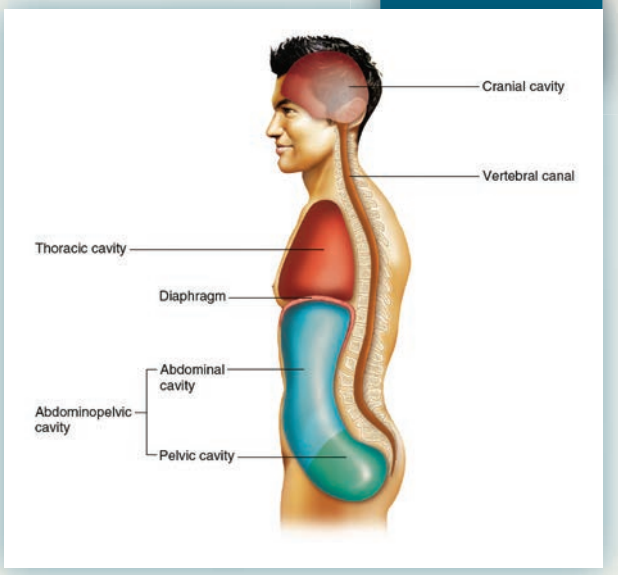
DYNAMIC NEW ART PROGRAM

Every piece of art has been updated to make it more vibrant, three-dimensional, and instructional. The authors examined every piece of art to ensure it was engaging and accurate. The twelfth edition's art program will help students understand the key concepts of anatomy and physiology.

12th Edition



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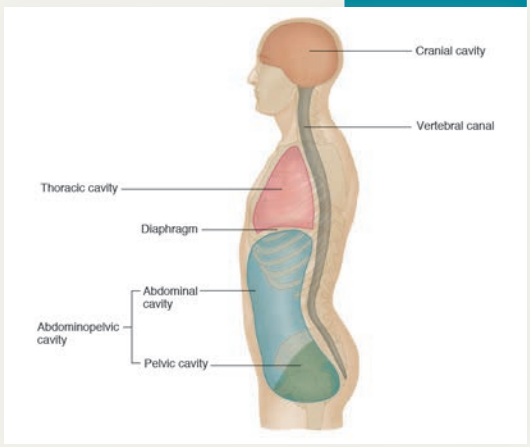

Realistic, three-dimensional figures provide depth and orientation.

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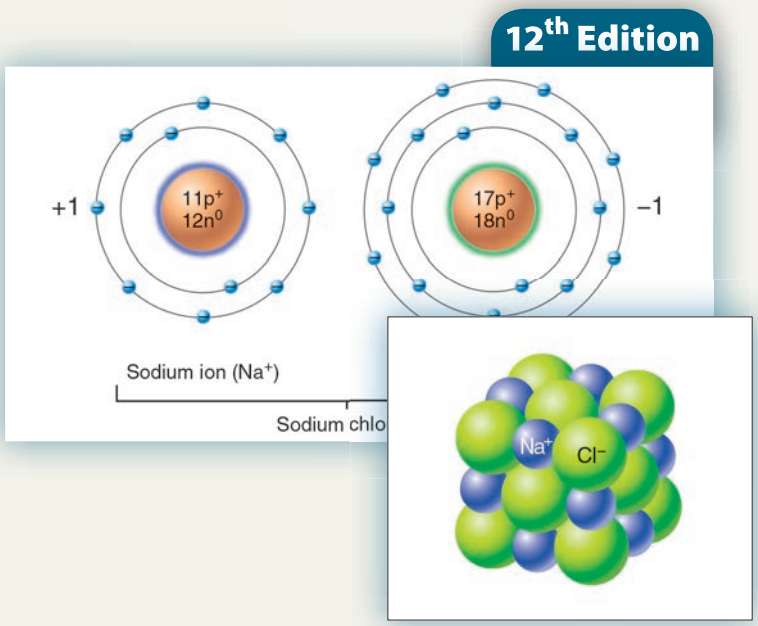

