

The Muscular System

FOCUS: Muscle tissue is specialized to contract with a force; it is responsible for body movements. According to the sliding filament mechanism, the movement of actin myofilaments past myosin myofilaments results in the shortening of muscle fibers (cells) and therefore muscles. The three types of muscle tissue are skeletal, smooth, and cardiac muscle. Muscles that work together to perform a

particular movement, such as flexing the forearm, are called synergists. Muscles that produce the opposite movement of other muscles, such as extending the forearm, are called antagonists. The study of muscle actions can be approached by examining groups of muscles first and then individual muscles within a group.

CONTENT LEARNING ACTIVITY

Characteristics of Skeletal Muscle

“Muscle has four functional characteristics: contractility, excitability, extensibility, and elasticity.”

Match these terms with the correct statement or definition:

Contractility
Elasticity

Excitability
Extensibility

1. Ability to shorten with a force.
2. The capacity to respond to a stimulus.
3. Ability to be stretched.
4. Ability to recoil to original resting length after being stretched.



The metabolism that occurs in the body's large mass of muscle tissue produces heat essential for the maintenance of normal body temperature.

Structure

“Skeletal muscles are composed of skeletal muscle fibers and associated connective tissue.”

A. Match these terms with the correct statement or definition:

Endomysium
Epimysium (fascia)
Muscle fasciculus

Muscle fiber
Perimysium

1. Connective tissue sheath that surrounds each skeletal muscle.
2. Muscle bundle.
3. Connective tissue that surrounds muscle fasciculi.
4. Single muscle cell; makes up muscle fasciculi.
5. Connective tissue that surrounds a muscle fiber.

B. Match these terms with the correct statement or definition:

Actin myofilament
Myofibril
Myosin myofilament

Tropomyosin
Troponin

1. Thread-like structure that extends from one end of the muscle fiber to the other.
2. Thin myofilament which resembles two minute strands of pearls twisted together.
3. Provide calcium binding sites on actin myofilaments.
4. Covers and uncovers attachment sites for myosin on actin myofilaments.
5. Thick myofilaments which resemble bundles of golf clubs.

C. Match these terms with the correct statement or definition:

A band
H zone
I band

M line
Sarcomere
Z disk

1. The basic structural and functional unit of the muscle.
2. Forms an attachment site for actin myofilaments; the end of the sarcomere.
3. Part of a myofibril that contains only actin myofilaments.
4. Part of a myofibril where actin and myosin myofilaments overlap.
5. Part of a myofibril that contains only myosin myofilaments.
6. Anchors the myosin myofibrils in the center of the sarcomere.

D. Match these terms with the correct statement or definition:

Sarcoplasm
Sarcolemma

Sarcoplasmic reticulum
T tubules

1. The cytoplasm of a muscle fiber.
2. The cell membrane of a muscle fiber.
3. Invaginations of the sarcolemma that wrap around sarcomeres.
4. Highly organized, smooth endoplasmic reticulum; contains high concentrations of calcium.
5. Connect the sarcolemma and the sarcoplasmic reticulum.

E. Match these terms with the correct parts labeled in figure 7.1

Actin myofilament
Endomysium
Epimysium (fascia)
Fasciculi
Myofibrils

Myosin myofilament
Muscle fibers
Perimysium
Sarcoplasmic reticulum
Transverse tubule

