

Physiology of the Muscular System

Although the muscular system has several functions, the primary purpose is to provide movement or power. Muscles produce power by contracting. The ability of a large muscle or muscle group to contract depends on the ability of microscopic muscle fibers to contract within the larger muscle. An understanding of these microscopic muscle fibers will assist you as your study progresses to the larger muscles and muscle groups.

Three types of muscles provide us with a variety of motions. When skeletal or voluntary muscles contract, they provide movement of bones, heat production, and posture. Smooth muscles are found throughout the viscera of our body and assist with involuntary functions such as peristalsis. Cardiac muscle is the third and final type of muscle. It makes up the wall of the heart and provides the pumping action necessary for life. Our muscles must be used to keep the body healthy and in good condition. Scientific evidence keeps pointing to the fact that the proper use and exercise of muscles may prolong life. An understanding of the structure and function of the muscular system may, therefore, add quality and quantity to our lives.

I—FUNCTION OF SKELETAL MUSCLE TISSUE

Multiple Choice—select the best answer.

1. Which of the following is *not* a general function of muscle tissue?
 - a. movement
 - b. protection
 - c. heat production
 - d. posture

2. The skeletal muscle fiber characteristic of excitability directly results in these cells being capable of:
 - a. responding to nerve signals.
 - b. shortening.
 - c. returning to resting length after contracting.
 - d. producing heat.

3. The correct order of arrangement of skeletal muscle cells, from largest to smallest, is:
 - a. fiber, myofibril, myofilament.
 - b. myofibril, myofilament, fiber.
 - c. myofilament, myofibril, fiber.
 - d. fiber, myofilament, myofibril.
4. Sarcoplasmic reticulum is:
 - a. a system of transverse tubules that extend at a right angle to the long axis of the cell.
 - b. a segment of the myofibril between two successive Z lines.
 - c. a unique name for the plasma membrane of a muscle fiber.
 - d. none of the above.
5. Which of the following are myofilament proteins?
 - a. troponin
 - b. tropomyosin
 - c. a and b
 - d. none of the above
6. The contractile unit of a myofibril is the:
 - a. sarcomere.
 - b. triad.
 - c. sarcolemma.
 - d. cross-bridge.
7. The chief function of the T tubule is to:
 - a. provide nutrients to the muscle fiber.
 - b. allow the fiber to contract.
 - c. allow the electrical signal to move deep into the cell.
 - d. allow the generation of new muscle fibers.
8. Myosin heads are also called:
 - a. cross-bridges.
 - b. motor endplates.
 - c. synapses.
 - d. motor neurons.
9. During muscle contraction, Ca^{++} is released from the:
 - a. synaptic cleft.
 - b. mitochondria.
 - c. sarcoplasmic reticulum.
 - d. sarcoplasm.

