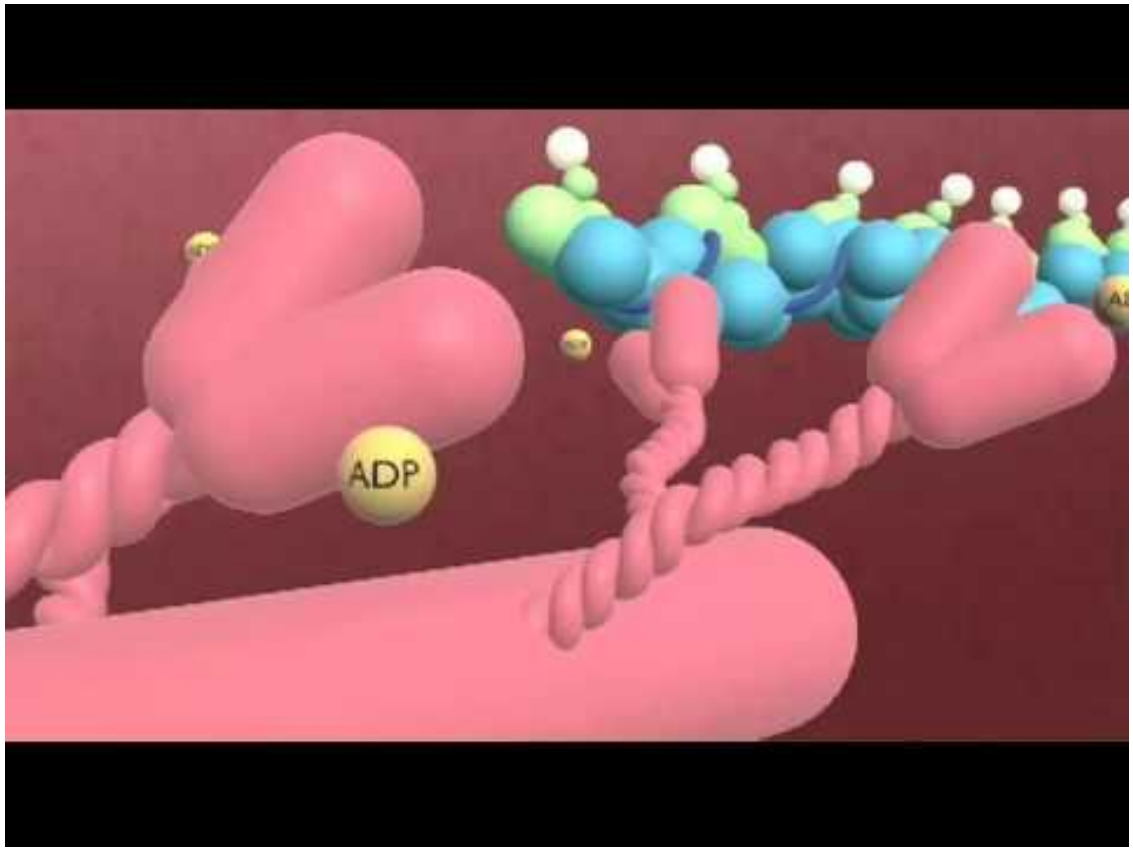
Mechanism of Muscle Contraction: The Sliding Filament Theory