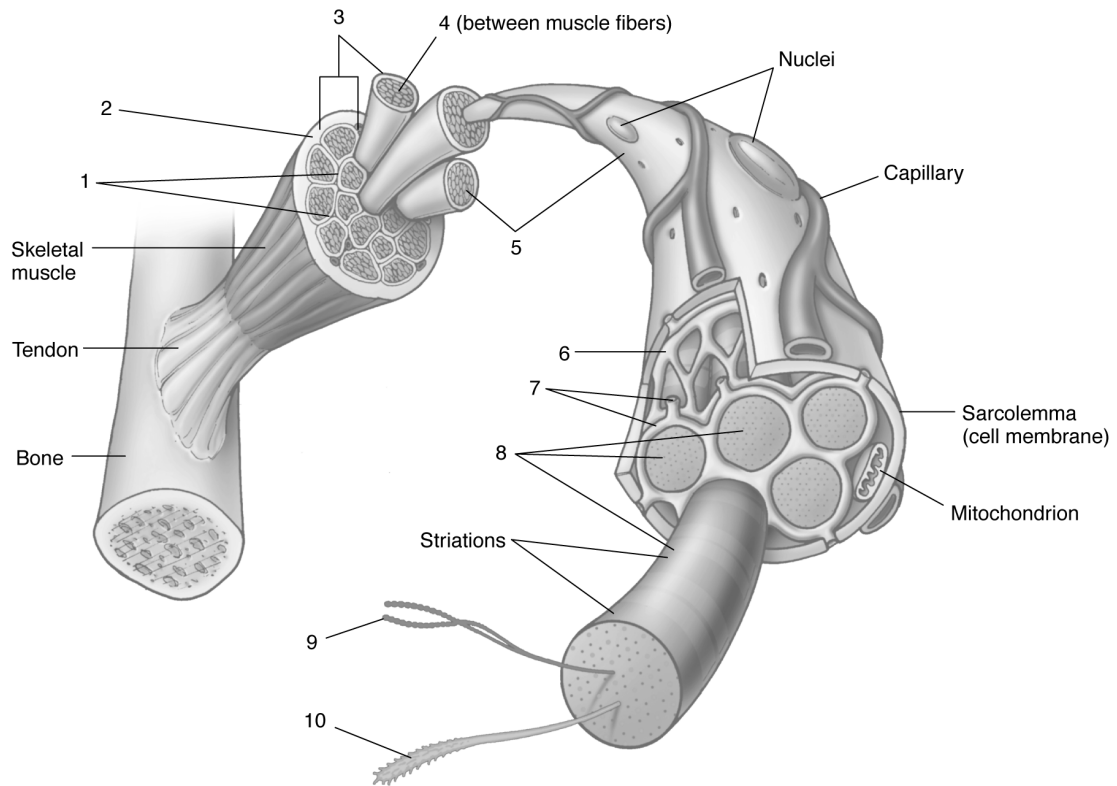


Figure 7.1

| | | |
|----------|----------|-----------|
| 1. _____ | 5. _____ | 8. _____ |
| 2. _____ | 6. _____ | 9. _____ |
| 3. _____ | 7. _____ | 10. _____ |
| 4. _____ | | |

F. Match these terms with the correct parts labeled in figure 7.2

A band
Actin
Actin myofilament
H zone
I band
M line

Myosin myofilament
Myosin molecule
Sarcomere
Tropomyosin
Troponin
Z disk

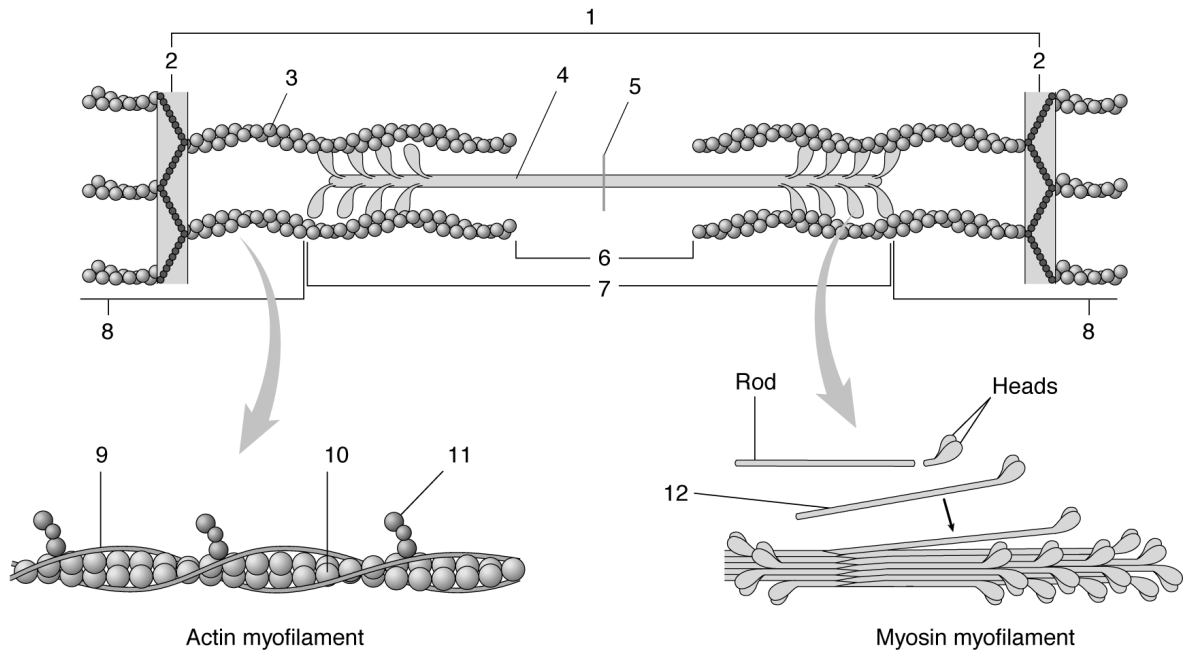


Figure 7.2

- | | | |
|----------|----------|-----------|
| 1. _____ | 5. _____ | 9. _____ |
| 2. _____ | 6. _____ | 10. _____ |
| 3. _____ | 7. _____ | 11. _____ |
| 4. _____ | 8. _____ | 12. _____ |

Membrane Potentials

“Membrane potentials result from charge differences across the cell membrane.”

