DMD affects cardiac muscle; consequently, heart failure occurs in a large number of people with advanced DMD. Cardiac involvement becomes serious in as many as 95% of cases and is one of the leading causes of death for individuals with DMD.
Lymphatic and Immune	No obvious direct effects occur to the lymphatic system, but damaged muscle fibers are phagocytized by macrophages.
Respiratory	Deformity of the thorax and increasing weakness of the respiratory muscles results in inadequate respiratory movements, which cause an increase in respiratory infections, such as pneumonia. Insufficient movement of air into and out of the lungs due to weak respiratory muscles is a major contributing factor in many deaths.
Digestive	DMD affects smooth muscle tissue, and the reduced ability of smooth muscle to contract can cause disorders of the digestive system. Digestive system disorders include an enlarged colon diameter, and twisting of the small intestine, resulting in intestinal obstruction, cramping, and reduced absorption of nutrients.
Urinary	Reduced smooth muscle function and wheelchair dependency increase the frequency of urinary tract infections.

Predict 6

A boy with advanced Duchenne muscular dystrophy developed pulmonary edema (accumulation of fluid in the lungs) and pneumonia caused by a bacterial infection. His physician diagnosed the condition in the following way: The pulmonary edema was the result of heart failure, and the increased fluid in the lungs provided a site where bacteria could invade and grow. The fact that the boy could not breathe deeply or cough effectively made the condition worse. How would the muscle tissues in a boy with advanced DMD with heart failure and ineffective respiratory movements differ from the muscle tissues in a boy with less advanced DMD?

Every Systems Pathology box includes a Predict Question specific to the case study.

DISEASES AND DISORDERS Muscular System

CONDITION	DESCRIPTION
Cramps	Painful, spastic contractions of a muscle; usually due to a buildup of lactic acid
Fibromyalgia (fi-brō-mi-al'ja)	Non-life-threatening, chronic, widespread pain in muscles with no known cure; also known as chronic muscle pain syndrome
Hypertrophy	Enlargement of a muscle due to an increased number of myofibrils, as occurs with increased muscle use
Atrophy	Decrease in muscle size due to a decreased number of myofilaments; can occur due to disuse of a muscle, as in paralysis
Muscular dystrophy	Group of genetic disorders in which all types of muscle degenerate and atrophy
Duchenne muscular dystrophy	See Systems Pathology
Myotonic muscular dystrophy	Muscles are weak and fail to relax following forceful contractions; affects the hands most severely; dominant trait in 1/20,000 births
Myasthenia gravis	See A Case in Point, earlier in this chapter
Tendinitis (ten-di-nī'tis)	Inflammation of a tendon or its attachment point due to overuse of the muscle

Go to **www.mhhe.com/seeleyess7** for additional information on these pathologies.

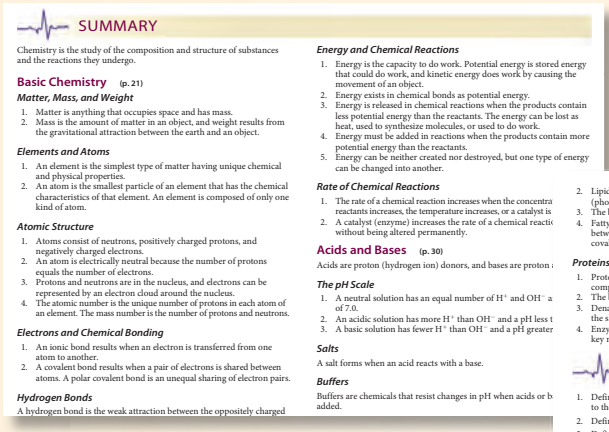
New! Diseases and Disorders Tables

Examples of diseases and/or disorders related to a particular system are collected in one easy-to-read table for students, helping them appreciate the clinical possibilities related to that body system.

Guided Tour

STUDY FEATURES ENSURE SUCCESS

A carefully devised set of learning aids at the end of each chapter assists students in reviewing the chapter content, evaluating their grasp of key concepts, and utilizing what they've learned.



SUMMARY

Chemistry is the study of the composition and structure of substances and the reactions they undergo.

Basic Chemistry (p. 21)

Matter, Mass, and Weight

1. Matter is anything that occupies space and has mass.
2. Mass is the amount of matter in an object, and weight results from the gravitational attraction between the earth and an object.

Elements and Atoms

1. An element is the simplest type of matter having unique chemical and physical properties.
2. An atom is the smallest particle of an element that has the chemical characteristics of that element. An element is composed of only one kind of atom.