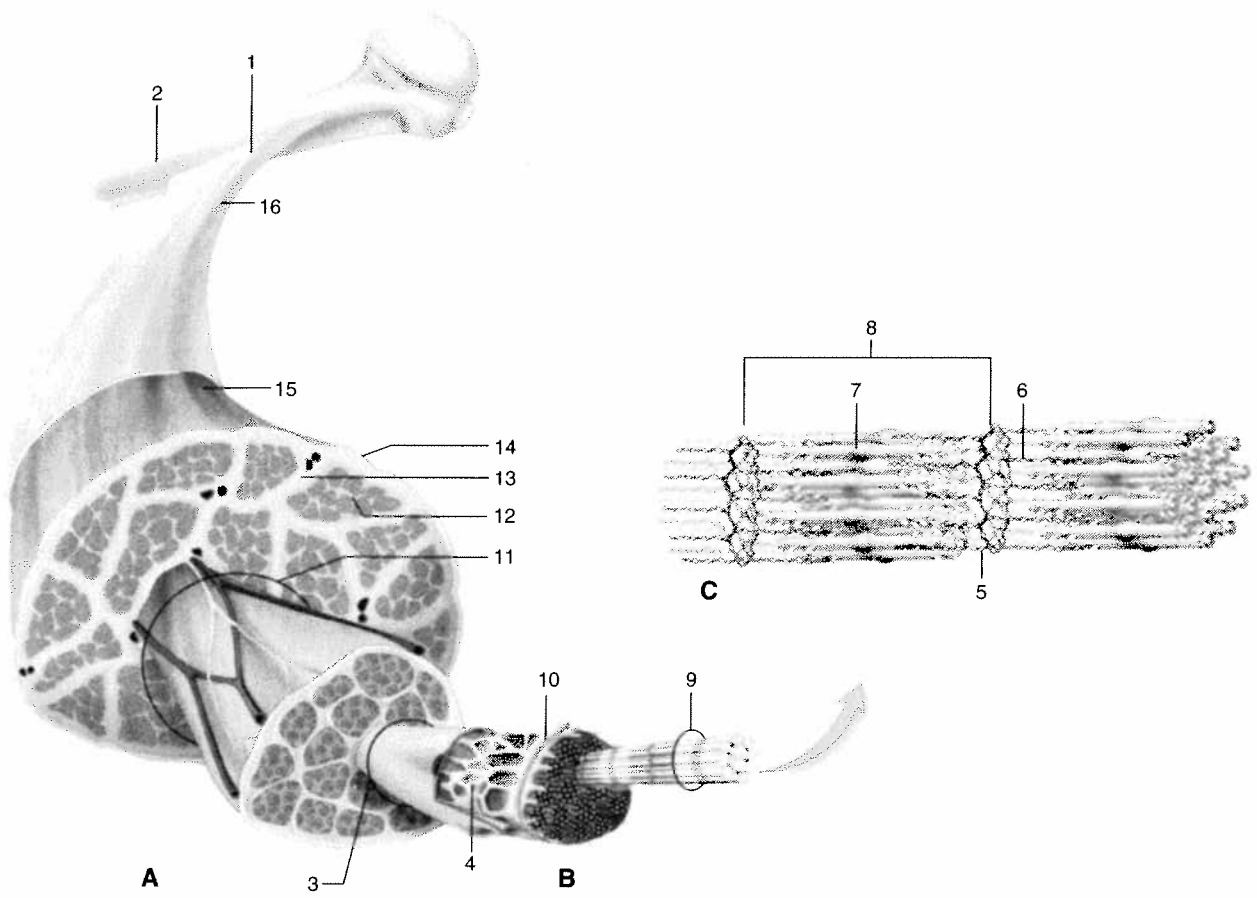
10. The region of a muscle fiber where a motor neuron connects to the muscle fiber is called the:
 - a. synaptic vesicle.
 - b. motor endplate.
 - c. H band.
 - d. none of the above.

True or false

11. _____ The thick myofilament is made up of myosin.
12. _____ Skeletal muscle has a poor ability to stretch.
13. _____ A T tubule sandwiched between sacs of sarcoplasmic reticulum is called a *codon*.
14. _____ Actin, troponin, and tropomyosin are present on the thin myofilament.
15. _____ The I band resides within a single sarcomere.
16. _____ Rigor mortis is caused by a lack of ATP to "turn off" muscle contraction.
17. _____ The cell membrane of a muscle fiber is called the *sarcoplasmic reticulum*.
18. _____ Anaerobic respiration is the first choice of the muscle cell for the production of ATP.
19. _____ During rest, excess oxygen molecules in the sarcoplasm are attracted to a large protein molecule called *myoglobin*.
20. _____ Anaerobic respiration results in the formation of an incompletely catabolized molecule called *lactic acid*.

Labeling—match each term with its corresponding number on the following diagram of the structure of skeletal muscle.