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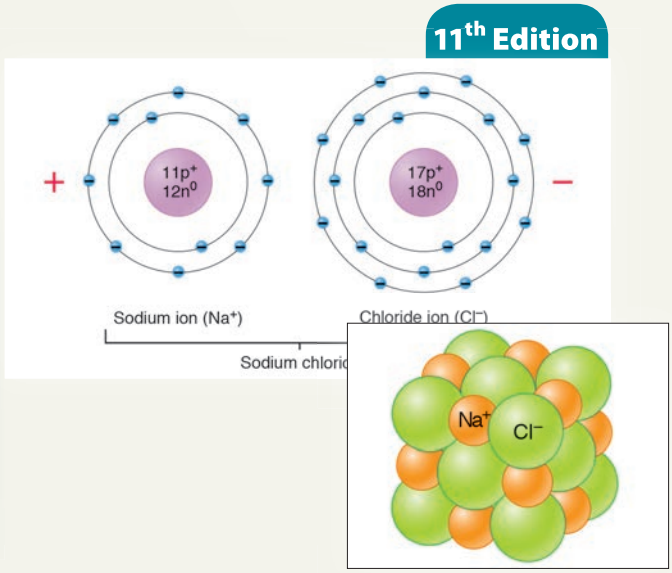

Colors highlighting atomic nuclei complement the atom colors in molecular models.

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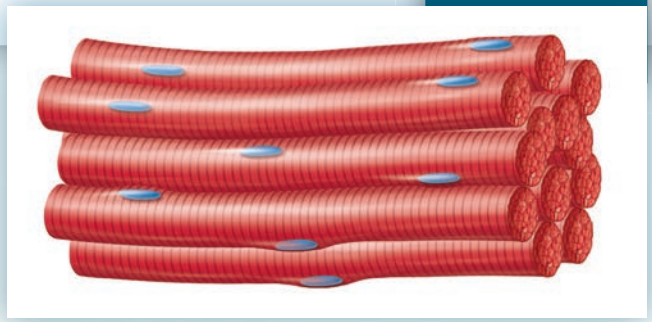

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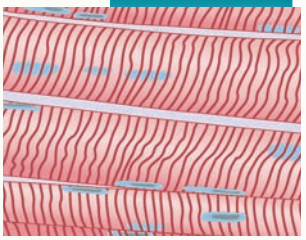

Line art for micrographs is three-dimensional to help students visualize more than just the flat microscopic sample.

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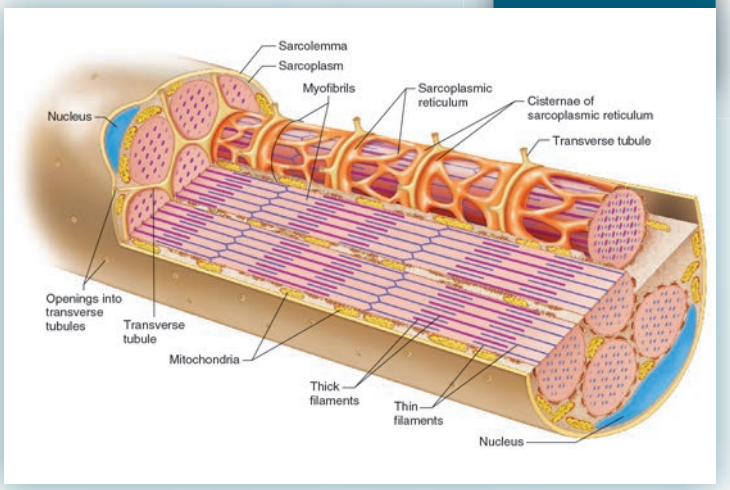

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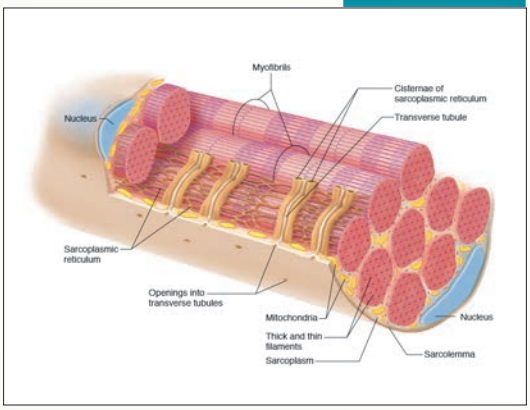

This longitudinal section shows the interior structures of a muscle fiber revealing more detail of the myofibrils, and thick and thin filaments.