A. Using the terms provided, complete these statements:

Higher
Less
Lower

More
Positively
Negatively

1. _____
2. _____
3. _____

The resting membrane potential is a charge difference across the cell membrane which develops because there is a (1) concentration of potassium ions inside the cell than outside, and because the cell membrane is (2) permeable to potassium ions than other ions. The movement of potassium ions from inside to outside the cell causes the outside of the cell membrane to become (3) charged compared to the inside.

B. Using the terms provided, complete these statements:

Action potential
Decreases
Depolarization
Increases

Into
Out of
Repolarization

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

When a muscle or nerve cell is stimulated, the membrane permeability to sodium ions (1), and sodium ions move (2) the cell. This movement causes (3) as the inside of the cell membrane becomes more positive compared to the outside. Next, the permeability to sodium ions (4) and the permeability to potassium ions (5). As a result of these permeability changes, potassium ions move (6) the cell, causing (7) as the outside of the cell membrane becomes more positive compared to the inside. Depolarization and repolarization together are called an (8). Following the action potential, an active transport pump restores ion balance across the cell membrane by moving sodium ions (9) the cell and potassium ions (10) the cell.

Nerve Supply

“Nerve cells chemically stimulate skeletal muscle fibers.”

Match these terms with the correct statement or definition:

| | |
|------------------------|----------------|
| Acetylcholine | Motor neuron |
| Acetylcholinesterase | Motor unit |
| Neuromuscular junction | Synaptic cleft |

- | | |
|-------|--|
| _____ | 1. Nerve cell that carries action potentials to skeletal muscle fibers. |
| _____ | 2. Point where the axon of a motor neuron joins with a skeletal muscle fiber; an example of a synapse. |
| _____ | 3. Motor neuron and all the skeletal muscle fibers it supplies. |
| _____ | 4. Space between the presynaptic terminal and the muscle fiber membrane. |
| _____ | 5. Neurotransmitter released from synaptic vesicles of the presynaptic terminal. |
| _____ | 6. Enzyme that breaks down acetylcholine. |



Acetylcholine diffuses across the synaptic cleft and produces an action potential in skeletal muscle cells.

Muscle Contraction

“Muscle contraction occurs as actin and myosin myofilaments slide past one another.”

A. Using the terms provided, complete these statements:

| | |
|------------------------|----------------------------|
| ATP molecules | Sliding filament mechanism |
| Cross bridges | T tubules |
| Heat | Troponin |
| Sarcoplasmic reticulum | Tropomyosin |

Action potentials in skeletal muscle fibers travel along the cell membrane and the (1). When the action potentials reach the (2), they release calcium ions. The calcium ions bind to (3), which causes (4) to move and expose myosin attachment sites on actin myofilaments. Myosin myofilaments bind to actin myofilaments to form (5). Bending of the myosin heads of the cross bridges moves actin myofilament over the myosin myofilaments. This is called the (6). The bending of the myosin heads requires the breakdown of (7) for energy, and in the process (8) is released causing an increase in body temperature. Transport of calcium ions into the (9) results in muscle relaxation.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____



ATP molecules are also required for muscle to relax. After death, rigor mortis occurs because ATP molecules are not available.

B. Match these terms with the correct statement or definition:

| | |
|----------------------|------------------|
| All-or-none response | Recruitment |
| Contraction phase | Relaxation phase |
| Lag phase | Tetanus |
| Muscle twitch | |

- _____
- _____
- _____
- _____
- _____
- _____

1. Contraction of an entire muscle in response to a stimulus that causes an action potential in one or more muscle fibers.
2. Below a threshold stimulus a muscle fiber does not contract; a threshold or stronger stimulus causes the muscle fiber to contract maximally.
3. Time between application of a stimulus and the beginning of contraction.
4. Time during which a muscle shortens.
5. Condition where a muscle remains contracted without relaxing; results from rapid stimulation of the muscle.
6. The number of motor units being activated increases.



A smooth, sustained contraction occurs when some motor units contract and are held in tetanus while other motor units are relaxing.

C. Match these terms with the correct statement or definition:

Aerobic respiration
Anaerobic respiration
ATP

Creatine phosphate
Oxygen debt
Muscle fatigue

- _____
- _____
- _____
- _____
- _____
- _____
- _____
1. Molecule used to provide energy for muscle contraction.
 2. Molecule used to store energy; used to quickly produce ATP.
 3. Type of respiration that requires oxygen.
 4. Type of respiration that produces lactic acid.
 5. Type of respiration that produces the most ATP molecules for each glucose molecule used.
 6. Type of respiration used during short periods of intense exercise.
 7. Amount of oxygen needed to convert lactic acid to glucose.
 8. Results when ATP is used during muscle contraction faster than it can be produced in muscle cells, and lactic acid builds up faster than it can be removed.



