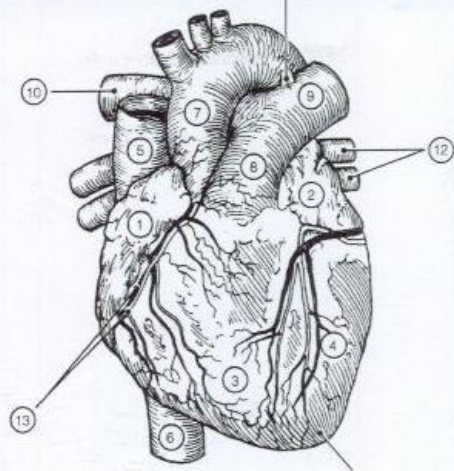


6 THE MUSCULAR SYSTEM

Key



Muscles, the specialized tissues that facilitate body movement, make up about 40% of body weight. Most body muscle is the voluntary type, called skeletal muscle because it is attached to the bony skeleton. Skeletal muscle contributes to body contours and shape, and it composes the organ system called the muscular system. These muscles allow you to grin, frown, run, swim, shake hands, swing a hammer, and to otherwise manipulate your environment. The balance of body muscle is smooth and cardiac muscles, which form the bulk of the walls of hollow organs and the heart. Smooth and cardiac muscles are involved in the transport of materials within the body.

Study activities in this chapter deal with microscopic and gross structure of muscle, identification of voluntary muscles, body movements, and important understandings of muscle physiology.

OVERVIEW OF MUSCLE TISSUES

1. Nine characteristics of muscle tissue are listed below and on page 104. Identify the muscle tissue type described by choosing the correct response(s) from the key choices. Enter the appropriate term(s) or letter(s) of the key choice in the answer blank.

Key Choices

A. Cardiac

B. Smooth

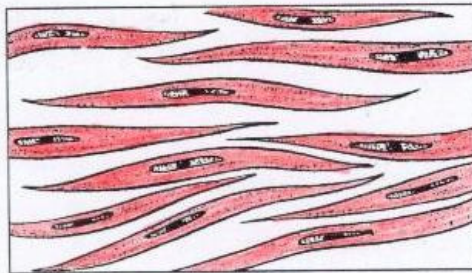
C. Skeletal

1. Involuntary
A, B
2. Banded appearance
A, C
3. Longitudinally and circularly arranged layers
B
4. Dense connective tissue packaging
C
5. Figure-8 packaging of the cells
A
6. Coordinated activity to act as a pump
A

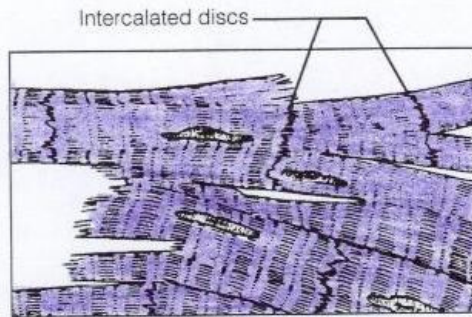


- C _____ 7. Moves bones and the facial skin
C _____ 8. Referred to as the muscular system
C _____ 9. Voluntary

2. Identify the type of muscle in each of the illustrations in Figure 6-1. Color the diagrams as you wish.



A Smooth _____



B Cardiac _____

Figure 6-1

3. Regarding the functions of muscle tissues, circle the term in each of the groupings that does not belong with the other terms.