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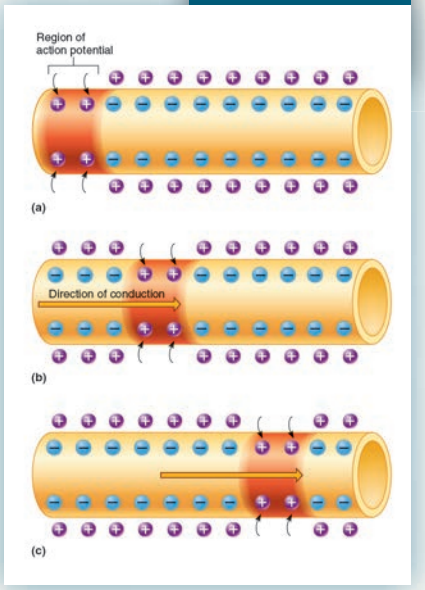

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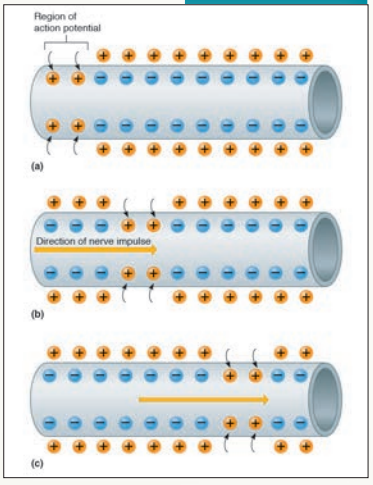

Color follows the movement of the action potential.

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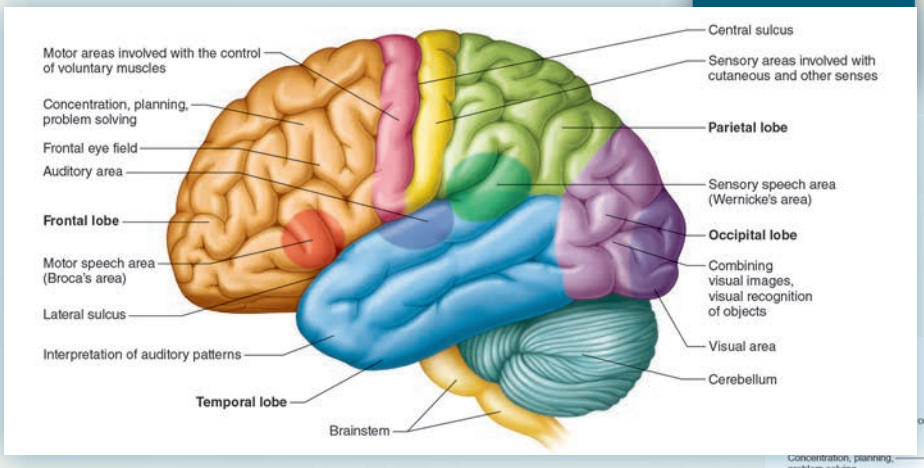

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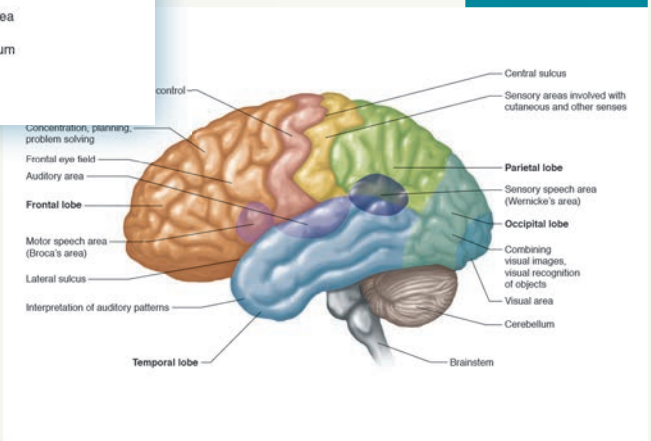

Colors distinguish functional areas more readily and figures are more accurately drawn.

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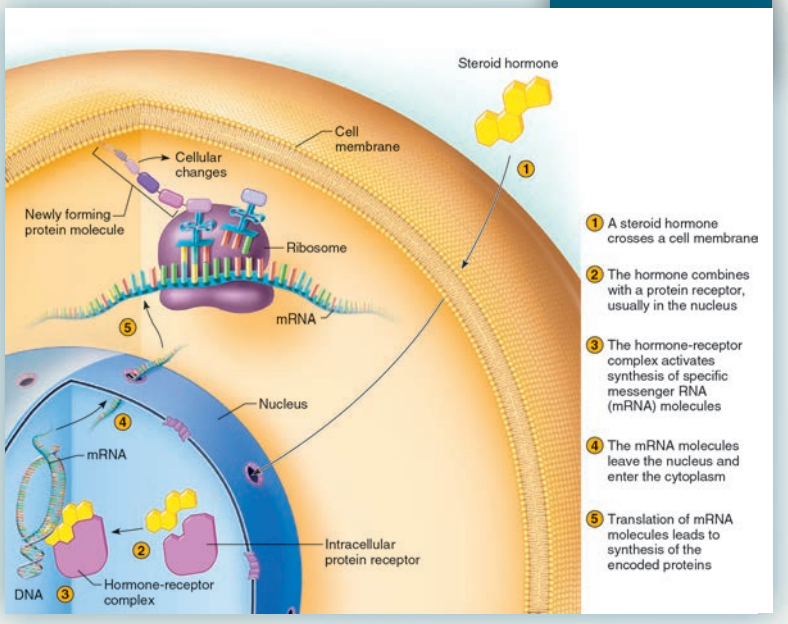