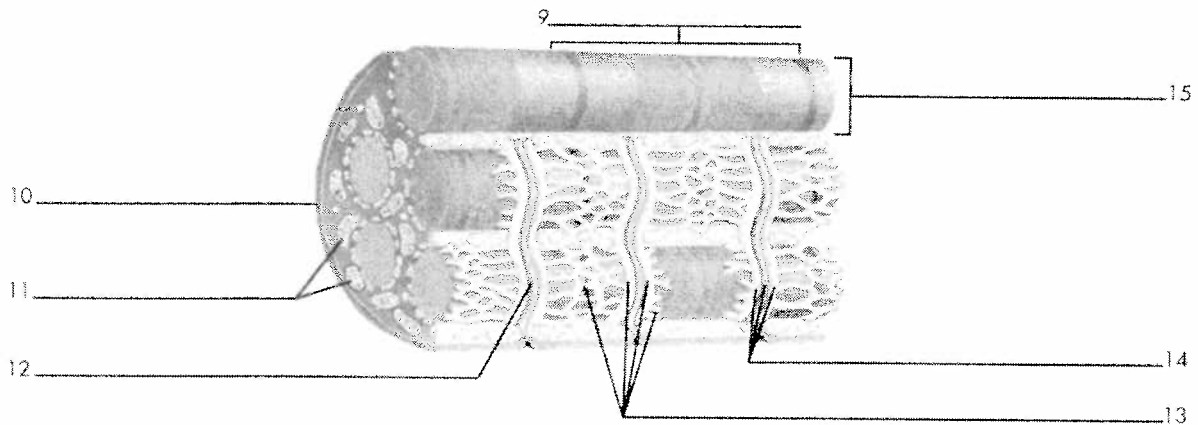
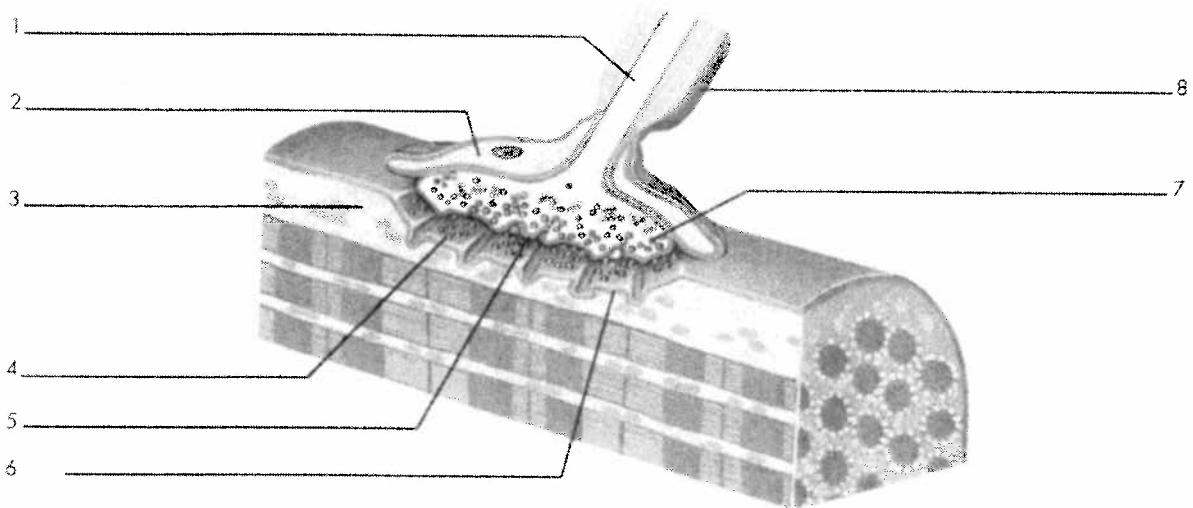
- | | |
|------------------------------|----------------------------------|
| _____ sarcomere | _____ muscle fiber (muscle cell) |
| _____ sarcoplasmic reticulum | _____ perimysium |
| _____ myofibril | _____ epimysium |
| _____ thin filament | _____ Z disk |
| _____ bone | _____ thick filament |
| _____ T tubule | _____ tendon |
| _____ fascicle | _____ endomysium |
| _____ fascia | _____ muscle |



Labeling—using the terms provided, label the following diagrams.

sarcoplasm
 synaptic vesicles (containing Ach)
 sarcoplasmic reticulum
 motor neuron fiber
 Ach receptor sites
 Schwann cell
 motor endplate
 sarcomere

sarcolemma
 triad
 myelin sheath
 synaptic cleft
 myofibril
 mitochondria
 T tubule



▶ *If you had difficulty with this section, review pages 339-352.*

II—FUNCTION OF SKELETAL MUSCLE ORGANS

Multiple Choice—select the best answer.

