



# Chapter 9

# Muscles and Muscle Tissue

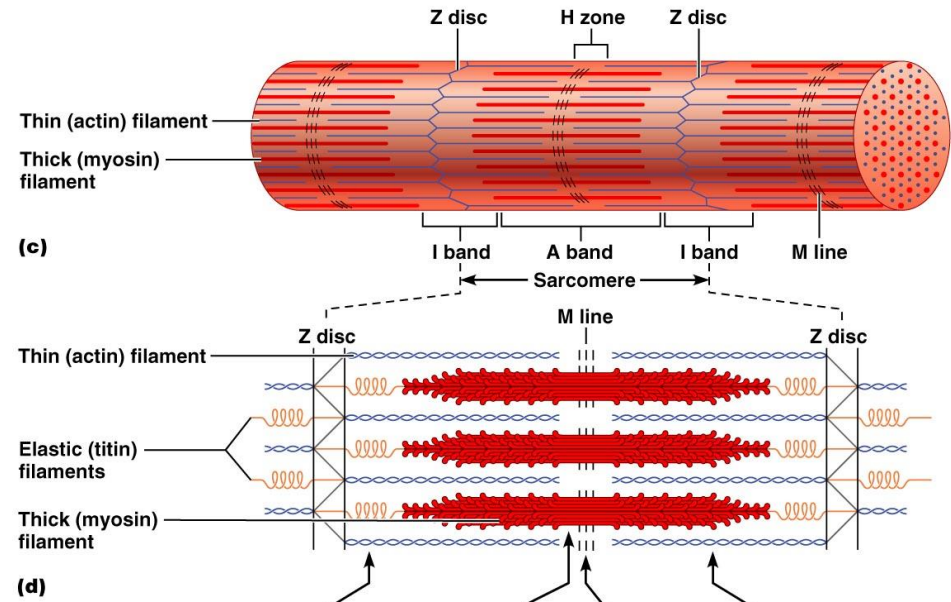
Sarcomere and Contraction



# Skeletal Muscle Fibers – Regions of the Sarcomere

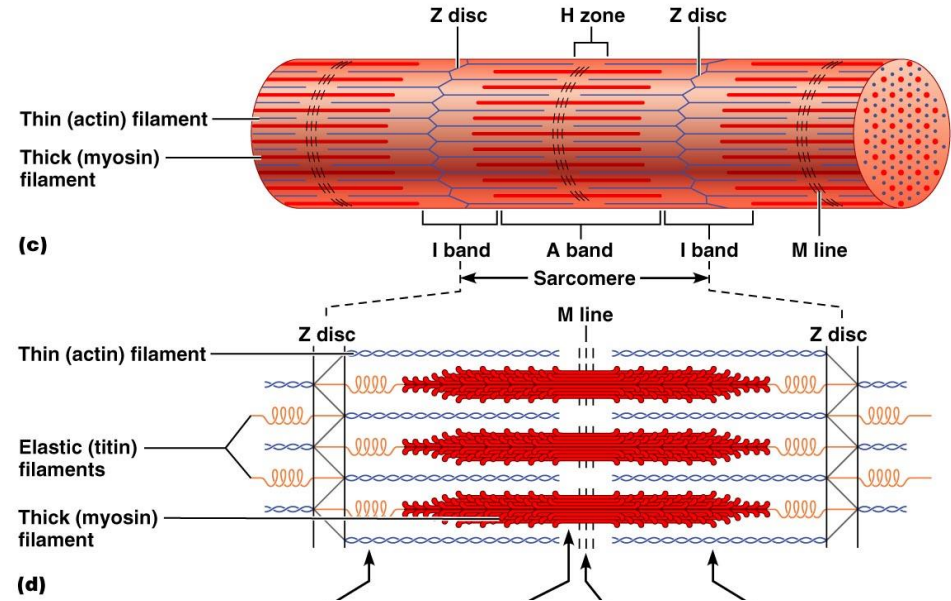
- **Sarcomere**

- the smallest functional unit of the muscle fiber.
- Interactions between the thick and thin filaments of sarcomeres are responsible for muscle contraction



