What is the Muscle Contraction Mechanism?

Worksheet

Muscle contraction occurs when myosin heads pull actin filaments toward the center of the sarcomere in a process called the sliding filament mechanism, triggered by calcium ions released after a nerve impulse.

Questions

1. Which ion directly triggers the start of muscle contraction?

A) Sodium
B) Calcium
C) Potassium
D) Chloride

2. What role does ATP play right before a myosin head detaches from actin?

A) It powers the power stroke
B) It binds myosin, allowing detachment from actin
C) It triggers calcium release
D) It builds new actin filaments

3. Which protein blocks the myosin-binding site on actin at rest?

A) Troponin
B) Titin
C) Tropomyosin
D) Myosin

4. During contraction, what happens to the sarcomere?

A) It lengthens
B) The filaments themselves shorten
C) It shortens as filaments slide, without filament length changing
D) It disappears

5. Trace what happens from nerve impulse to muscle fiber shortening.

6. What happens if ATP is unavailable after myosin has bound actin?

7. How does removing Ca end a contraction?

8. Define: What is the sliding filament theory?

9. Define: What ion triggers muscle contraction?

10. Define: What is the power stroke?

Answer Key

1. B) Calcium - Ca released from the sarcoplasmic reticulum binds troponin, exposing myosin-binding sites.

2. B) It binds myosin, allowing detachment from actin - ATP must bind the myosin head to break the actin-myosin cross-bridge.

3. C) Tropomyosin - Tropomyosin covers the binding sites until calcium-bound troponin shifts it aside.

4. C) It shortens as filaments slide, without filament length changing - The sliding filament model: filament length is constant, but overlap increases, shortening the sarcomere.

5. 1. Motor neuron releases acetylcholine at the neuromuscular junction 2. Action potential spreads along the sarcolemma and down T-tubules 3. Sarcoplasmic reticulum releases Ca into the sarcoplasm 4. Ca binds troponin, shifting tropomyosin to expose myosin-binding sites 5. Myosin heads bind actin and pull (power stroke), shortening the sarcomere

6. Without ATP, myosin heads cannot detach from actin The cross-bridges stay locked in place This produces rigor (as seen in rigor mortis after death)

7. Ca is pumped back into the sarcoplasmic reticulum by active transport Troponin returns to its resting shape Tropomyosin re-covers the myosin-binding sites on actin The muscle fiber relaxes

8. The model explaining that actin and myosin filaments slide past each other, shortening the sarcomere, without the filaments themselves changing length.

9. Calcium (Ca), released from the sarcoplasmic reticulum, binds troponin to start the cross-bridge cycle.

10. The step where the myosin head pivots and pulls the actin filament toward the sarcomere's center, using energy stored from ATP hydrolysis.