21. The principal component(s) of a motor unit is/are:
- one somatic motor neuron.
 - the muscle fibers supplied by a somatic motor neuron.
 - none of the above.
 - both a and b.
22. The staircase phenomenon is also known as:
- tetanus.
 - electromyography.
 - wave summation.
 - treppe.
23. Skeletal muscles are innervated by:
- somatic motor neurons.
 - autonomic motor neurons.
 - both a and b.
 - internal stimulation.
24. Which of the following statements concerning isometric contractions is true?
- The length of the muscle changes.
 - Muscle tension decreases.
 - Joint movements are swift.
 - Muscle length remains constant.
25. Physiologic muscle fatigue is caused by:
- relative lack of ATP.
 - oxygen debt.
 - lack of will.
 - none of the above.
26. Increase in muscle size is called:
- hyperplasia.
 - atrophy.
 - hypertrophy.
 - treppe.
27. Endurance training is also called:
- isometrics.
 - hypertrophy.
 - aerobic training.
 - anaerobic training.

True or false

28. _____ A muscle contracts the instant it is stimulated.
29. _____ Isotonic contraction is one in which the tone or tension within a muscle remains the same, but the length of the muscle changes.
30. _____ One method of studying muscle contraction is called *myography*.
31. _____ Muscles with more tone than normal are described as *flaccid*.

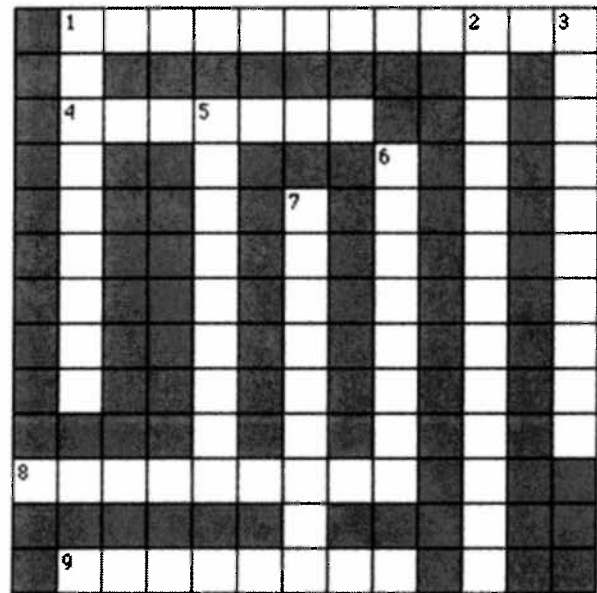
Crossword Puzzle

Across

- Thick and thin
- Smooth, sustained muscle contraction
- "Same length"
- Transverse structure unique to muscle cells (two words)

Down

- Motor neuron plus the muscle fibers (two words)
- Junction between nerve endings and muscle fibers
- Plasma membrane of striated muscle fiber
- Principle that states a muscle fiber will contract fully or not at all (three words)
- "Same tension"
- Fine subunit of muscle fiber



APPLYING WHAT YOU KNOW

- Throughout Linda's life, she wanted to be a star in the 100-meter dash. However, no matter how hard she trained, she could never excel in this sport. On the other hand, she *did* achieve great success in much longer track events, especially the 10-kilometer race. Explain Linda's situation from the aspect of which skeletal muscle fiber type she may possess disproportionately by virtue of her genetics.
- John is working in a hospital while he is studying to become a physician. One of his duties is to transport recently deceased patients to the morgue. While moving the patients onto the gurney, he is surprised to discover how stiff the bodies can be. Which physiologic phenomenon is responsible for this stiffness? Exactly why is it that these muscles can temporarily display stiffness?



DID YOU KNOW

- The simple act of walking requires the use of 200 muscles in the human body.

- People who are on bedrest or totally inactive lose approximately 1% of muscle strength per day.



ONE LAST QUICK CHECK

Multiple Choice—select the best answer.

- When a muscle does not shorten and no movement results, the contraction is:
 - isometric.
 - isotonic.
 - twitch.
 - tetanic.
- Pushing against a wall is an example of which type of contraction?
 - isotonic
 - isometric
 - twitch
 - tetanic
- Prolonged inactivity causes muscles to shrink in mass, a condition called:
 - hypertrophy.
 - disuse atrophy.
 - paralysis.
 - muscle fatigue.