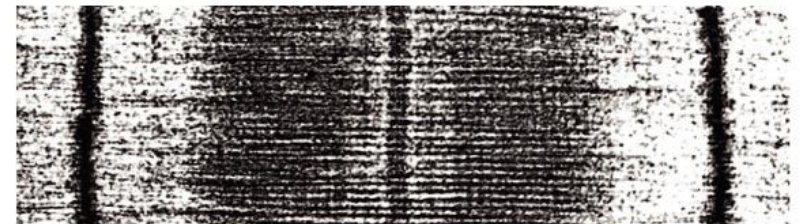
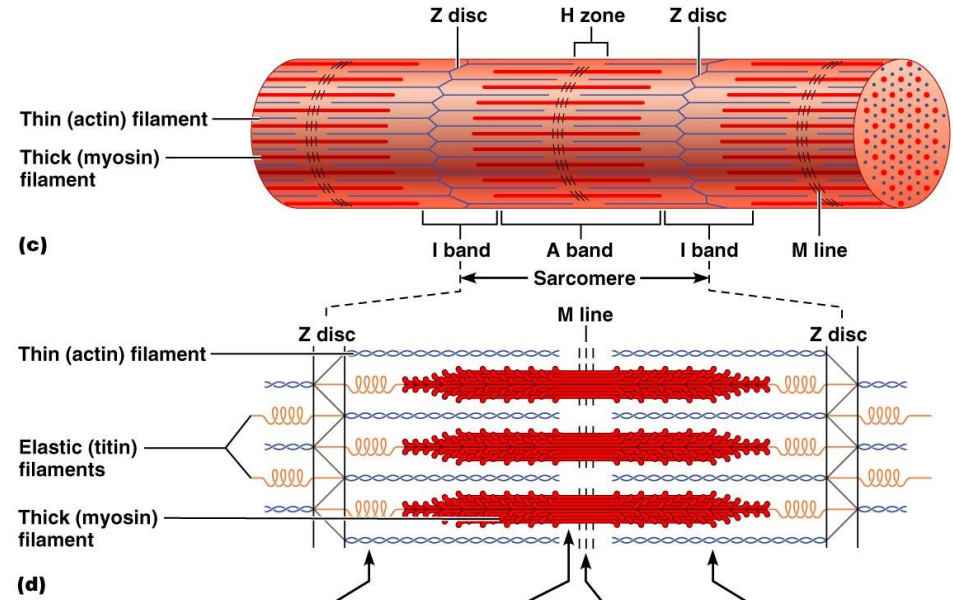
# Skeletal Muscle Fibers – Regions of the Sarcomere

- **A band** – Dark band; mainly thick filaments
- **I band** – Light band; mainly thin filaments
  - **Note:** In skeletal muscle fibers, these bands are almost perfectly aligned giving the striped appearance known as striations.



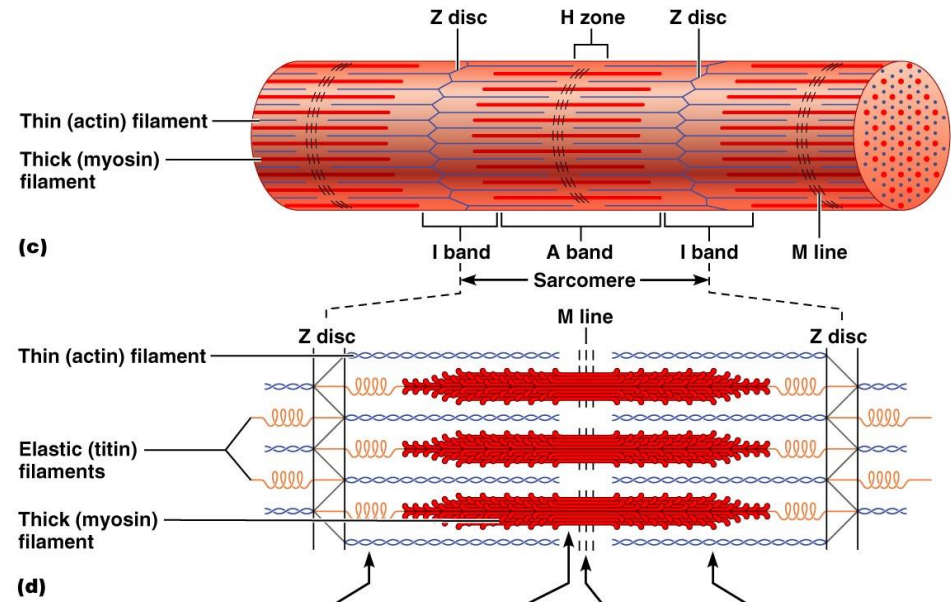
# Skeletal Muscle Fibers – Regions of the Sarcomere

