Assignment 4: The skeletal Muscle: Chapter 9

Due: 11:59pm on Tuesday, February 5, 2013

Note: To understand how points are awarded, read your instructor's Grading Policy.

Chapter 9 Chapter Test Question 1

Part A

Which of the following is CORRECTLY paired?

ANSWER:

- smooth muscle: striated
- cardiac muscle: voluntary control
- cardiac muscle: nonstriated
- skeletal muscle: voluntary control

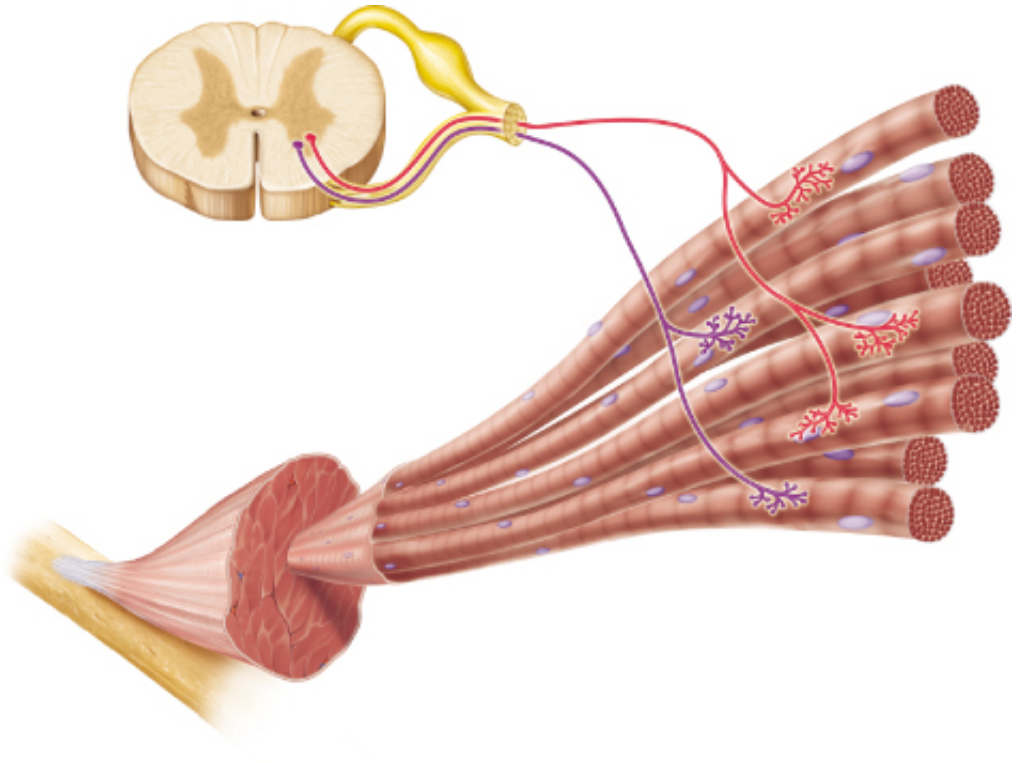
Correct

Correct; skeletal muscle is under voluntary control.

Art Question Chapter 9 Question 21

Part A

If both of the neurons in the figure were activated, more muscle fibers would contract than if either neuron alone were active. This mechanism for control of the force of muscle contraction is known as _____.



ANSWER:

- tetanus
- wave summation
- recruitment
- excitation-contraction coupling

Correct

Recruitment refers to the increased force generated by the activation of increasing numbers of motor units.

Chapter 9 Multiple Choice Question 40

Part A

The giant protein titin maintains the organization of the _____ assisting in muscle stretching.