Atomic Structure

1. Atoms consist of neutrons, positively charged protons, and negatively charged electrons.
2. An atom is electrically neutral because the number of protons equals the number of electrons.
3. Protons and neutrons are in the nucleus, and electrons can be represented by an electron cloud around the nucleus.
4. The atomic number is the unique number of protons in each atom of an element. The mass number is the number of protons and neutrons.

Electrons and Chemical Bonding

1. An ionic bond results when an electron is transferred from one atom to another.
2. A covalent bond results when a pair of electrons is shared between atoms. A polar covalent bond is an unequal sharing of electron pairs.

Hydrogen Bonds

A hydrogen bond is the weak attraction between the oppositely charged

Energy and Chemical Reactions

1. Energy is the capacity to do work. Potential energy is stored energy that could do work, and kinetic energy does work by causing the movement of an object.
2. Energy exists in chemical bonds as potential energy.
3. Energy is released in chemical reactions when the products contain less potential energy than the reactants. The energy can be lost as heat, used to synthesize molecules, or used to do work.
4. Energy must be added in reactions when the products contain more potential energy than the reactants.
5. Energy can be neither created nor destroyed, but one type of energy can be changed into another.

Rate of Chemical Reactions

1. The rate of a chemical reaction increases when the concentra reactants increases, the temperature increases, or a catalyst is
2. A catalyst (enzyme) increases the rate of a chemical reacti without being altered permanently.

Acids and Bases (p. 30)

Acids are proton (hydrogen ion) donors, and bases are proton

The pH Scale

1. A neutral solution has an equal number of H^+ and OH^- a of 7.0.
2. An acidic solution has more H^+ than OH^- and a pH less t
3. A basic solution has fewer H^+ than OH^- and a pH greater

Salts

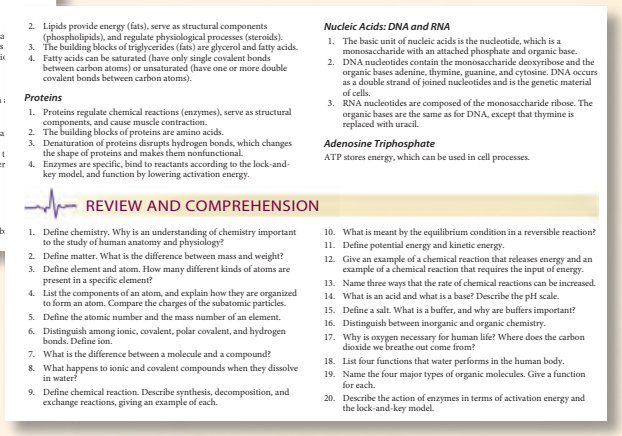
A salt forms when an acid reacts with a base.

Buffers

Buffers are chemicals that resist changes in pH when acids or b added.

Chapter Summary

The summary outline briefly states the important facts and concepts covered in each chapter to provide a convenient "big picture" of the chapter content.



2. Lipids provide energy (fats), serve as structural components (phospholipids), and regulate physiological processes (steroids).
3. The building blocks of triglycerides (fats) are glycerol and fatty acids.
4. Fatty acids can be saturated (have only single covalent bonds between carbon atoms) or unsaturated (have one or more double covalent bonds between carbon atoms).

Proteins

1. Proteins regulate chemical reactions (enzymes), serve as structural components, and cause muscle contraction.
2. The building blocks of proteins are amino acids.
3. Denaturation of proteins disrupts hydrogen bonds, which changes the shape of proteins and makes them nonfunctional.
4. Enzymes are specific, bind to reactants according to the lock-and-key model, and function by lowering activation energy.

Nucleic Acids: DNA and RNA

1. The basic unit of nucleic acids is the nucleotide, which is a monosaccharide with an attached phosphate and organic base.
2. DNA nucleotides contain the monosaccharide deoxyribose and the organic bases adenine, thymine, guanine, and cytosine. DNA occurs as a double strand of joined nucleotides and is the genetic material of cells.
3. RNA nucleotides are composed of the monosaccharide ribose. The organic bases are the same as for DNA, except that thymine is replaced with uracil.

Adenosine Triphosphate

ATP stores energy, which can be used in cell processes.