- **M line** – Central portion of each thick filament
- **H zone/line** – lighter region on either side of the M line. Only seen in resting muscle fibers



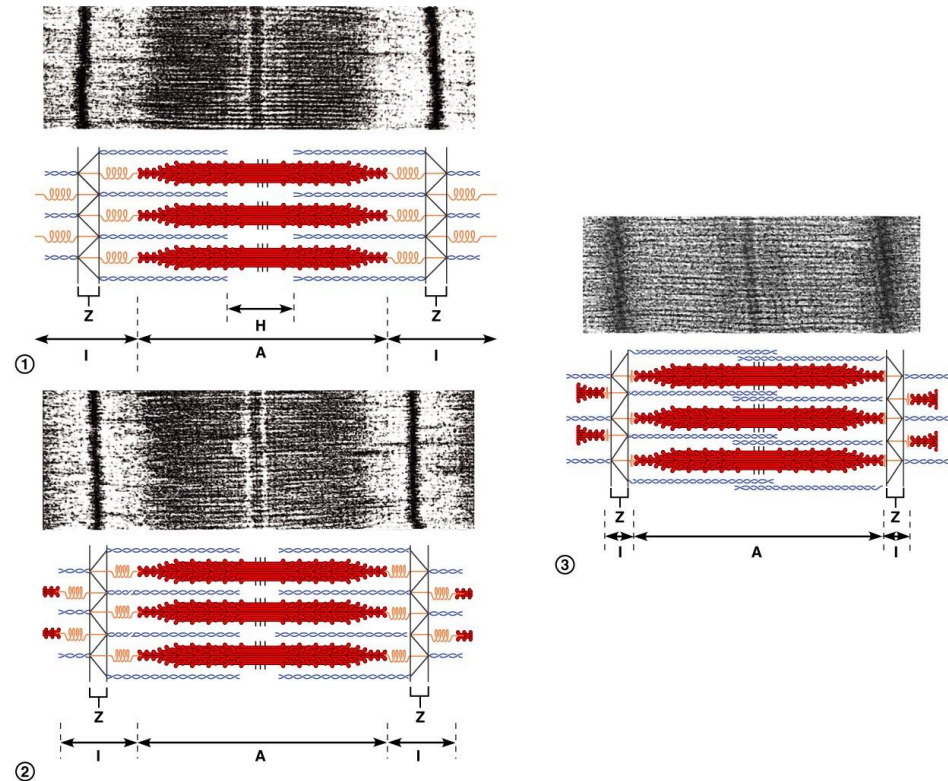
# Skeletal Muscle Fibers – Regions of the Sarcomere

- **Zone of overlap** – where the thin filaments are found between thick filaments
- **Z line**- mark the boundary lines between adjacent sarcomeres (midline interruption of the I band)