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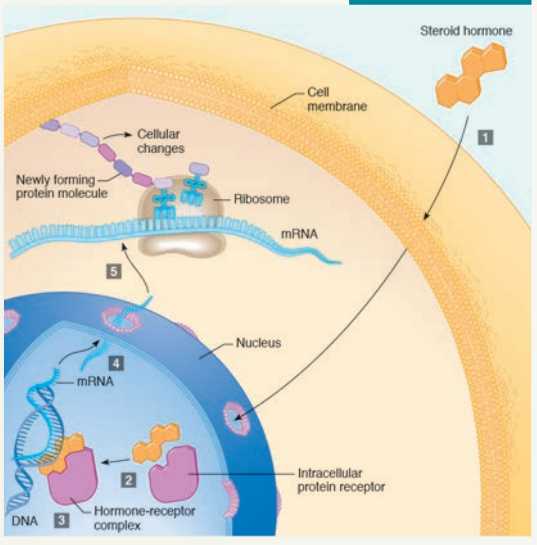

The explanation has been moved out of the legend to become part of the figure.

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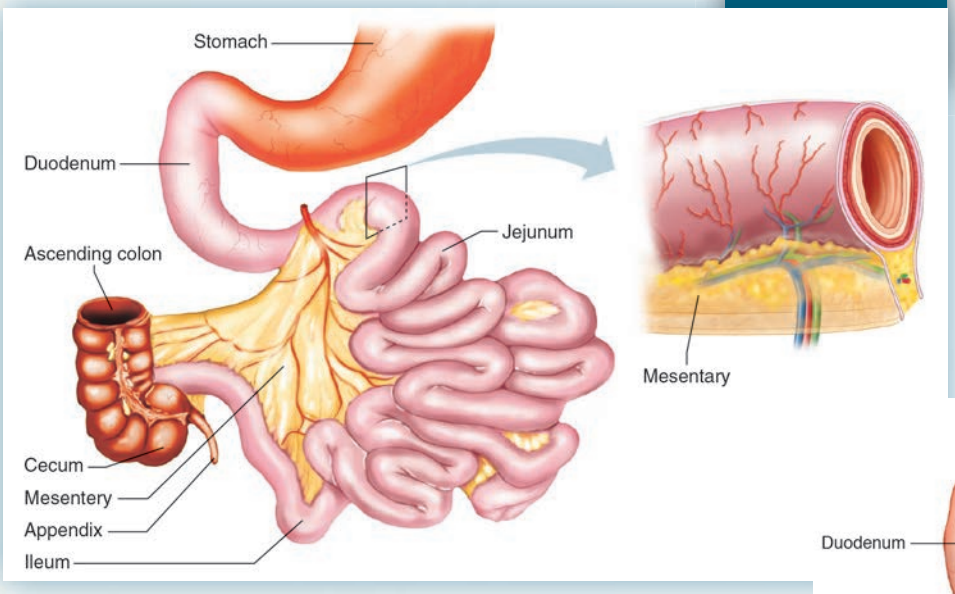

New enlargement shows the detail in the structure of the mesentery.

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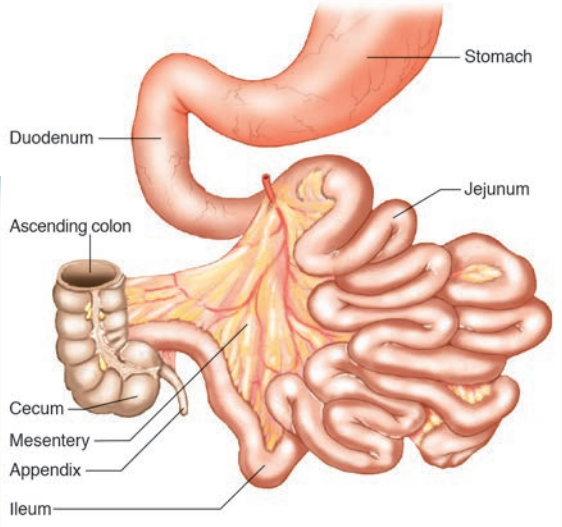