ANSWER:

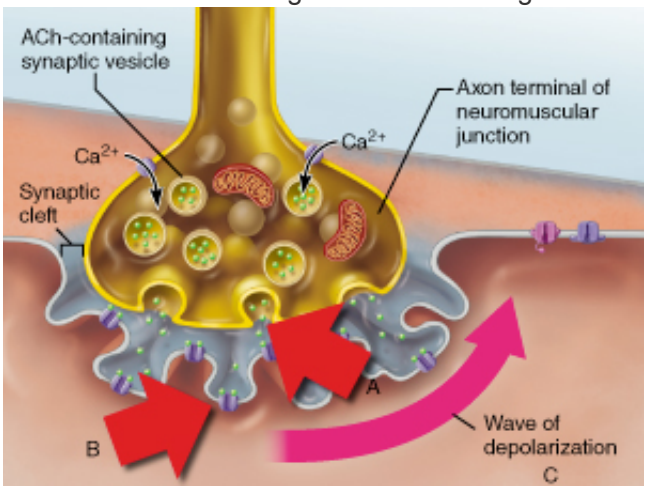
- M line
- I band
- A band
- Z disc

Correct

Art Question Chapter 9 Question 13

Part A

Which event is most significant in initiating the "wave of depolarization" shown in event C?



ANSWER:

- diffusion of acetylcholine down the length of the muscle fiber
- diffusion of acetylcholine into the muscle fiber
- diffusion of Na^+ into the muscle fiber
- diffusion of K^+ out of the muscle fiber

Correct

Excitation of the muscle fiber involves the opening of Na^+ channels in the sarcolemma. Diffusion of Na^+ into the muscle fiber causes the inside of the cell to become more positively charged (depolarized).

Chapter 9 Multiple Choice Question 30

Part A

When a muscle is unable to respond to stimuli temporarily, it is in which of the following periods?

ANSWER:

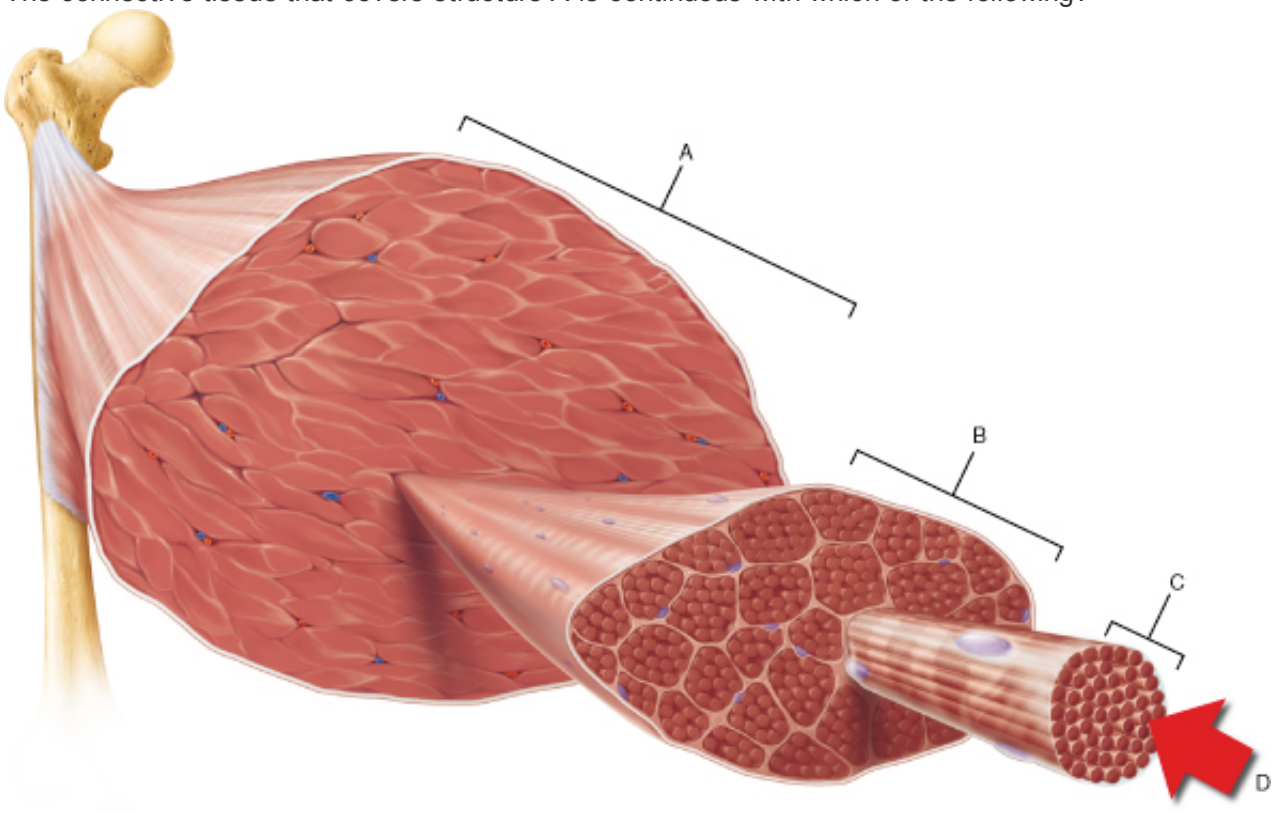
- refractory period
- fatigue period
- relaxation period
- latent period