Physiological contracture is an inability of muscles to contract or relax. It is extreme muscle fatigue caused by a lack of ATP molecules.

D. Match these terms with the correct statement or definition:

Concentric
Eccentric
Isometric

Isotonic
Muscle tone

- _____
- _____
- _____
- _____
1. Contraction in which the length of muscle does not change, but the amount of tension increases.
 2. Contraction responsible for movement of the arms or fingers.
 3. Isotonic contraction in which tension is maintained as the muscle lengthens.
 4. Constant tension produced for long periods of time; responsible for maintaining posture.

E. Match these terms with the correct statement or definition:

Fast-twitch muscle fibers
Slow-twitch muscle fibers

- _____
- _____
- _____
- _____
1. Most resistant to fatigue.
 2. Has a richer blood supply and contains myoglobin, which temporarily stores oxygen.
 3. Predominant muscle fiber in the upper limbs.
 4. Intense exercise resulting in anaerobic respiration has the greatest effect on this type of muscle fiber.



Enlargement of skeletal muscles after birth because of growth or exercise is the result of an increase in the size of existing muscle fibers.

Smooth Muscle and Cardiac Muscle

“Smooth muscle and cardiac muscle form the walls of hollow organs.”

Match these terms with the correct statement or definition:

Both smooth muscle and cardiac muscle
Cardiac muscle
Smooth muscle

1. Unlike skeletal muscle, do not have sarcomeres and therefore are not striated.
2. Unlike skeletal muscle, under involuntary control.
3. Capable of autorhythmic contractions.
4. Has intercalated disks, which facilitate action potential conduction between cells.

General Principles of Muscle Anatomy

“Muscle contraction causes body movements by pulling one bone toward another across a movable joint.”

Match these terms with the correct statement or definition:

Antagonist
Aponeurosis
Belly
Fixator
Insertion

Origin
Prime mover
Synergists
Tendon

1. General term for the attachment of a muscle to a bone.
2. A broad, sheetlike tendon.
3. The most stationary end of a muscle; the head.
4. End of the muscle attached to the bone undergoing the greatest movement.
5. Part of the muscle between the origin and insertion.
6. Muscles that work together to accomplish a movement.
7. Muscle working in opposition to another muscle.
8. Muscle that plays the major role in accomplishing a particular movement.
9. Muscle that holds a bone in place.

Muscles of the Head and Neck

“Head muscles are responsible for facial expression, mastication, tongue movements, swallowing, voice production, and eye movements. Neck muscles move the head.”

A. Match these terms with the correct statement or definition:

Buccinator
 Depressor anguli oris
 Levator labii superioris
 Occipitofrontalis

Orbicularis oculi
 Orbicularis oris
 Zygomaticus

1. Raises the eyebrows.
2. Closes the eye.
3. Two muscles that pucker the mouth.
4. Flattens the cheek.
5. Responsible for smiling.
6. Accomplishes sneering.
7. Responsible for frowning.

B. Match these terms with the correct statement or definition:

Extrinsic tongue muscles
 Hyoid muscles
 Intrinsic tongue muscles
 Masseter
 Pharyngeal constrictors

Pharyngeal elevators
 Pterygoid muscles
 Soft palate muscles
 Sternocleidomastoid muscle
 Temporalis

1. Easily seen and felt on the side of the head, these two muscles close the mandible during mastication.
2. Deep muscles that open and close the mandible.
3. Function to change the shape of the tongue.
4. Muscles that can elevate the larynx.
5. Close the posterior opening of the nasal cavity during swallowing.
6. Force food into the esophagus.
7. Prime mover of the lateral neck muscles.

Trunk Muscles

“Trunk muscles include those moving the vertebral column, those of the thorax and abdominal wall, and those of the pelvic floor.”

Match these terms with the correct statement or definition:

| | |
|----------------------------|-------------------------|
| Deep back muscles | Linea alba |
| Diaphragm | Pelvic diaphragm |
| Erector spinae | Perineum |
| External abdominal oblique | Rectus abdominis |
| External intercostals | Tendinous intersections |
| Internal abdominal oblique | Transversus abdominis |
| Internal intercostals | |

- _____ 1. Group of muscles on each side of the back; primarily responsible for keeping the back straight.
- _____ 2. Elevate the ribs during inspiration.
- _____ 3. Responsible for the major movement of breathing.
- _____ 4. Tendinous area of the abdominal wall extending from the sternum to the pubis.
- _____ 5. Muscle located on each side of the linea alba; flexes the vertebral column.
- _____ 6. Subdivide the rectus abdominis at three or more locations.
- _____ 7. The most superficial lateral abdominal wall muscle.
- _____ 8. The deepest lateral abdominal wall muscle.
- _____ 9. Between the external abdominal oblique and the transversus abdominis.
- _____ 10. Forms most of the pelvic floor.
- _____ 11. Area inferior to the pelvic floor; contains muscles associated with reproductive structures.