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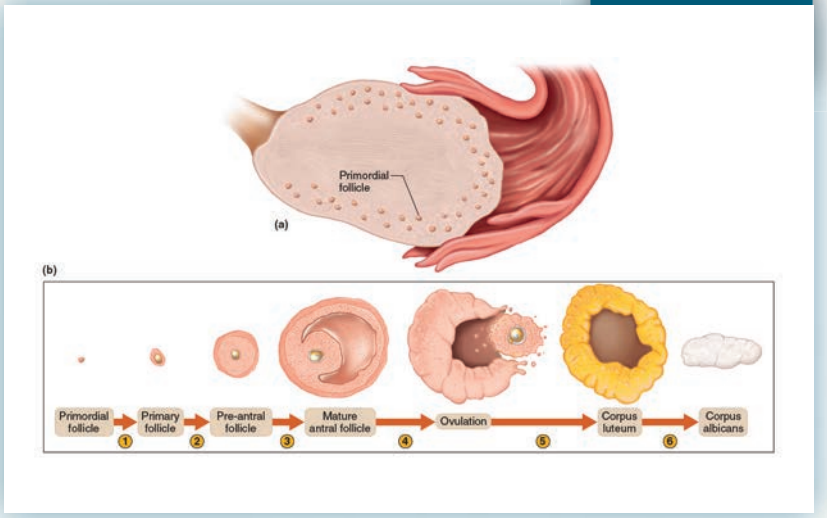

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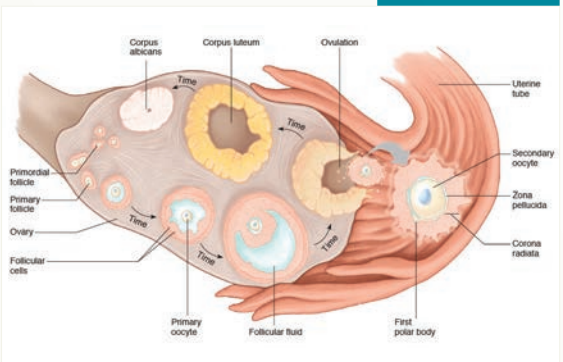
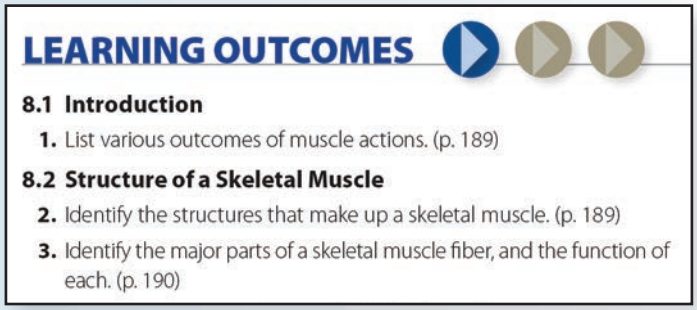


Process portrayed more accurately.

Learn, Practice, Assess!

Learn

Learning Outcomes open chapters, and are closely linked to Chapter Assessments and Integrative Assessments/Critical Thinking questions found at the end of each chapter.



LEARNING OUTCOMES

8.1 Introduction

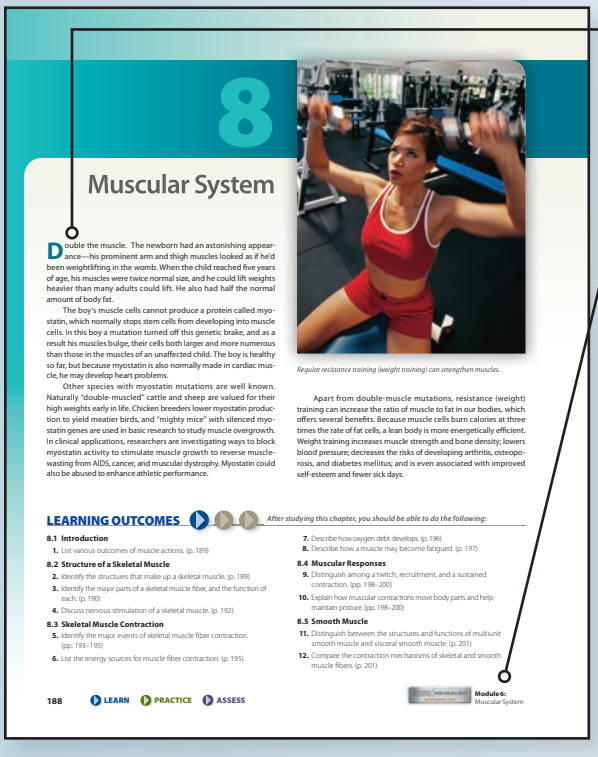
1. List various outcomes of muscle actions. (p. 189)

8.2 Structure of a Skeletal Muscle

2. Identify the structures that make up a skeletal muscle. (p. 189)
3. Identify the major parts of a skeletal muscle fiber, and the function of each. (p. 190)

Learning tools to help you succeed. . .