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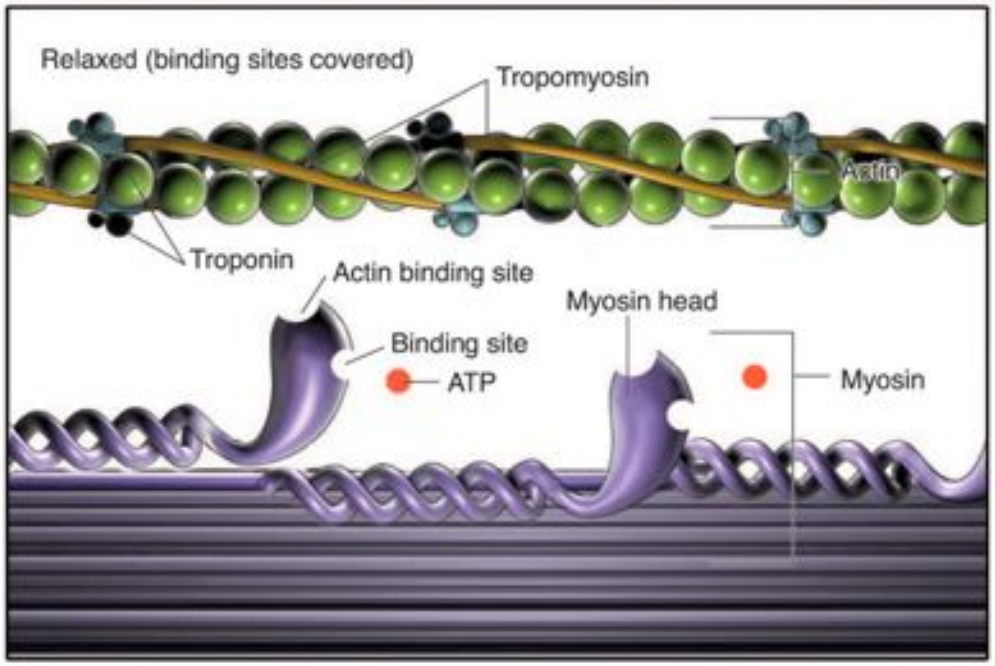
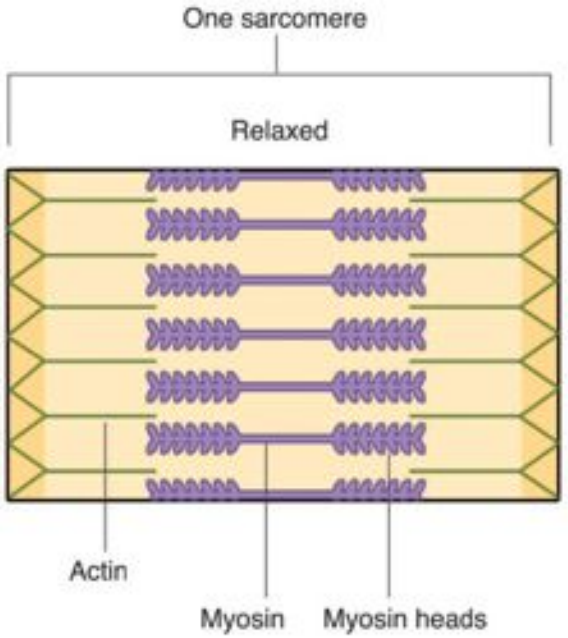
- In a relaxed muscle, actin filaments contain regulatory proteins - **troponin and tropomyosin** - that **cover the myosin-binding sites**.





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- When a nerve impulse is received at the muscle:

  1. The impulse stimulates **the release of calcium ions (Ca^{2+}) from the sarcoplasmic reticulum** to the sarcomere.

  2. **Ca^{2+} binds to troponin:**
     - Troponin-Tropomyosin proteins change shape and move
     - **Myosin-binding sites are exposed** on the actin filaments

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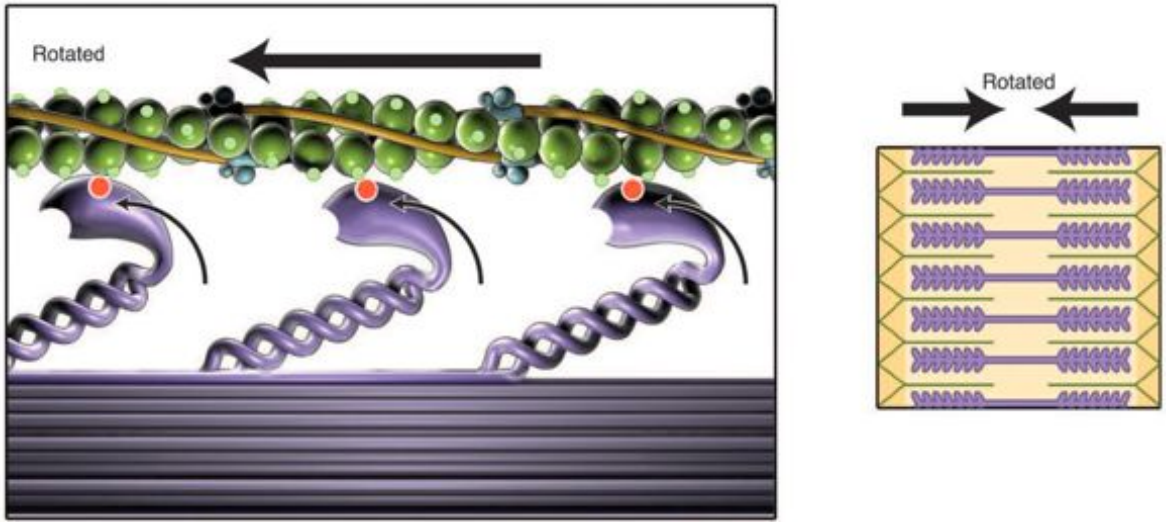
3. **Myosin binds to myosin-binding sites on the actin filaments,** forming a **"cross-bridge"**