Correct

Art Question Chapter 9 Question 2

Part A

The connective tissue that covers structure A is continuous with which of the following?



ANSWER:

- endomysium
- ligament
- sarcolemma
- tendon (selected)

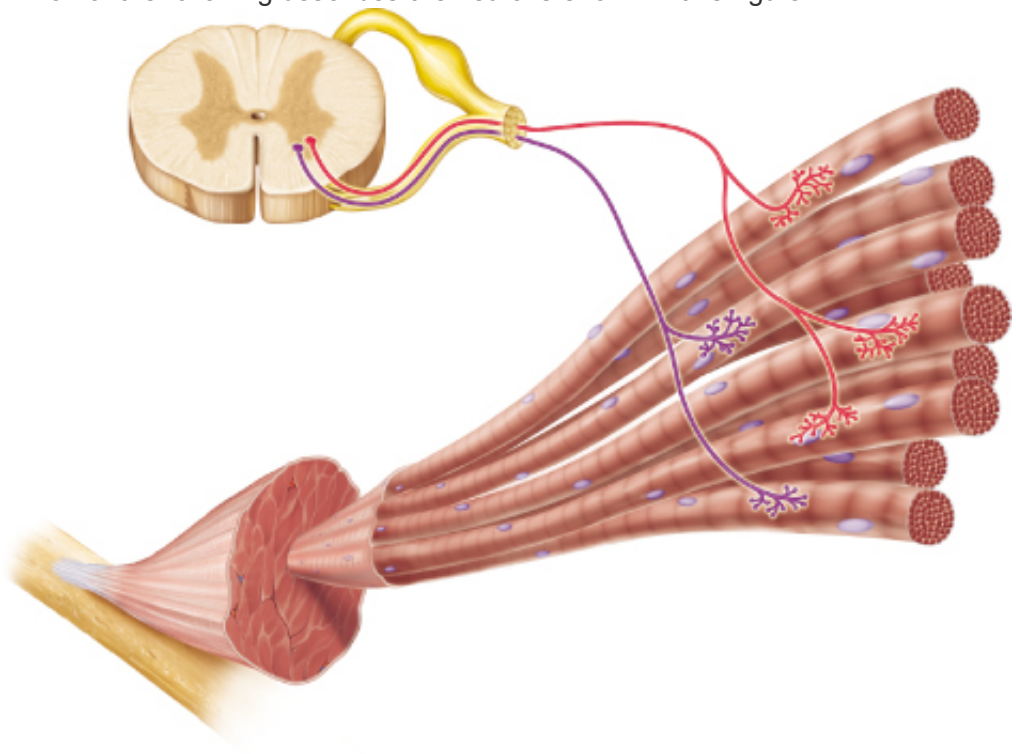
Correct

The dense connective tissue of the epimysium is continuous with the tendon that connects the muscle to a bone.

Art Question Chapter 9 Question 20

Part A

Which of the following describes the neurons shown in this figure?



ANSWER:

- sensory neurons
- somatic motor neurons (selected)
- autonomic motor neurons

Correct

Contraction of skeletal muscle is controlled by somatic motor neurons.

Chapter 9 Homeostatic Imbalance Question 2

Part A

Cross bridge formation between myosin heads and actin molecules is caused by the elevation of calcium ion concentration in the cytosol. During rigor mortis, this elevation of calcium ion concentration in the cytosol is permanent because _____.