Check out the Chapter Preview, *Foundations for Success*, on page 1. The Chapter Preview was specifically designed to help you **LEARN** how to study. It provides helpful study tips.



8

Muscular System

Double the muscle. The newborn had an astonishing appearance—his prominent arm and thigh muscles looked as if he'd been weightlifting in the womb. When the child reached five years of age, his muscles were twice normal size, and he could lift weights heavier than many adults could lift. He also had half the normal amount of body fat.

The boy's muscle cells cannot produce a protein called myostatin, which normally stops stem cells from developing into muscle cells. In this boy a mutation turned off this genetic brake, and as a result his muscles bulge, their cells both larger and more numerous than those in the muscles of an unaffected child. The boy is healthy so far, but because myostatin is also normally made in cardiac muscle, he may develop heart problems.

Other species with myostatin mutations are well known. Naturally "double-muscled" cattle and sheep are valued for their high weights early in life. Chicken breeders lower myostatin production to yield meatier birds, and "mighty mice" with silenced myostatin genes are used in basic research to study muscle overgrowth. In clinical applications, researchers are investigating ways to block myostatin activity to stimulate muscle growth to reverse muscle-wasting from AIDS, cancer, and muscular dystrophy. Myostatin could also be abused to enhance athletic performance.

Regular resistance training (weight training) can strengthen muscles.

Apart from double-muscle mutations, resistance (weight) training can increase the ratio of muscle to fat in our bodies, which offers several benefits. Because muscle cells burn calories at three times the rate of fat cells, a lean body is more energetically efficient. Weight training increases muscle strength and bone density; lowers blood pressure; decreases the risks of developing arthritis, osteoporosis, and diabetes mellitus; and is even associated with improved self-esteem and fewer sick days.

LEARNING OUTCOMES *After studying this chapter, you should be able to do the following:*

8.1 Introduction
1. List various outcomes of muscle actions. (p. 189)

8.2 Structure of a Skeletal Muscle
2. Identify the structures that make up a skeletal muscle. (p. 189)
3. Identify the major parts of a skeletal muscle fiber, and the function of each. (p. 190)
4. Discuss nervous stimulation of a skeletal muscle. (p. 192)

8.3 Skeletal Muscle Contraction
5. Identify the major events of skeletal muscle fiber contraction. (pp. 193–195)
6. List the energy sources for muscle fiber contraction. (p. 195)
7. Describe how oxygen debt develops. (p. 196)
8. Describe how a muscle may become fatigued. (p. 197)

8.4 Muscular Responses
9. Distinguish among a twitch, recruitment, and a sustained contraction. (pp. 198–200)
10. Explain how muscular contractions move body parts and help maintain posture. (pp. 198–200)

8.5 Smooth Muscle
11. Distinguish between the structures and functions of multiunit smooth muscle and visceral smooth muscle. (p. 201)
12. Compare the contraction mechanisms of skeletal and smooth muscle fibers. (p. 201)

188 LEARN PRACTICE ASSESS

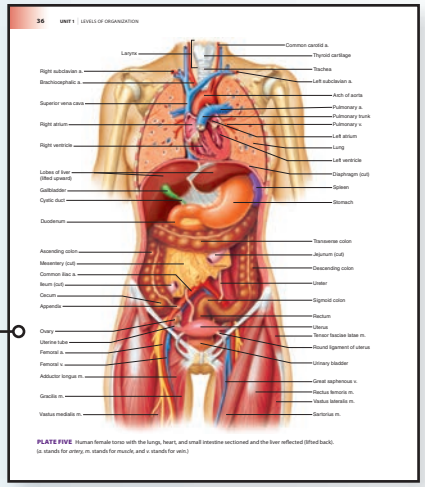
Module 6: Muscular System

Vignettes lead into chapter content. They connect you to many areas of health care including technology, physiology, medical conditions, historical perspectives, and careers.

Anatomy and Physiology Revealed (APR) icon at the beginning of each chapter tells you which system in APR applies to this chapter.