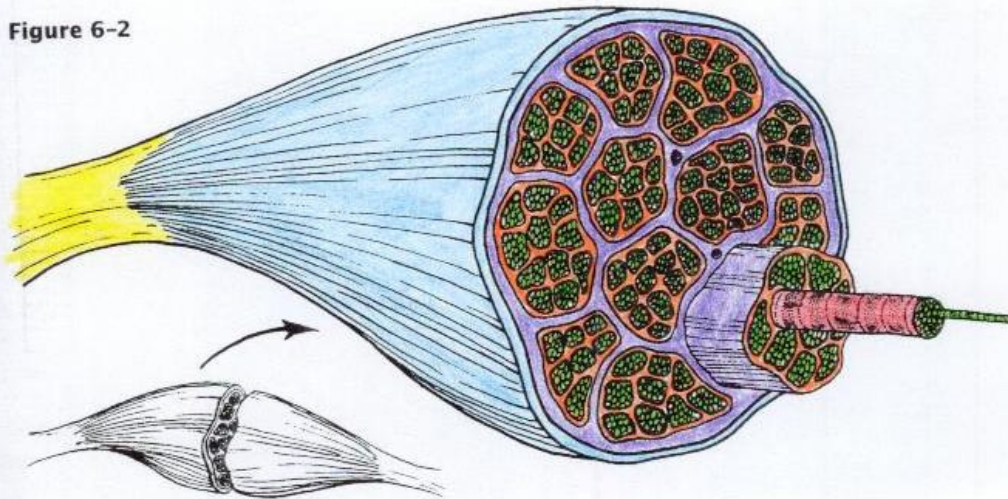
- | | | | |
|-----------------------|------------------------|------------------------|------------------------------------|
| 1. Urine | Foodstuffs | <u>Bones</u> | Smooth muscle |
| 2. Heart | Cardiac muscle | Blood pump | <u>Promotes labor during birth</u> |
| 3. Excitability | Response to a stimulus | <u>Contractility</u> | Action potential |
| 4. Ability to shorten | Contractility | Pulls on bones | <u>Stretchability</u> |
| 5. Maintains posture | Movement | <u>Promotes growth</u> | Generates heat |

MICROSCOPIC ANATOMY OF SKELETAL MUSCLE

4. First, identify the structures in Column B by matching them with the descriptions in Column A. Enter the correct letters (or terms if desired) in the answer blanks. Then, select a different color for each of the terms in Column B that has a color-coding circle and color in the structures on Figure 6-2.

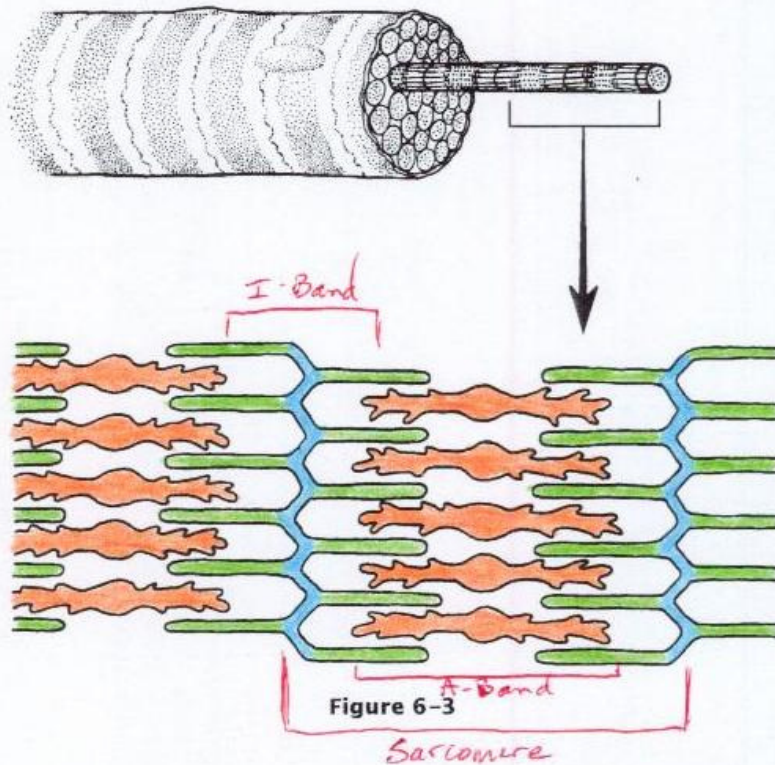
Column A	Column B
<u>G</u> _____ 1. Connective tissue surrounding a fascicle	A. Endomysium ●
<u>B</u> _____ 2. Connective tissue ensheathing the entire muscle	B. Epimysium ●
<u>I</u> _____ 3. Contractile unit of muscle	C. Fascicle
<u>D</u> _____ 4. A muscle cell	D. Fiber ●
<u>A</u> _____ 5. Thin connective tissue investing each muscle cell	E. Myofilament
<u>H</u> _____ 6. Plasma membrane of the muscle cell	F. Myofibril ●
<u>F</u> _____ 7. A long, filamentous organelle found within muscle cells that has a banded appearance	G. Perimysium ●
<u>E</u> _____ 8. Actin- or myosin-containing structure	H. Sarcolemma
<u>K</u> _____ 9. Cordlike extension of connective tissue beyond the muscle, serving to attach it to the bone	I. Sarcomere
<u>C</u> _____ 10. A discrete bundle of muscle cells	J. Sarcoplasm
	K. Tendon ●