ANSWER:

- mitochondria stop producing ATP molecules required by the sarcoplasmic reticulum's calcium ion pumps
- troponin molecules bind irreversibly to calcium ions to prevent them from being removed from the cytosol
- tropomyosin molecules bind irreversibly to calcium ions to prevent them from being removed from the cytosol
- acetylcholine continues to stimulate the release of calcium ions from the sarcoplasmic reticulum

Correct

A pump is considered an active transport process. Active transport moves molecules against their concentration gradient, which requires energy in the form of ATP.

Chapter 9 Multiple Choice Question 24

Part A

What is the functional unit of a skeletal muscle called?

ANSWER:

- the sarcoplasmic reticulum
- a myofibril
- a myofilament
- a sarcomere

Correct

Chapter 9 Multiple Choice Question 45

Part A

After nervous stimulation stops, what prevents ACh in the synaptic cleft from continuing to stimulate contraction?

ANSWER:

- the tropomyosin blocking the myosin once full contraction is achieved
- calcium ions returning to the terminal cisternae
- acetylcholinesterase destroying the ACh
- the action potential stops going down the overloaded T tubules

Correct

A&P Flix: Events at the Neuromuscular Junction

Watch the animation, then answer the questions below.

Part A

Action potential propagation in a skeletal muscle fiber ceases when acetylcholine is removed from the

synaptic cleft. Which of the following mechanisms ensures a rapid and efficient removal of acetylcholine?

Hint 1. Methods of acetylcholine removal

Acetylcholine removal occurs in two ways. Which of these two ways would ensure a rapid and efficient removal of acetylcholine?

ANSWER:

- Acetylcholine is transported back into the axon terminal by a reuptake mechanism.
- Acetylcholine diffuses away from the cleft.
- Acetylcholine is transported into the postsynaptic neuron by receptor-mediated endocytosis.
- Acetylcholine is degraded by acetylcholinesterase.

Correct

Yes! Acetylcholinesterase is an enzyme that degrades acetylcholine. This degradation results in a rapid cessation of the acetylcholine signal and a swift removal from the cleft.

Part B

The neuromuscular junction is a well-studied example of a chemical synapse. Which of the following statements describes a critical event that occurs at the neuromuscular junction?

Hint 1. Events at the neuromuscular junction

Events at the neuromuscular junction occur in seven coordinated steps. Identify one of these steps.

ANSWER:

- Acetylcholine is released by axon terminals of the motor neuron.
- Acetylcholine binds to its receptor in the junctional folds of the sarcolemma. Its receptor is linked to a G protein.
- When the action potential reaches the end of the axon terminal, voltage-gated sodium channels open and sodium ions diffuse into the terminal.
- Acetylcholine is released and moves across the synaptic cleft bound to a transport protein.

Correct

Yes! Acetylcholine is released into the synaptic cleft via exocytosis.

Part C

Action potentials travel the length of the axons of motor neurons to the axon terminals. These motor

neurons _____.

Hint 1. The origin of motor neurons

Where are the cell bodies?

ANSWER:

- arise in the epimysium of a skeletal muscle and extend to individual skeletal muscle fibers
- extend from the brain or spinal cord to the sarcolemma of a skeletal muscle fiber
- extend from the spinal cord to the sarcolemma of a skeletal muscle fiber
- extend from the brain to the sarcolemma of a skeletal muscle fiber

Correct

Yes! The cell bodies of motor neurons to muscles in the head and neck are located in the brain. The cell bodies of motor neurons to the rest of our muscles are located in the spinal cord.

Part D

Calcium entry into the axon terminal triggers which of the following events?

Hint 1. The effect of calcium

Calcium ions are necessary for acetylcholine release.

ANSWER:

- Acetylcholine binds to its receptor.
- Cation channels open and sodium ions enter the axon terminal while potassium ions exit the axon terminal.
- Synaptic vesicles fuse to the plasma membrane of the axon terminal and release acetylcholine.
- Acetylcholine is released into the cleft by active transporters in the plasma membrane of the axon terminal.