REVIEW AND COMPREHENSION

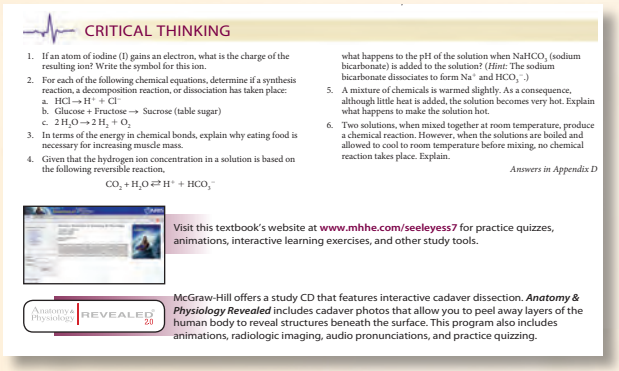
1. Define chemistry. Why is an understanding of chemistry important to the study of human anatomy and physiology?
2. Define matter. What is the difference between mass and weight?
3. Define element and atom. How many different kinds of atoms are present in a specific element?
4. List the components of an atom, and explain how they are organized to form an atom. Compare the charges of the subatomic particles.
5. Define the atomic number and the mass number of an element.
6. Distinguish among ionic, covalent, polar covalent, and hydrogen bonds. Define ion.
7. What is the difference between a molecule and a compound?
8. What happens to ionic and covalent compounds when they dissolve in water?
9. Define chemical reaction. Describe synthesis, decomposition, and exchange reactions, giving an example of each.
10. What is meant by the equilibrium condition in a reversible reaction?
11. Define potential energy and kinetic energy.
12. Give an example of a chemical reaction that releases energy and an example of a chemical reaction that requires the input of energy.
13. Name three ways that the rate of chemical reactions can be increased.
14. What is an acid and what is a base? Describe the pH scale.
15. Define a salt. What is a buffer, and why are buffers important?
16. Distinguish between inorganic and organic chemistry.
17. Why is oxygen necessary for human life? Where does the carbon dioxide we breathe out come from?
18. List four functions that water performs in the human body.
19. Name the four major types of organic molecules. Give a function for each.
20. Describe the action of enzymes in terms of activation energy and the lock-and-key model.

Review and Comprehension

These practice questions cover the main points presented in the chapter. Completing these exercises helps students gauge their mastery of the material.

Answers to Predict Questions

The Predict Questions that appear throughout the text are answered in Appendix E, allowing students to evaluate their responses and understand the logic used to arrive at the correct answer.



CRITICAL THINKING

1. If an atom of iodine (I) gains an electron, what is the charge of the resulting ion? Write the symbol for this ion.
2. For each of the following chemical equations, determine if a synthesis reaction, a decomposition reaction, or dissociation has taken place:
   a. $HCl \rightarrow H^+ + Cl^-$
   b. Glucose + Fructose $\rightarrow$ Sucrose (table sugar)
   c. $2\,H_2O \rightarrow 2\,H_2 + O_2$
3. In terms of the energy in chemical bonds, explain why eating food is necessary for increasing muscle mass.
4. Given that the hydrogen ion concentration in a solution is based on the following reversible reaction,

$$CO_2 + H_2O \rightleftarrows H^+ + HCO_3^-$$

what happens to the pH of the solution when $NaHCO_3$ (sodium bicarbonate) is added to the solution? (*Hint:* The sodium bicarbonate dissociates to form Na^+ and HCO_3^-.)

5. A mixture of chemicals is warmed slightly. As a consequence, although little heat is added, the solution becomes very hot. Explain what happens to make the solution hot.
6. Two solutions, when mixed together at room temperature, produce a chemical reaction. However, when the solutions are boiled and allowed to cool to room temperature before mixing, no chemical reaction takes place. Explain.

Answers in Appendix D

Visit this textbook's website at **www.mhhe.com/seeleyess7** for practice quizzes, animations, interactive learning exercises, and other study tools.

McGraw-Hill offers a study CD that features interactive cadaver dissection. ***Anatomy & Physiology Revealed*** includes cadaver photos that allow you to peel away layers of the human body to reveal structures beneath the surface. This program also includes animations, radiologic imaging, audio pronunciations, and practice quizzing.

Critical Thinking

These innovative exercises encourage students to apply chapter concepts to solve a problem. Answering these questions helps students build a working knowledge of anatomy and physiology while developing reasoning skills. Answers are provided in Appendix D.

Website Study Support

Practice quizzes, animation quizzes, flashcards, and many more interesting features are all available on the website accompanying this book at **http://www.mhhe.com/vanputte/anp7**