Upper Limb Muscles

“The muscles of the upper limb include those that attach the limb and girdle to the body and those that are in the arm, forearm, and hand.”

A. Match these terms with the correct statement or definition:

Deltoid
Latissimus dorsi
Pectoralis major

Pectoralis minor
Rotator cuff
Trapezius

1. Attaches the scapula to the thorax; forms the upper line from each shoulder to the neck.
2. Attaches the scapula to the thorax; anterior chest muscle.
3. Attaches the humerus to the anterior thorax; adducts, flexes, and extends the arm.
4. Attaches the humerus to the posterior thorax; extends and adducts the arm.
5. Attaches the humerus to the scapula; rotates the arm.
6. Attaches the humerus to the scapula; major abductor of the upper limb.



The muscles that attach the scapula to the thorax act as fixators to hold the scapula in position when the arm muscles contract. They also move the scapula into different positions, thereby increasing the range of movement of the upper limb.

B. Match these terms with the correct statement or definition:

Anterior forearm muscles
Biceps brachii
Brachialis
Brachioradialis
Intrinsic hand muscles

Posterior forearm muscles
Pronator muscles
Supinator
Triceps brachii

1. Posterior arm muscle; extends the forearm.
2. Two anterior arm muscles; flex the forearm.
3. Muscle located in the forearm that flexes the forearm.
4. Two muscles that supinate the forearm.
5. Group of muscles that flex the wrist and fingers.
6. Group of muscles that extend the wrist and fingers.
7. Muscles located in the hand; responsible for finger movements.

Lower Limb Muscles

“The lower limb muscles include those located in the hip, thigh, leg, and foot.”

A. Match these terms with the correct statement or definition:

Anterior thigh muscles
Gluteus maximus
Gluteus minimus
Iliopsoas

Medial thigh muscles
Posterior thigh muscles
Tensor fasciae latae

1. Anterior hip muscle that flexes the thigh.
2. Forms most of the mass of the buttocks; extends and abducts the thigh.
3. Common site for injections; abducts the thigh.
4. Attaches to a thick band of connective tissue; abducts the thigh.
5. Group of thigh muscles that flex the thigh.
6. Group of thigh muscles that extend the thigh.
7. Group of thigh muscles that adduct the thigh.

B. Match these terms with the correct statement or definition:

Adductor muscles
Anterior leg muscles
Gastrocnemius
Hamstring muscles
Intrinsic foot muscles

Peroneus muscles
Quadriceps femoris
Sartorius
Soleus

1. Anterior thigh muscles; extend the leg.
2. Anterior thigh muscle; flexes the leg.
3. Posterior thigh muscles; flex the leg.
4. Medial thigh muscles, adduct the thigh.
5. Two posterior leg muscles that join the calcaneal tendon; plantar flex the foot.
6. Leg muscles that dorsiflex the foot and extend the toes.
7. Lateral leg muscles; evert the foot.
8. Muscles located in the foot; responsible for toe movements.

Location of Superficial Muscles

A. Match these terms with the correct parts labeled in figure 7.3:

- Adductors of thigh
- Biceps brachii
- Brachioradialis
- Deltoid
- External abdominal oblique
- Flexors of the wrist and fingers
- Pectoralis major
- Quadriceps femoris
- Rectus abdominis
- Rectus femoris
- Sartorius
- Serratus anterior
- Sternocleidomastoid
- Tensor fasciae latae
- Vastus lateralis
- Vastus medialis

1. _____
2. _____
3. _____
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16. _____

