What Is Muscle Contraction?

Worksheet

Muscle contraction is the shortening of muscle fibers caused by myosin heads pulling actin filaments inward, triggered by a nerve impulse and calcium release, and powered by ATP - known as the sliding filament theory.

Questions

1. According to the sliding filament theory, which two proteins slide past each other?

A) Collagen and keratin
B) Actin and myosin
C) Troponin and tropomyosin
D) Hemoglobin and myoglobin

2. What triggers calcium release from the sarcoplasmic reticulum?

A) A drop in body temperature
B) An action potential spreading across the muscle fiber
C) A decrease in ATP
D) Lactic acid buildup

3. What is required for a myosin head to detach from actin?

A) Calcium removal only
B) ATP binding to myosin
C) Loss of troponin
D) An increase in body temperature

4. Why does rigor mortis occur after death?

A) Excess ATP locks muscles in place
B) Without ATP, myosin cannot detach from actin
C) Calcium disappears entirely from cells
D) Muscles stop containing actin

5. A sprinter's leg muscle contracts explosively at the start of a race. Trace the process from nerve signal to contraction.

6. After death, muscles become stiff (rigor mortis). Explain this using the sliding filament theory.

7. A weightlifter's muscle fatigues after many repetitions. What limits further contraction?

8. Define: What is muscle contraction?

9. Define: What role does calcium play in contraction?

10. Define: What role does ATP play in contraction?

Answer Key

1. B) Actin and myosin - Thin actin filaments and thick myosin filaments slide past each other, shortening the sarcomere.

2. B) An action potential spreading across the muscle fiber - The action potential from the neuromuscular junction spreads into the muscle fiber and triggers calcium release.

3. B) ATP binding to myosin - ATP must bind to the myosin head to release it from actin, allowing the cross-bridge cycle to continue or the muscle to relax.

4. B) Without ATP, myosin cannot detach from actin - ATP is needed to release myosin from actin; without it after death, the cross-bridges stay locked, causing stiffness.

5. A motor neuron fires, releasing acetylcholine at the neuromuscular junction This triggers an action potential that spreads across the muscle fiber Calcium is released from the sarcoplasmic reticulum, binding troponin and exposing actin's binding sites Myosin heads repeatedly bind, pull, and release actin (powered by ATP), sliding the filaments and shortening the sarcomere for a powerful contraction

6. Without living cells, ATP production stops and existing ATP is used up ATP is required to detach myosin heads from actin after each power stroke Without ATP, myosin heads remain locked onto actin filaments The muscle stays contracted/rigid because the cross-bridges cannot release - this is rigor mortis

7. Repeated contractions deplete local ATP and calcium ion reserves ATP is needed both for the myosin power stroke and to pump calcium back into the sarcoplasmic reticulum Lactic acid buildup from anaerobic metabolism also interferes with calcium and enzyme function With insufficient ATP and calcium cycling, cross-bridge cycling slows and the muscle can no longer generate the same force

8. The shortening of muscle fibers as myosin filaments pull actin filaments inward, described by the sliding filament theory.

9. Calcium binds troponin, shifting tropomyosin to expose myosin-binding sites on actin, allowing cross-bridges to form.

10. ATP powers the myosin power stroke and is required to detach myosin from actin, allowing the cycle to repeat and eventually relax the muscle.