Correct

Yes! When synaptic vesicles fuse to the plasma membrane, acetylcholine is released via exocytosis.

Part E

Acetylcholine binds to its receptor in the sarcolemma and triggers _____.

Hint 1. The acetylcholine receptor

The acetylcholine receptor in the sarcolemma is a complex protein. It is more than just a binding site for acetylcholine.

ANSWER:

- the opening of ligand-gated cation channels
- the opening of calcium-release channels
- the opening of ligand-gated anion channels
- the opening of voltage-gated calcium channels

Correct

Yes! These channels permit sodium ions to diffuse inward and potassium ions to diffuse outward.

Part F

Sodium and potassium ions do not diffuse in equal numbers through ligand-gated cation channels. Why?

Hint 1. Flux through ligand-gated cation channels

The chemical gradients across the sarcolemma for sodium and potassium ions are about the same. Therefore, sodium and potassium ions diffuse down concentration gradients. What critical factor leads to a greater flux of one of these ions than the other?

ANSWER:

- The inside surface of the sarcolemma is negatively charged compared to the outside surface. Potassium ions diffuse inward along favorable chemical *and* electrical gradients.
- The outside surface of the sarcolemma is negatively charged compared to the inside surface. Sodium ions diffuse outward along favorable chemical *and* electrical gradients.
- The inside surface of the sarcolemma is negatively charged compared to the outside surface. Sodium ions diffuse inward along favorable chemical *and* electrical gradients.
- The outside surface of the sarcolemma is negatively charged compared to the inside surface. Potassium ions diffuse outward along favorable chemical *and* electrical gradients.

Correct

Yes! The resting membrane potential of all cells is negative (inside compared to outside). Therefore, given the direction of the chemical and electrical gradients, more sodium ions diffuse inward than potassium ions diffuse outward.

Video Tutor: Excitation-Contraction Coupling

Watch the Video Tutor on Excitation-Contraction Coupling, then answer the questions below.

Part A

Which of the following is true concerning the anatomy of a skeletal muscle fiber?

Hint 1. Muscle fiber anatomy

ANSWER:

- Myofibrils contain thick and thin filaments.
- T tubules are extensions of the sarcoplasmic reticulum.
- The sarcolemma is the muscle fiber's cytoplasm.
- A triad consists of a T tubule and the nearby sarcolemma.

Correct

Each skeletal muscle fiber contains many myofibrils. And each of these myofibrils contains many thick and thin filaments (myofilaments). These myofilaments are arranged as numerous sarcomeres within the myofibril.

Part B

The calcium that initiates skeletal muscle contraction is released from what structure(s)?

Hint 1. Location of calcium release sites

ANSWER:

- sarcolemma
- terminal cisternae
- sarcomeres
- T tubules

Correct

The terminal cisternae release calcium, which is the “go” signal for a muscle contraction. The terminal cisternae are the enlarged ends of the sarcoplasmic reticulum.

Part C

Which of the following are composed of myosin?

Hint 1. Myosin structure and location

ANSWER:

- thin filaments
- thick filaments
- intermediate filaments
- tropomyosin

Correct

Each thick filament is made of hundreds of myosin molecules.

Part D

In muscle fibers, which regulatory protein blocks the attachment of myosin heads to actin?

Hint 1. Arrangement of proteins around actin

ANSWER:

- thick filaments
- acetylcholinesterase
- tropomyosin
- calcium

Correct

Tropomyosin covers the active site on actin, preventing cross bridge formation.

Part E

What event most directly triggers the release of calcium from the terminal cisternae?

Hint 1. Details of calcium release

ANSWER:

- action potential propagating down the T tubule
- cross bridge formation between the thick and thin filaments
- movement of tropomyosin away from the active sites on actin
- action potential propagating toward the axon terminal

Correct

The action potential propagating down the T tubule causes voltage sensitive tubule proteins to change shape, which opens calcium release channels in the terminal cisternae.

Part F

How do calcium ions initiate contraction in skeletal muscle fibers?