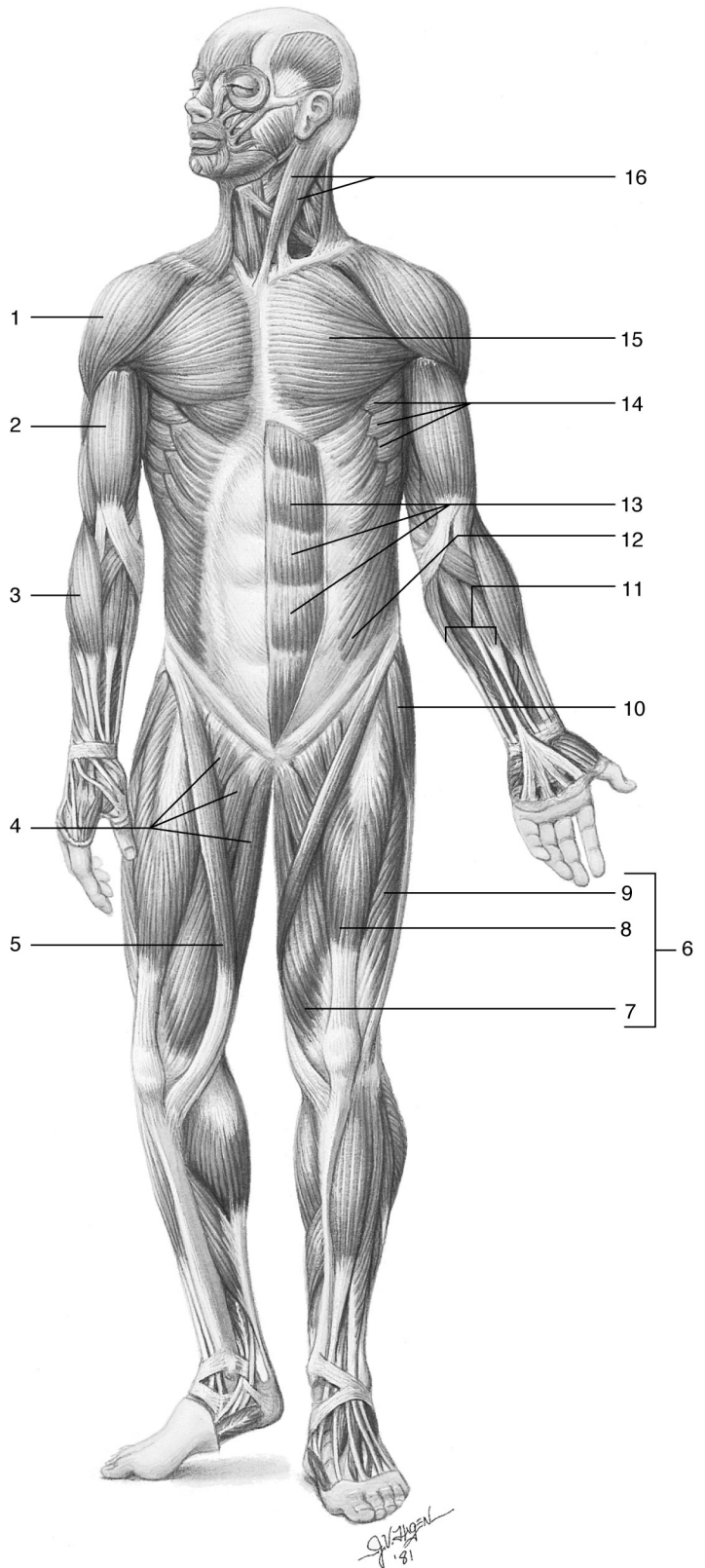


Figure 7.3

B. Match these terms with the correct parts labeled in figure 7.4:

- Adductor muscles
- Biceps femoris
- Extensors of the wrist and fingers
- Gastrocnemius
- Gluteus maximus
- Gluteus medius
- Hamstring muscles
- Infraspinatus
- Latissimus dorsi
- Semimembranosus
- Semitendinosus
- Soleus
- Teres major
- Teres minor
- Trapezius
- Triceps brachii

1. _____
2. _____
3. _____
4. _____
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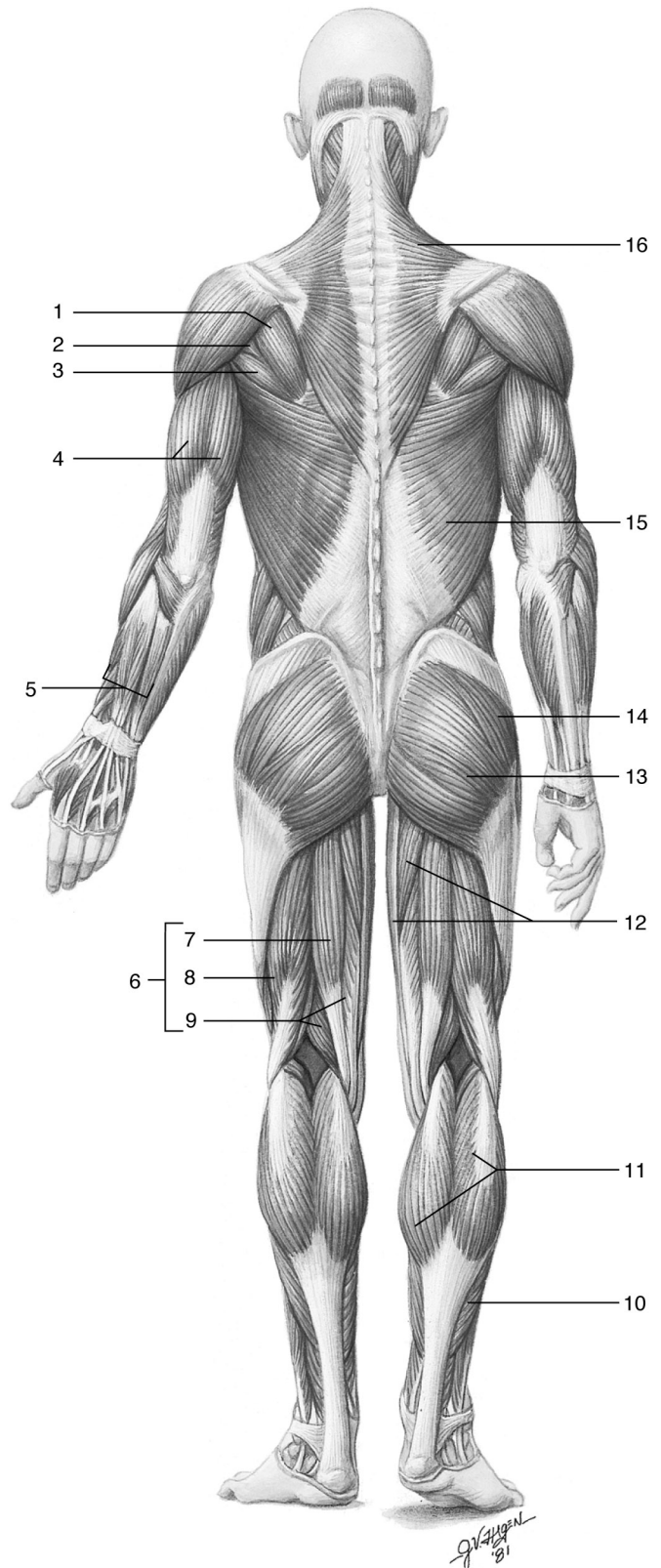