Aids to Understanding Words examines root words, stems, prefixes, suffixes, and pronunciations to help you build a solid anatomy and physiology vocabulary.

Reference Plates offer vibrant detail of body structures.



36 UNIT 1 | LEVELS OF ORGANIZATION

PLATE FIVE Human female torso with the lungs, heart, and small intestine sectioned and the liver reflected (lifted back). (a. stands for artery, m. stands for muscle, and v. stands for vein.)

Practice

Practice with a question or series of questions after major sections. They will test your understanding of the material.

Interesting applications help you practice and apply knowledge. . .

Figure Questions allow an additional assessment. Found on key figures throughout the chapter.

PRACTICE

14. What are the functions of anabolism? Of catabolism?
15. What is the product of anabolism of monosaccharides? Of glycerol and fatty acids? Of amino acids?
16. Distinguish between dehydration synthesis and hydrolysis.

FIGURE 8.5 APR A neuromuscular junction includes the end of a motor neuron and the motor end plate of a muscle fiber.

Q *How does neurotransmitter released into the synaptic cleft reach the muscle fiber membrane?*

Answer can be found in Appendix F on page 582.

Boxed information expands on the concepts discussed in the text.

> Several hours after death, skeletal muscles partially contract and become rigid, fixing the joints in place. This condition, *rigor mortis,* may continue for 72 hours or more. It results from an increase in membrane permeability to calcium ions and a decrease in ATP in muscle fibers, which prevents relaxation. The actin and myosin filaments of the muscle fibers remain linked until the muscles begin to decompose.

Facts of Life provides interesting bits of anatomy and physiology information, adding a touch of wonder to chapter topics.

FACTS OF LIFE The human body has more than 600 distinct skeletal muscles. The face alone includes 60 muscles, more than 40 of which are used to frown, and 20 to smile. Thinner than a thread and barely visible, the stapedius in the middle ear is the body's smallest muscle. In contrast is the gluteus maximus, the largest muscle, located in the buttock. The sartorius, which pulls on the leg just below the knee, is the longest muscle in the body.

Clinical Applications present disorders, physiological responses to environmental factors, and other topics of general interest and applies them to clinical situations.

CLINICAL APPLICATION 18.2

Sodium and Potassium Imbalances

Extracellular fluids usually have high sodium ion concentrations, and intracellular fluid usually has a high potassium ion concentration. Renal regulation of sodium is closely related to that of potassium, because active reabsorption of sodium (under the influence of aldosterone) is accompanied by tubular secretion (and excretion) of potassium. Therefore, conditions resulting from sodium ion imbalance often also involve potassium ion imbalance.

Such disorders include:

1. *Low blood sodium concentration (hyponatremia)* Possible causes of sodium deficiencies include prolonged sweating, vomiting, or diarrhea; renal disease in which sodium is inadequately reabsorbed; adrenal cortex form of diabetes insipidus, the secretion of antidiuretic hormone (ADH) is insufficient for the renal tubules and collecting ducts to conserve water. Hypernatremia may disturb the central nervous system, causing confusion, stupor, and coma.
3. *Low blood potassium concentration (hypokalemia)* Possible causes of potassium deficiency include the release of excess aldosterone by the adrenal cortex (Cushing syndrome), which increases renal excretion of potassium; use of diuretic drugs that promote potassium excretion; kidney disease; and prolonged vomiting or diarrhea. Possible effects of hypokalemia include muscular weakness or paralysis, respiratory difficulty, and severe cardiac dis-

Genetics Connections explore the molecular underpinnings of familiar as well as not so familiar illnesses. Read about such topics as ion channel disorders, muscular dystrophy, and cystic fibrosis.

GENETICS CONNECTION 8.1

Inherited Diseases of Muscle

Several inherited conditions affect muscle tissue. These disorders differ in the nature of the genetic defect, the type of protein that is abnormal in form or function, and the muscles that are impaired.

The Muscular Dystrophies—Missing Proteins

A muscle cell is packed with filaments of actin and myosin. Much less abundant, but no less important, is a protein called *dystrophin.* It holds skeletal muscle cells together by linking actin in the cell to glycoproteins in the cell membrane

Missing or abnormal dystrophin or the glycoproteins cause muscular dystrophies. These illnesses vary in severity and age of onset, but in all cases, muscles weaken and degenerate. Eventually, fat and connective tissue replace muscle.

