

# CHAPTER 8

## MUSCULAR SYSTEM

### OVERVIEW

In conjunction with the skeletal system, the muscular system moves the body. This chapter introduces the three types of muscle; the major events in contraction of skeletal, smooth, and cardiac muscles; the energy supply to muscle fiber for contraction; the occurrence of oxygen debt; and the process of muscle fatigue (learning outcomes 4, 5 and 6). This chapter also describes the structure and function of a skeletal muscle; distinguishes between a twitch and a sustained contraction; explains how various kinds of muscle contraction produce body movements and maintain posture; shows how the location and interaction of muscles produce body movements; identifies the location and action of major skeletal muscles; and differentiates the structure and function of a multiunit smooth muscle and a visceral smooth muscle (learning outcomes 1, 2, 3, 7, 8, 9, 10, 11, 12, and 13).

The skeletal system can be thought of as the passive partner in producing movement: think of the muscular system as the active partner. This chapter explains how muscles interact with bones to maintain posture and produce movement. In addition, it tells the characteristics and functions of skeletal, smooth, and cardiac muscles. This knowledge is a foundation for the study of other organ systems, such as the digestive, respiratory, and cardiovascular systems.

### LEARNING OUTCOMES

After you have studied this chapter, you should be able to:

- 8.1 Introduction
  1. List various outcomes of muscular actions.
- 8.2 Structure of a Skeletal Muscle
  2. Describe how connective tissue is part of a skeletal muscle.
  3. Name the major parts of a skeletal muscle fiber, and describe the function of each.
- 8.3 Skeletal Muscle Contraction
  4. Explain the major events of skeletal muscle fiber contraction.
  5. Explain how the muscle fiber contraction mechanism obtains energy.
  6. Describe how oxygen debt develops and how a muscle may become fatigued.
- 8.4 Muscular Responses
  7. Distinguish between a twitch and a sustained contraction.
  8. Explain how the types of muscular contractions produce body movements and help maintain posture.
- 8.5 Smooth Muscles
  9. Distinguish between the structures and functions of a multiunit smooth muscle and a visceral smooth muscle.
  10. Compare the contraction mechanisms of skeletal and smooth muscle fibers.
- 8.6 Cardiac Muscle
  11. Compare the contraction mechanisms of skeletal and cardiac muscle fibers.
- 8.7 Skeletal Muscle Actions
  12. Explain how the locations and interactions of skeletal muscles are related to the movements they produce and describe how muscles interact to produce such movements.
- 8.8 Major Skeletal Muscle.
  13. Describe the locations and actions of the major skeletal muscles of each body region.

### FOCUS QUESTION

How do muscle cells use energy and interact with bones to get you from your anatomy and physiology classroom to track team practice?

## MASTERY TEST

Now take the mastery test. Do not guess. As soon as you complete the test, correct it. Note your successes and failures so that you can read the chapter to meet your learning needs.

1. The kind of energy that muscles use to contract is
  - a. chemical.
  - b. electrical.
  - c. heat.
2. List the tissues found in skeletal muscle.
3. An individual skeletal muscle is separated from adjacent muscles by \_\_\_\_\_.
4. Layers of connective tissue extending into the muscle to form partitions between muscle bundles are continuous with attachments of muscle to periosteum called
  - a. ligaments.
  - b. tendons.
  - c. aponeuroses.
  - d. elastin.
5. The characteristic striated appearance of skeletal muscle is due to the arrangement of alternating protein filaments composed of \_\_\_\_\_ and \_\_\_\_\_.
6. The functional units of muscle contraction are
  - a. fascia
  - b. myofibrils
  - c. sarcomeres
  - d. troponin.
7. An injury in which a few muscle fibers are torn but the fascia is left intact is called a \_\_\_\_\_.
8. I bands are composed of \_\_\_\_\_.
9. The union between a nerve fiber and a muscle fiber is the
  - a. motor neuron.
  - b. motor end plate.
  - c. neuromuscular junction.
  - d. neurotransmitter.
10. A motor neuron and the muscle fibers it controls are called a \_\_\_\_\_.
11. When the cross-bridge of the myosin molecule forms linkages with actin filaments, the result is
  - a. shortening of the muscle fiber.
  - b. membrane polarization.
  - c. release of acetylcholine.
12. The neurotransmitter that is necessary for the transmission of an impulse from a nerve to a skeletal muscle fiber is \_\_\_\_\_.
13. The energy used in muscle contraction is supplied by the decomposition of \_\_\_\_\_.
14. A substance that stores energy released when stores of the substance in number 12 are in low supply is \_\_\_\_\_.
15. The ion necessary to link myosin and actin is
  - a. sodium.
  - b. calcium.
  - c. magnesium.
  - d. potassium.
16. A person feels out of breath after vigorous exercise because of oxygen debt. Which of the following statements helps explain this phenomenon?
  - a. Anaerobic respiration increases during strenuous activity.
  - b. Lactic acid is metabolized more efficiently when the body is at rest.
  - c. Conversion of lactic acid to glycogen occurs in the liver and requires energy.
  - d. Priority in energy use is given to ATP synthesis.
17. After prolonged muscle use, muscle fatigue occurs due to an accumulation of \_\_\_\_\_.
18. The tissue that produces the major source of heat in the body is \_\_\_\_\_ tissue.
19. The minimal strength stimulus needed to elicit contraction of a single muscle fiber is called a(n) \_\_\_\_\_.