Figure 6-2



5. Figure 6-3 is a diagrammatic representation of a small portion of a relaxed muscle cell (bracket indicates the portion enlarged). First, select different colors for the structures listed below. Use them to color the coding circles and corresponding structures on Figure 6-3. Then bracket and label an A band, an I band, and a sarcomere. When you have finished, draw a contracted sarcomere in the space beneath the figure and label the same structures, as well as the light and dark bands.

- Myosin
- Actin filaments
- Z disc



Dark Band

1. Looking at your diagram of a contracted sarcomere from a slightly different angle, which region of the sarcomere shortens during contraction—the dark band, the light band, or both?

SKELETAL MUSCLE ACTIVITY

6. Complete the following statements relating to the neuromuscular junction. Insert the correct answers in the numbered answer blanks.

Motor Unit 1.
Axon Terminals 2.
Synaptic Cleft 3.
Acetylcholine 4.
Nerve Impulse/A.P. 5.
Depolarization 6.

A motor neuron and all of the skeletal muscle cells it stimulates is called a (1). The axon of each motor neuron has numerous endings called (2). The actual gap between an axonal ending and the muscle cell is called a (3). Within the axonal endings are many small vesicles containing a neurotransmitter substance called (4).

When the (5) reaches the ends of the axon, the neurotransmitter is released, and it diffuses to the muscle cell membrane to combine with receptors there. Binding of the neurotransmitters with muscle membrane receptors causes the membrane to become permeable to sodium, resulting in the influx of sodium ions and (6) of the membrane. Then contraction of the muscle cell occurs.

7. Figure 6-4 shows the components of a neuromuscular junction. Identify the parts by coloring the coding circles and the corresponding structures in the diagram. Add small arrows to indicate the location of the ACh receptors and label appropriately.

- | | | |
|--|--|--|
| ● Mitochondrion | ● T tubule | ● Sarcomere |
| ● Synaptic vesicles | ● Synaptic cleft | ● Junctional folds |