Hint 1. The role of calcium in a contraction

ANSWER:

- (•) Calcium ions bind to troponin, changing troponin's shape.
- ( ) Calcium ions bind to tropomyosin, exposing the active sites on actin.
- ( ) Calcium ions provide the energy necessary for the myosin head power stroke.
- ( ) Calcium ion movement depolarizes the sarcolemma at the synaptic cleft.

Correct

The shape change in troponin, caused by calcium binding, causes a shift in the position of tropomyosin along the thin filament. This exposes active sites to myosin and allows cross bridges to form. The cycling of cross bridges is what creates tension during contraction.

Part G

Which of the following best describes the events of "excitation" in "excitation-contraction coupling"?

Hint 1. Excitation and the release of calcium

ANSWER:

- movement of tropomyosin away from the active sites on actin
- cross bridge formation
- release of calcium from the terminal cisternae
- propagation of the action potential along the sarcolemma

Correct

"Excitation-contraction coupling" connects muscle fiber excitation to muscle fiber contraction. The action potential propagating along the sarcolemma represents the "excitation" of the muscle fiber. The ensuing cross bridge formation represents the "contraction" of the muscle fiber.

Part H

Which of the following best describes the events of "contraction" in "excitation-contraction coupling"?

Hint 1. Calcium release and muscle contraction

ANSWER:

- sliding of myofilaments
- release of calcium from the terminal cisternae
- propagation of the action potential along the sarcolemma of the muscle fiber
- cross bridge formation

Correct

“Excitation-contraction coupling” connects muscle fiber excitation to the muscle fiber contraction (cross bridge formation). During contraction, myosin heads form cross bridges many times—with each cross bridge generating a small amount of tension in the muscle fiber.

A&P Flix: The Cross Bridge Cycle

Watch the animation, then answer the questions below.

Part A

The cross bridge cycle is a series of molecular events that occur after excitation of the sarcolemma. What is a cross bridge?

Hint 1. What a cross bridge connects

A cross bridge connects a thick myofilament to a thin myofilament.

ANSWER:

- (•) A myosin head bound to actin
- ( ) ATP bound to a myosin head
- ( ) Calcium bound to troponin
- ( ) Troponin bound to tropomyosin

Correct

Yes! As soon as the activated myosin head forms a cross bridge with actin, the power stroke begins.

Part B

What structure is the functional unit of contraction in a skeletal muscle fiber?

Hint 1. Muscle fibers, myofibrils, and…

A skeletal muscle fiber is typically quite long and is filled with molecular assemblies, called myofibrils. What is the repeating unit in a myofibril?

ANSWER:

- The junctional folds of the sarcolemma
- The cross bridge
- The sarcomere
- The triad

Correct

Yes! A sarcomere is a regular arrangement of thin and thick myofilaments that extends from one Z disc to the next. A myofibril consists of a series of sarcomeres.

Part C

Calcium ions couple excitation of a skeletal muscle fiber to contraction of the fiber. Where are calcium ions stored within the fiber?

Hint 1. Calcium storage

Skeletal muscle fibers store significant amounts of calcium because of a vast quantity of a specific organelle. Identify this organelle.

ANSWER:

- Calcium ions are stored in the mitochondria.
- Calcium ions are stored in the transverse tubules.
- Calcium ions are stored in the nuclei.
- Calcium ions are stored in the sarcoplasmic reticulum.

Correct

Yes! Sarcoplasmic reticulum is the specific name given to the smooth endoplasmic reticulum in muscle fibers. The sarcoplasmic reticulum is very elaborate in skeletal muscle fibers, allowing for significant storage of calcium ions.

Part D

After a power stroke, the myosin head must detach from actin before another power stroke can occur. What causes cross bridge detachment?

Hint 1. Cross bridge detachment

The formation of a specific chemical bond releases the myosin head from actin. Identify the bond.

ANSWER:

- Acetylcholine binds to receptors in the junctional folds of the sarcolemma.
- ATP binds to the myosin head.
- ADP and inorganic phosphate are bound to the myosin head.
- Calcium ions bind to troponin.

Correct

Yes! The binding of ATP to the myosin head weakens the bond between myosin and actin, forcing the myosin head to detach. ATP also provides the energy for the next power stroke.

Part E

How does the myosin head obtain the energy required for activation?