Duchenne muscular dystrophy (DMD) is the most severe type of the illness (fig. 8B). Symptoms begin by age five and affect only boys. By age thirteen, the person cannot walk, and by early adulthood he usually dies from failure of the respiratory muscles. In DMD, dystrophin is absent or shortened. In Becker muscular dystrophy, symptoms begin

Assess

Tools to help you make the connection and master anatomy & physiology!

Chapter Assessments check your understanding of the chapter's learning outcomes.

Integrative Assessments/Critical Thinking questions allow you to connect and apply information from previous chapters as well as information within the current chapter.

Chapter Summary Outlines help you review the chapter's main ideas.

CHAPTER ASSESSMENTS

8.1 Introduction

1. The three types of muscle tissue are _____, _____, and _____. (p. 189)

8.2 Structure of a Skeletal Muscle

2. Describe the difference between a tendon and an aponeurosis. (p. 189)

3. Describe how connective tissue associates with skeletal muscle. (p. 190)

4. List the major parts of a skeletal muscle fiber, and describe the function of each part. (p. 190)

5. Describe a neuromuscular junction. (p. 192)

6. A neurotransmitter _____. (p. 192)

a. binds actin filaments, causing them to slide

b. diffuses across a synapse from a neuron to a muscle cell

8.6 Cardiac Muscle

21. Make a table comparing contraction mechanisms of cardiac and skeletal muscle fibers. (p. 202)

8.7 Skeletal Muscle Actions

22. Distinguish between a muscle's origin and its insertion. (p. 202)

23. Define *agonist, antagonist,* and *synergist.* (p. 204)

8.8 Major Skeletal Muscles

24. Match the muscles to their descriptions and functions. (pp. 204–217)

(1) buccinator	A. inserted on coronoid process of mandible
(2) epicranius	B. elevates corner of mouth
(3) orbicularis oris	C. elevates scapula
(4) platysma	D. brings head into an upright position
(5) rhomboid major	E. elevates eyebrow

222 UNIT 2 | SUPPORT AND MOVEMENT

INTEGRATIVE ASSESSMENTS/CRITICAL THINKING

OUTCOMES 4.4, 8.3

1. As lactate and other substances accumulate in an active muscle, they stimulate pain receptors and the muscle may feel sore. How might the application of heat or substances that dilate blood vessels relieve such soreness?

OUTCOMES 5.3, 8.2

2. Discuss how connective tissue is part of the muscular system.

OUTCOMES 8.3, 8.4

3. A woman takes her daughter to a sports medicine specialist and

4. Following an injury to a nerve, the muscle it supplies with motor nerve fibers may become paralyzed. How would you explain to a patient the importance of moving the disabled muscles passively or contracting them using electrical stimulation?

OUTCOMES 8.4, 8.8

5. What steps might be taken to minimize atrophy of the skeletal muscles in patients confined to bed for prolonged times?

Summary Outline

8.1 Introduction (p. 189)

The three types of muscle tissue are skeletal, smooth, and cardiac.

8.2 Structure of a Skeletal Muscle (p. 189)

Individual muscles are the organs of the muscular system. They include skeletal muscle tissue, nervous tissue, blood, and connective tissues.

1. Connective tissue coverings
   a. Fascia covers skeletal muscles.
   b. Other connective tissues attach muscles to bones or to other muscles.
   c. A network of connective tissue extends throughout the muscular system.
2. Skeletal muscle fibers
   a. Each skeletal muscle fiber is a single muscle cell.
   b. The cytoplasm contains mitochondria, sarcoplasmic reticulum, and myofibrils of actin and myosin.
   c. The organization of actin and myosin filaments produces striations.
   d. Transverse tubules extend inward from the cell membrane and associate with the sarcoplasmic reticulum.
3. Neuromuscular junction
   a. Motor neurons stimulate muscle fibers to contract.
5. Oxygen debt
   a. During rest or moderate exercise, muscles receive enough oxygen to respire aerobically.
   b. During strenuous exercise, oxygen deficiency may cause lactic acid to be produced. Lactic acid dissociates to form lactate.
   c. Oxygen debt is the amount of oxygen required to convert lactate to glucose and to restore supplies of ATP and creatine phosphate.
6. Muscle fatigue
   a. A fatigued muscle loses its ability to contract.
   b. Muscle fatigue may be due in part to increased production of lactic acid.
7. Heat production
   a. More than half of the energy released in cellular respiration is lost as heat.
   b. Muscle action is an important source of body heat.

8.4 Muscular Responses (p. 198)

1. Threshold stimulus is the minimal stimulus required to elicit a muscular contraction.
2. Recording a muscle contraction
   a. A twitch is a single, short contraction reflecting stimulation of