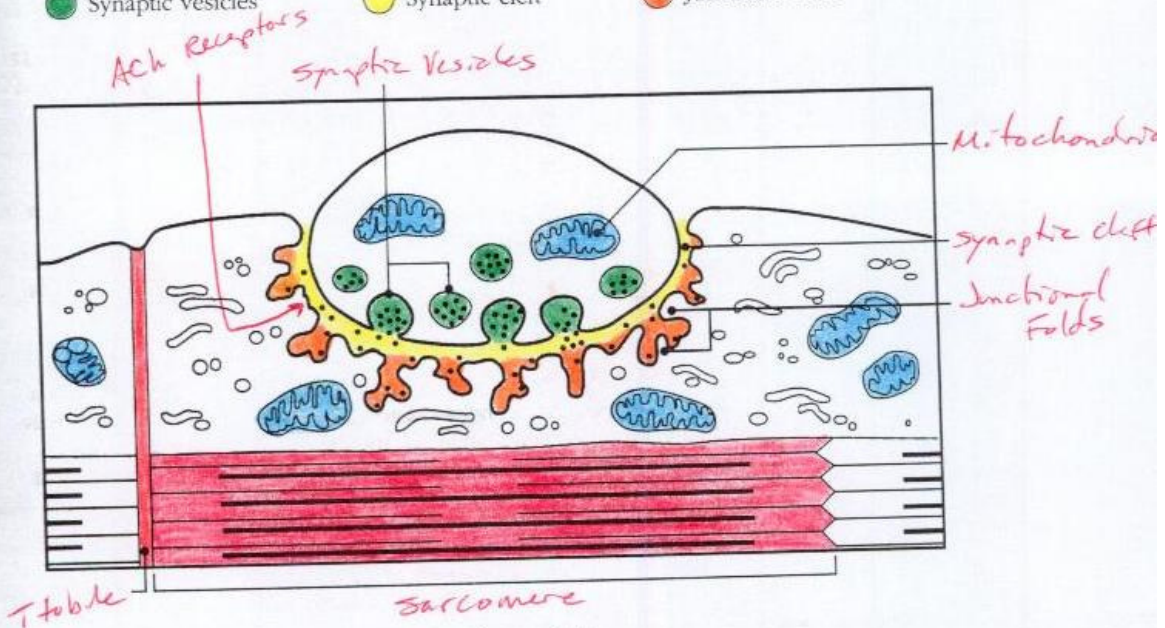


Figure 6-4

8. Number the following statements in their proper sequence to describe the contraction mechanism in a skeletal muscle cell. The first step has already been identified as number 1.

- 1 1. Acetylcholine is released into the neuromuscular junction by the axonal terminal.
- 4 2. The action potential, carried deep into the cell, causes the sarcoplasmic reticulum to release calcium ions.
- 7 3. The muscle cell relaxes and lengthens.
- 2 4. Acetylcholine diffuses across the neuromuscular junction and binds to receptors on the sarcolemma.
- 5 5. The calcium ion concentration at the myofilaments increases; the myofilaments slide past one another, and the cell shortens.
- 3 6. Depolarization occurs, and the action potential is generated.
- 6 7. As calcium is actively reabsorbed into the sarcoplasmic reticulum, its concentration at the myofilaments decreases.

9. The following incomplete statements refer to a muscle cell in the resting, or polarized, state just before stimulation. Complete each statement by choosing the correct response from the key choices and entering the appropriate letter in the answer blanks.

Key Choices

- A. Na^+ diffuses out of the cell
- B. K^+ diffuses out of the cell
- C. Na^+ diffuses into the cell
- D. K^+ diffuses into the cell
- E. Inside the cell
- F. Outside the cell
- G. Relative ionic concentrations on the two sides of the membrane during rest
- H. Electrical conditions
- I. Activation of the sodium-potassium pump, which moves K^+ into the cell and Na^+ out of the cell
- J. Activation of the sodium-potassium pump, which moves Na^+ into the cell and K^+ out of the cell

- F 1. There is a greater concentration of Na^+ (1), and there is a greater concentration of K^+ (2). When the stimulus is delivered, the permeability of the membrane is changed, and (3), initiating the depolarization of the membrane. Almost as soon as the depolarization wave begins, a repolarization wave follows it across the membrane. This occurs as (4).
- E 2. Repolarization restores the (5) of the resting cell membrane. The (6) is (are) reestablished by (7).
- C 3.
- B 4.
- H 5.
- G 6. I 7.

10. Complete the following statements by choosing the correct response from the key choices and entering the appropriate letter or term in the answer blanks.

Key Choices

- | | | |
|-------------------------|--------------------------|---------------------|
| A. Fatigue | E. Isometric contraction | I. Many motor units |
| B. Isotonic contraction | F. Whole muscle | J. Repolarization |
| C. Muscle cell | G. Fused tetanus | K. Depolarization |
| D. Muscle tone | H. Few motor units | L. Unfused tetanus |

- G _____ 1. _____ is a continuous contraction that shows no evidence of relaxation.
- B _____ 2. A(n) _____ is a contraction in which the muscle shortens and work is done.
- I _____ 3. To accomplish a strong contraction, _____ are stimulated at a rapid rate.
- H _____ 4. When a weak but smooth muscle contraction is desired, _____ are stimulated at a rapid rate.
- A _____ 5. When a muscle is being stimulated but is not able to respond because of "oxygen deficit," the condition is called _____.
- E _____ 6. A(n) _____ is a contraction in which the muscle does not shorten, but tension in the muscle keeps increasing.

11. The terms in the key refer to the three ways that muscle cells replenish their ATP supplies. Select the term(s) that best apply to the conditions described and insert the correct key letter(s) in the answer blanks.