4. **Myosin-actin cross-bridges pull the actin filaments towards the center of the sarcomere** in a rowing motion as the myosin heads pivot



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5. **ATP binds to myosin** on the myosin-actin cross-bridge
   - **Myosin detaches from the actin**

6. **ATPase splits the ATP into ADP + P,** causing the **myosin head to pivot back to its original position**

7. **Myosin head attaches to another myosin-binding site farther along the actin filament**
   - Myofilaments (actin and myosin) DO NOT shorten during contraction; they simply slide past each other.

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8. **Continuous cycles of the cross-bridges forming and releasing** causes the **sliding or overlap of the actin and myosin filaments.**

- Different myosin heads on a myofibril are always in contact with actin filaments, so that the actin cannot slide backward.

- This process occurs simultaneously in sarcomeres throughout the muscle fiber, causing the cell to shorten.

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9. When nerve impulse is removed, **Ca^{2+} levels begin to drop**
   - Ca^{2+} detaches from troponin
   - Troponin and tropomyosin complex changes back to its original shape, **blocking the myosin-binding sites**

10. **Muscle relaxes**

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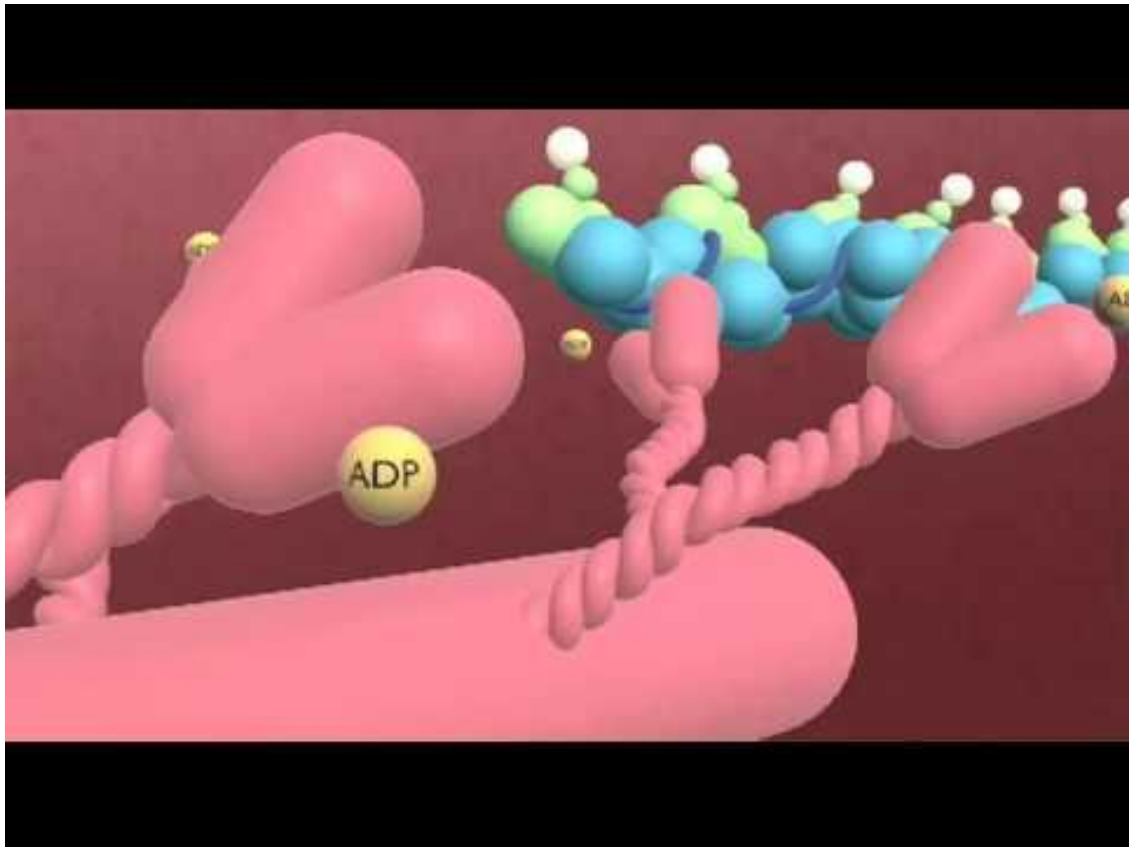
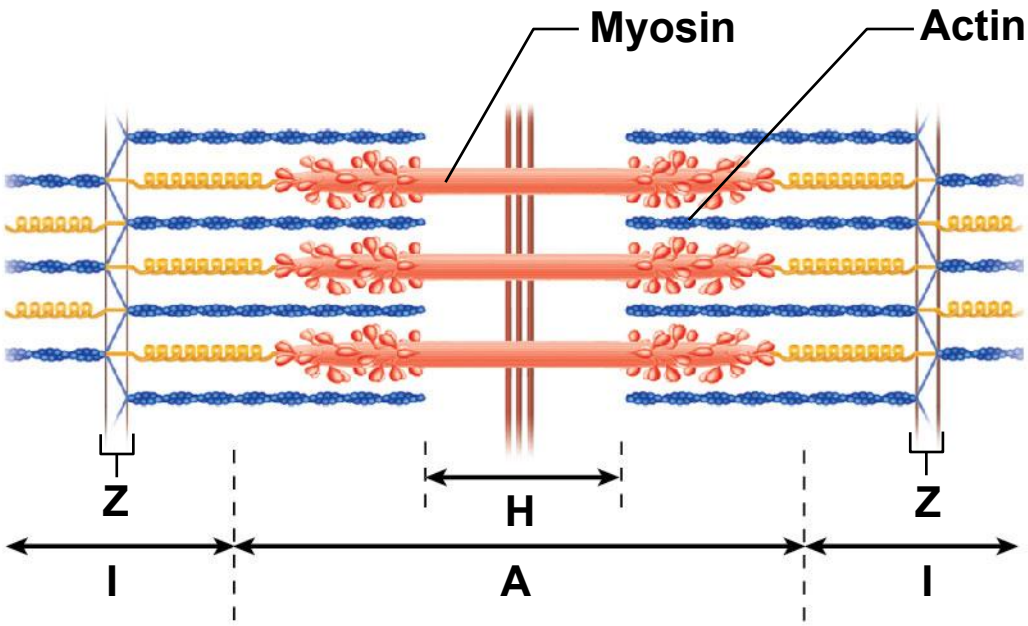
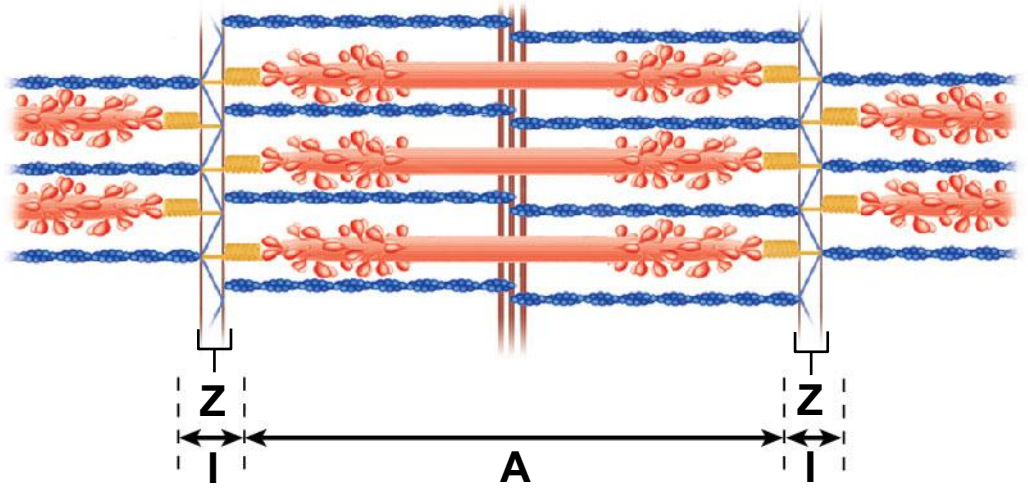




(a) Relaxed sarcomere



(b) Fully contracted sarcomere