Figure 7.4

QUICK RECALL

1. List seven functions of the muscular system.
2. List the four functional characteristics of muscle.
3. Name the three connective tissue structures associated with skeletal muscle, and describe what each surrounds.
4. Name the two kinds of membrane potentials.
5. Name the two parts of an action potential. Describe the ion movements that produce each part. Explain how ion balance is restored following an action potential.
6. List the parts of a neuromuscular junction.
7. List the parts of a sarcomere found in the I band, A band, and H zone.
8. Describe the all-or-none response of a skeletal muscle fiber.

9. Name two ways to increase the force of contraction of a muscle.

10. Name two types of muscle contraction.

11. Name two types of skeletal muscle fibers.

WORD PARTS

Give an example of a new vocabulary word that contains each word part.

| WORD PART | MEANING | EXAMPLE |
|-----------|-----------------|----------|
| my- | muscle | 1. _____ |
| aer- | the air | 2. _____ |
| sarco- | flesh | 3. _____ |
| -plasm | formed material | 4. _____ |
| syn- | together | 5. _____ |
| -erg | work | 6. _____ |

MASTERY LEARNING ACTIVITY

Place the letter corresponding to the correct answer in the space provided.

- _____ 1. The connective tissue sheath that surrounds a muscle fasciculus is the
- epimysium.
 - endomysium.
 - perimysium.

- _____ 2. Given the following structures:
- whole muscle
 - muscle fiber (cell)
 - myofilament
 - myofibril
 - muscle fasciculus

Choose the arrangement that lists the structures in the correct order from the outside to the inside of a skeletal muscle.

- 1, 2, 5, 3, 4
- 1, 2, 5, 4, 3
- 1, 5, 2, 3, 4
- 1, 5, 2, 4, 3
- 1, 5, 4, 2, 3

- _____ 3. Actin myofilaments
- are attached to the Z disk.
 - are found primarily in the H zone.
 - are thicker than myosin myofilaments.
 - all of the above

- _____ 4. Which of the following statements regarding membrane potentials is true?
- An action potential is a brief reversal of charge across a cell membrane.
 - In a resting membrane potential the outside of the membrane is negatively charged compared to the inside.
 - Stimulation of a cell membrane results in sodium ion movement out of the cell.
 - all of the above

- _____ 5. Given the following events:
- acetylcholine broken down
 - acetylcholine moves across the synaptic cleft
 - action potential reaches the terminal branch (presynaptic terminal) of a motor neuron
 - acetylcholine combines with a receptor molecule on a skeletal muscle (postsynaptic membrane)
 - action potential produced in skeletal muscle cell

Choose the arrangement that lists the events in the order they occur at a neuromuscular junction.

- 2, 3, 4, 1, 5
- 3, 2, 4, 5, 1
- 3, 4, 2, 1, 5
- 4, 5, 2, 1, 3

- _____ 6. Given the following events:
- sarcoplasmic reticulum releases calcium ions
 - sarcoplasmic reticulum takes up calcium ions
 - calcium ions bind to troponin molecules within actin myofilaments
 - action potentials move down the T tubule
 - cross bridges form and muscle contraction occurs

Choose the arrangement that lists the events in the order they occur following a single stimulus of a skeletal muscle.