Key Choices

- | | |
|--|------------------------|
| A. Coupled reaction of creatine phosphate (CP) and ADP | |
| B. Anaerobic glycolysis | C. Aerobic respiration |

- B 1. Accompanied by lactic acid formation
- C 2. Supplies the highest ATP yield per glucose molecule
- A 3. Involves the simple transfer of a phosphate group
- A, B 4. Requires no oxygen
- C 5. The slowest ATP regeneration process
- C 6. Produces carbon dioxide and water
- C 7. The energy mechanism used in the second hour of running in a marathon
- B 8. Used when the oxygen supply is inadequate over time
- A 9. Good for a sprint

12. Briefly describe how you can tell when you are repaying the oxygen deficit.

Respiratory rate increases as well as depth of breathing.

13. Which of the following occur within a muscle cell during oxygen deficit? Place a check (✓) by the correct choices.

- | | |
|--|---|
| <input checked="" type="checkbox"/> 1. Decreased ATP | <input type="checkbox"/> 5. Increased oxygen |
| <input type="checkbox"/> 2. Increased ATP | <input type="checkbox"/> 6. Decreased carbon dioxide |
| <input checked="" type="checkbox"/> 3. Increased lactic acid | <input checked="" type="checkbox"/> 7. Increased carbon dioxide |
| <input checked="" type="checkbox"/> 4. Decreased oxygen | <input type="checkbox"/> 8. Increased glucose |

MUSCLE MOVEMENTS, TYPES, AND NAMES

14. Relative to general terminology concerning muscle activity, first label the following structures on Figure 6-5: insertion, origin, tendon, resting muscle, and contracting muscle. Next, identify the two structures named below by choosing different colors for the coding circles and the corresponding structures in the figure.

- Movable bone
- Immobile bone

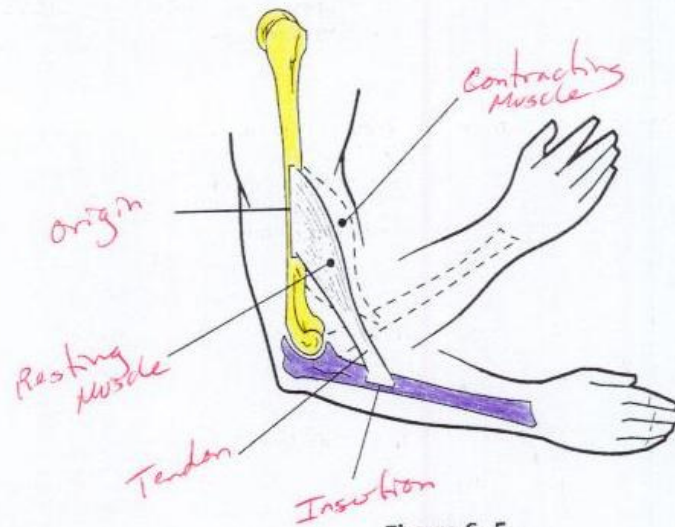


Figure 6-5

15. Complete the following statements. Insert your answers in the answer blanks.

- Plantar Flexion 1. Standing on your toes as in ballet is (1) of the foot. Walking on your heels is (2).
- Dorsi Flexion 2. Winding up for a pitch (as in baseball) can properly be called (3). To keep your seat when riding a horse, the tendency is to (4) your thighs.
- Circumduction 3.
- Adduct 4. In running, the action at the hip joint is (5) in reference to the leg moving forward and (6) in reference to the leg in the posterior position. When kicking a football, the action at the knee is (7). In climbing stairs, the hip and knee of the forward leg are both (8). You have just touched your chin to your chest; this is (9) of the neck.
- Flexion 5.
- Extension 6.
- Extension 7.
- Flexed 8. Using a screwdriver with a straight arm requires (10) of the arm. Consider all the movements of which the arm is capable. One often used for strengthening all the upper arm and shoulder muscles is (11).
- Flexion 9.
- Rotation 10.
- Circumduction 11. Moving the head to signify "no" is (12). Action that moves the distal end of the radius across the ulna is (13). Raising the arms laterally away from the body is called (14) of the arms.
- Rotation 12.
- Pronation 13.
- Abduction 14.

16. The terms provided in the key are often used to describe the manner in which muscles interact with other muscles. Select the key terms that apply to the following definitions and insert the correct letter or term in the answer blanks.