20. The strength of a muscle contraction in response to different levels of stimulation is determined by the
- level of stimulation delivered to individual muscle fibers.
  - number of fibers that respond in each motor unit.
  - number of motor units stimulated.
  - characteristics of each muscle group.
21. The period of time between a stimulus to a muscle and muscle response is called the
- latent period.
  - contraction.
  - refractory period.
22. *Muscle tone* refers to
- a state of sustained, partial contraction of muscles that is necessary to maintain posture.
  - a feeling of well-being following exercise.
  - the ability of a muscle to maintain contraction against an outside force.
  - the condition athletes attain after intensive training.
23. *Atrophy* refers to a(n) (increase, decrease) in the size and strength of a muscle.
24. Two types of smooth muscle are \_\_\_\_\_ muscle and \_\_\_\_\_ muscle.
25. Peristalsis is due to which of the following characteristics of smooth muscle?
- capacity of smooth muscle fibers to excite each other
  - automaticity
  - rhythmicity
  - sympathetic innervation
26. Smooth muscle contracts (more slowly, more rapidly) than skeletal muscle following stimulation.
27. Impulses travel relatively (rapidly, slowly) through cardiac muscle.
28. The attachment of a muscle to a relatively fixed part is called the \_\_\_\_\_; the attachment to a relatively movable part is called the \_\_\_\_\_.
29. Smooth body movements depend upon \_\_\_\_\_ giving way to prime movers.
30. The muscle that compresses the cheeks inward when it contracts is the
- orbicularis oris.
  - epicranius.
  - platysma.
  - buccinator.
31. The muscle that moves the head to one side is the
- sternocleidomastoid.
  - splenius capitis.
  - semispinalis capitis.
  - longissimus capitis.
32. The muscle that abducts the upper arm and can both flex and extend the humerus is the
- biceps brachii.
  - deltoid.
  - infraspinatus.
  - triceps brachii.
33. The band of tough connective tissue that extends from the xiphoid process to the symphysis pubis and serves as an attachment for muscles of the abdominal wall is the \_\_\_\_\_.
34. The heaviest muscle in the body, which straightens the leg at the hip during walking, is the
- psoas major.
  - gluteus maximus.
  - adductor longus.
  - gracilis.

## **STUDY ACTIVITIES**

### **I. Aids to Understanding Words**

Define the following word parts. (p. 177)

|        |        |
|--------|--------|
| calat- | myo-   |
| erg-   | sarco- |
| hyper- | syn-   |
| inter- | tetan- |
| laten- | -troph |

D. Describe these kinds of muscle contractions. (p. 187)

sustained contraction

muscle tone

## VI. 8.5 Smooth Muscles (pp. 189–190)

A. Compare the structure of smooth muscle fibers and skeletal muscle fibers. (p. 189)

B. Answer these questions about smooth muscle. (p. 189)

1. The two types of smooth muscle are \_\_\_\_\_ smooth muscle and \_\_\_\_\_ smooth muscle.

2. Where are each of these types of smooth muscle found?

3. The properties of smooth muscle that allows peristalsis are \_\_\_\_\_ and \_\_\_\_\_.

C. Answer these questions about smooth muscle contraction. (pp. 189–190)

1. The neurotransmitters that affect smooth muscle are \_\_\_\_\_ and \_\_\_\_\_.

2. Do these neurotransmitters always lead to muscle contraction?

3. Compare the characteristics of smooth muscle contraction and those of skeletal contraction.

4. Match the following descriptions with the genetic diseases they describe. (p. 191)

\_\_\_\_ a. muscular dystrophies

\_\_\_\_ b. Charcot-Marie-Tooth Disease

\_\_\_\_ c. myotonic dystrophy

\_\_\_\_ d. hereditary idiopathic dilated cardiomyopathy

1. delayed muscle relaxation following contraction in which the symptoms become increasingly severe in successive generations

2. a genetic error that leads to the change of a single DNA nucleotide base leading to a defect in the ability of actin to anchor to Z bands

3. muscles that weaken and degenerate due to abnormalities of the protein dystrophin

4. characterized by progressing weakness in the muscles of the hands and feet diagnosed by electromyography and nerve conduction velocity studies

## VII. 8.6 Cardiac Muscle (p. 190)

A. Describe the structure of the sarcoplasmic reticulum of cardiac muscle and the effect of this structure on cardiac muscle contraction. (p. 190)

B. Opposing ends of cardiac muscle fibers are connected by \_\_\_\_\_ (p. 190)

C. Describe the effect of the properties of self-excitation and rhythmicity and cardiac muscle contraction. (p. 190)

## VIII. 8.7 Skeletal Muscle Actions (pp. 190–192)

A. A skeletal muscle has at least two places of attachment to bone. For instance, the gluteus maximus, which extends the leg at the hip, is attached to the posterior surface of the ilium, the sacrum, and the coccyx at one end and to the posterior surface of the femur and the iliotibial tract at the other. One place of muscle attachment is the origin, and the other is the insertion. Explain the difference between the two. (p. 192)