Hint 1. Myosin head activation

During a cross bridge cycle, a myosin head binds to actin. The myosin head pulls the thin filament and then detaches. Energy is required to reset the head. Where does the energy come from?

ANSWER:

- The energy comes from the hydrolysis of ATP.
- The energy comes from the direct phosphorylation of ADP by creatine phosphate.
- The energy comes from the hydrolysis of GTP.
- The energy comes from oxidative phophorylation.

Correct

Yes! Myosin is a large, complex protein with a binding site for actin. It also contains an ATPase. The energy released during the hydrolysis of ATP activates the myosin head.

Part F

What specific event triggers the uncovering of the myosin binding site on actin?

Hint 1. Troponin and tropomyosin

The thin myofilament consists of actin filaments and the regulatory proteins troponin and

tropomyosin. Troponin and tropomyosin control the availability of the myosin binding sites on actin.

ANSWER:

- Calcium release channels open in the sarcoplasmic reticulum, and calcium levels rise in the sarcoplasm.
- Calcium ions bind to tropomyosin and change its shape.
- Sodium ions bind to troponin and change its shape.
- Calcium ions bind to troponin and change its shape.

Correct

Yes! The shape change caused by the binding of calcium to troponin shifts tropomyosin away from the myosin binding sites on actin.

Part G

When does cross bridge cycling end?

Hint 1. Cross bridge cycle and binding sites on actin

Cross bridge cycling continues as long as the myosin binding sites on actin are exposed. How is the exposure of these binding sites regulated at rest and during contraction?

ANSWER:

- Cross bridge cycling ends when calcium ions are passively transported back into the sarcoplasmic reticulum.
- Cross bridge cycling ends when ATP binds to the myosin head.
- Cross bridge cycling ends when sufficient calcium has been actively transported back into the sarcoplasmic reticulum to allow calcium to unbind from troponin.
- Cross bridge cycling ends when calcium release channels in the sarcoplasmic reticulum open.

Correct

Yes! The sarcoplasmic reticulum contains Ca^{2+}-ATPases that actively transport Ca^{2+} into the SR. Without Ca^{2+}, troponin returns to its resting shape, and tropomyosin glides over and covers the myosin binding sites on actin.

Chapter 9 Chapter Test Question 8

Part A

The distance between Z discs _____ during muscle contraction.

ANSWER:

- stays the same
- decreases
- decreases and then increases
- increases

Correct

During muscle contraction, the distance between Z discs decreases as the thin myofilaments slide across thick myofilaments, toward the M line in the center of each sarcomere. As the sarcomeres shorten, the myofibrils and, thus the myofibers shorten (contract).

Chapter 9 Chapter Test Question 9

Part A

The sliding filament model of contraction states that _____.

ANSWER:

- during contraction the thin myofilaments slide past the thick myofilaments so that the actin and myosin myofilaments overlap to a greater degree
- during contraction the thin myofilaments slide past T tubules so that the Z discs are overlapping
- during contraction the thin myofilaments slide past the thick myofilaments so that the actin and myosin myofilaments no longer overlap
- during contraction the thin myofilaments slide past the thick myofilaments so that calcium ions can be released from the sarcoplasmic reticulum

Correct

The sliding filament model of contraction states that during contraction, the thin myofilaments slide past the thick myofilaments so that actin and myosin myofilaments overlap to a greater degree. In a relaxed muscle fiber, the thick and thin myofilaments overlap only at the ends of the A band.

Chapter 9 Multiple Choice Question 22

Part A

The oxygen-binding protein found in muscle cells is _____.

ANSWER:

- ATP
- immunoglobin
- hemoglobin
- myoglobin

Correct

Chapter 9 True/False Question 5

Part A

A motor neuron and all the muscle cells that it stimulates are referred to as a motor end plate.

ANSWER:

- True
- False

Correct

Chapter 9 True/False Question 1

Part A

Once a motor neuron has fired, all the muscle fibers in a muscle contract.

ANSWER:

- True
- False

Correct

Score Summary:

Your score on this assignment is 90.5%.
You received 16.3 out of a possible total of 18 points.