Key Choices

- A. Antagonist B. Fixator C. Prime mover D. Synergist

- C 1. Agonist
- B 2. Postural muscles for the most part
- D 3. Stabilizes a joint so that the prime mover can act at more distal joints
- D 4. Performs the same movement as the prime mover
- A 5. Reverses and/or opposes the action of a prime mover
- B 6. Immobilizes the origin of a prime mover









17. Several criteria are applied to the naming of muscles. These are provided in Column B. Identify which criteria pertain to the muscles listed in Column A and enter the correct letter(s) in the answer blank.

Column A	Column B
<u>GE</u> 1. Gluteus maximus	A. Action of the muscle
<u>AG</u> 2. Adductor magnus	B. Shape of the muscle
<u>DE</u> 3. Biceps femoris	C. Location of the muscle's origin and/or insertion
<u>FE</u> 4. Transversus abdominis	D. Number of origins
<u>AE</u> 5. Extensor carpi ulnaris	E. Location of muscle relative to a bone or body region
<u>B</u> 6. Trapezius	F. Direction in which the muscle fibers run relative to some imaginary line
<u>FE</u> 7. Rectus femoris	G. Relative size of the muscle
<u>FE</u> 8. External oblique	

GROSS ANATOMY OF THE SKELETAL MUSCLES

Muscles of the Head

18. Identify the major muscles described in Column A by choosing a response from Column B. Enter the correct letter in the answer blank. Select a different color for each muscle described and color in the coding circle and corresponding muscle on Figure 6-6.

Column A	Column B
 <u>I</u> 1. Used to show you're happy	A. Buccinator
 <u>A</u> 2. Used to suck in your cheeks	B. Frontalis
 <u>D</u> 3. Used in winking	C. Masseter
 <u>B</u> 4. Wrinkles the forehead horizontally	D. Orbicularis oculi
 <u>E</u> 5. The "kissing" muscle	E. Orbicularis oris
 <u>C</u> 6. Prime mover of jaw closure	F. Sternocleidomastoid
 <u>G</u> 7. Synergist muscle for jaw closure	G. Temporalis
 <u>F</u> 8. Prime mover of head flexion; a two-headed muscle	H. Trapezius
	I. Zygomaticus

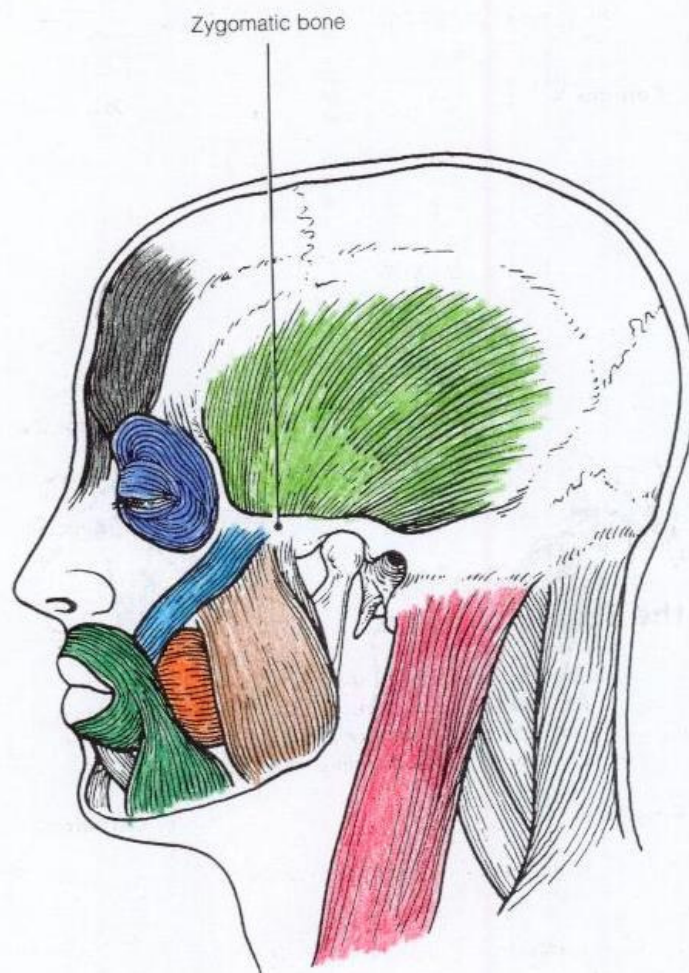


Figure 6-6