- 1, 4, 3, 5
- 2, 4, 3, 5
- 4, 1, 3, 5
- 5, 4, 3, 2

- _____ 7. Skeletal muscles
- require energy in order to contract.
 - require energy in order to relax.
 - relax when calcium ions are transported into sarcoplasmic reticulum.
 - all of the above
- _____ 8. Increasing the frequency of stimulation of a muscle
- results in rigor mortis.
 - increases the length of the relaxation phase
 - results in recruitment of motor units.
 - results in tetanus.
- _____ 9. Contrasting aerobic and anaerobic respiration,
- anaerobic respiration produces more ATP molecules per glucose molecule than does aerobic respiration.
 - anaerobic respiration requires oxygen.
 - the end product of anaerobic respiration is lactic acid.
 - anaerobic respiration produces ATP molecules slowly compared to aerobic respiration.
- _____ 10. During the first few minutes of exercise, the exercising muscle uses different energy sources to produce the ATP molecules necessary for contraction. Given the following sources of ATP production:
- anaerobic respiration
 - aerobic respiration
 - breakdown of creatine phosphate
- Choose the arrangement that lists the energy sources in the order they are used.
- 1, 2, 3
 - 1, 3, 2
 - 2, 1, 3
 - 2, 3, 1
 - 3, 1, 2
- _____ 11. A weight-lifter attempts to lift a weight from the floor, but the weight is so heavy he is unable to move it. The type of muscle contraction the weight-lifter used was mostly
- isometric.
 - isotonic.
 - notsometric.
 - notsotonic.
 - notsoeasy.
- _____ 12. Dudley Smartlips pulled into Kentucky Fried Chicken and placed an order for a McChicken burger. But, he wanted low myoglobin meat, hold the mayo. He was served
- chicken breasts (white meat)
 - chicken thighs (dark meat)
- _____ 13. Fast-twitch fibers
- can be changed into slow-twitch fibers with exercise.
 - are found in higher proportions in arm muscles than in back muscles.
 - are found in higher proportions in the thigh muscles of marathon runners than in the thigh muscles of sprinters.
 - are a specialized type of smooth muscle.
- _____ 14. Which of the following muscles types is correctly matched with its characteristic?
- skeletal muscle - spontaneous contractions
 - smooth muscle - autorhythmic
 - cardiac muscle - no striations
 - skeletal muscle - single nucleus per cell
- _____ 15. Muscles that oppose one another are
- synergist.
 - hateful.
 - prime movers.
 - antagonists.
- _____ 16. An aerial circus performer who supports herself only by her teeth while spinning around and around should have strong
- temporalis and masseter muscles.
 - zygomaticus muscles.
 - trapezius muscles.
 - tendinous intersections.

- _____ 17. A man lies flat on his back. While someone holds his feet he does a "sit-up." Which of the following muscles would be involved?
- rectus abdominis
 - iliopsoas
 - anterior thigh muscles
 - all of the above
- _____ 18. Which of the following muscles would one expect to be especially well developed in a boxer?
- biceps brachii
 - brachialis
 - deltoid
 - triceps brachii
- _____ 19. Which of the following would be well developed in a football player whose specialty is kicking field goals?
- hamstrings
 - quadriceps femoris
 - gluteus maximus
 - gastrocnemius
- _____ 20. Which of the following muscles would be especially well developed in a ballerina?
- pectoralis major
 - rectus abdominis
 - gastrocnemius
 - erector spinae



FINAL CHALLENGES



Use a separate sheet of paper to complete this section.

- Bob Canner improperly canned some home-grown vegetables. As a result, he contracted botulism poisoning after eating the vegetables. Botulism results from a toxin produced by bacteria. Symptoms included difficulty in swallowing and breathing. Eventually he died of respiratory failure because his respiratory muscles relaxed and would not contract. Assuming that botulism toxin affects the neuromuscular junction, propose as many ways as you can how botulism toxin could produce the observed symptoms.
- The following experiments were performed in an anatomy and physiology laboratory. The rate and depth of respiration for a resting student was determined. In experiment A the student ran in place for 30 seconds, immediately sat down and relaxed, and respiration rate and depth was again determined. Experiment B was just like experiment A except that the student held her breath while running in place. What differences in respiration would you expect for the two different experiments. Explain the basis for your predictions.
- Sally Gorgeous, an avid jogger, is running down the beach when she meets Sunny Beachbum, an avid weight lifter. Sunny flirts with Sally, who decides he has more muscles than brains. She runs down the beach, but Sunny runs after her. After about a half mile Sunny tires and gives up. Explain why Sally was able to outrun Sunny (i.e., do more muscular work) despite the fact that she obviously is less muscular.
- Describe the movement each of these muscles produces: biceps brachii, hamstrings, and pectoralis major. Name the muscles that act as synergists and antagonists for each movement of the muscle.