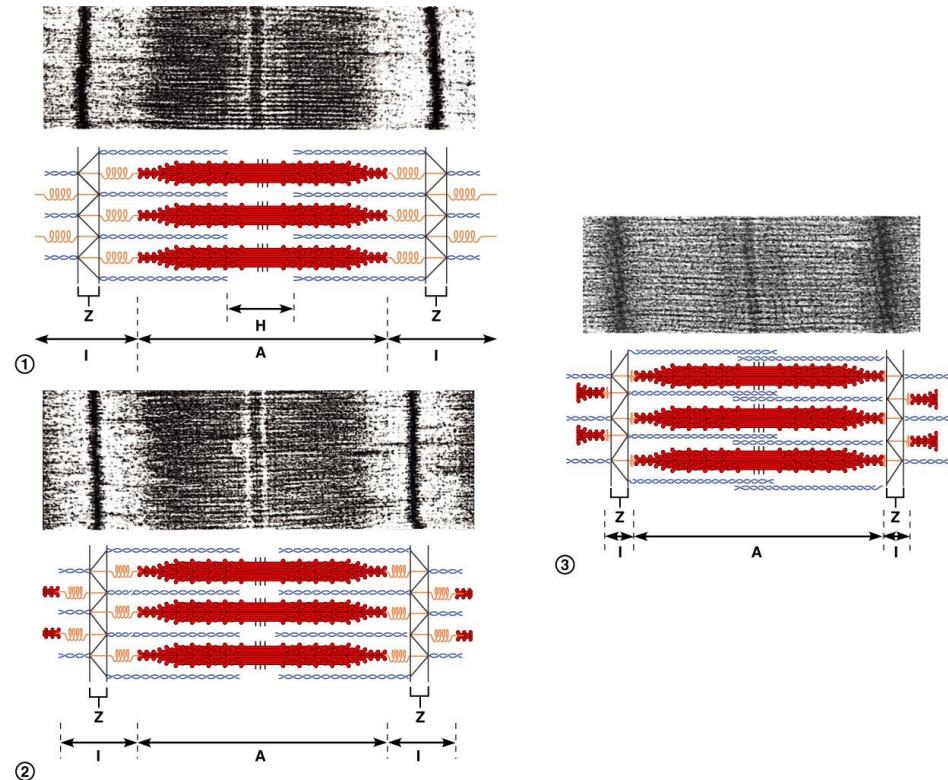
# Sliding Filament Theory

- Myosin heads attach to and “walk” along the thin filaments → pulling the thin filaments towards the M line → thin filaments are sliding toward the center of the sarcomere



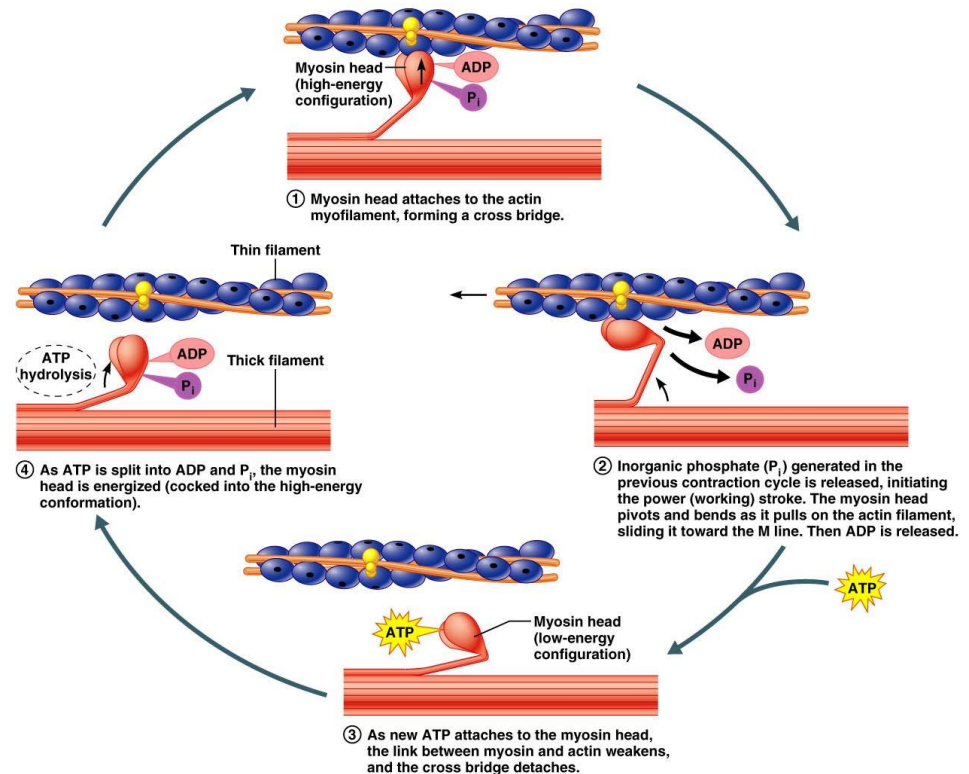
# Sliding Filament Theory

- Thin filaments slide inwards:
  - H band gets smaller (disappears)
  - I band gets smaller (disappears)
  - Z lines move closer together
  - A band width remains constant
  - Sarcomere shortens



# Skeletal Muscle Fiber Contraction

1. Nerve impulse travels to muscle cell
2. The impulse travels in all directions over the muscle cell and travels through the t tubules.

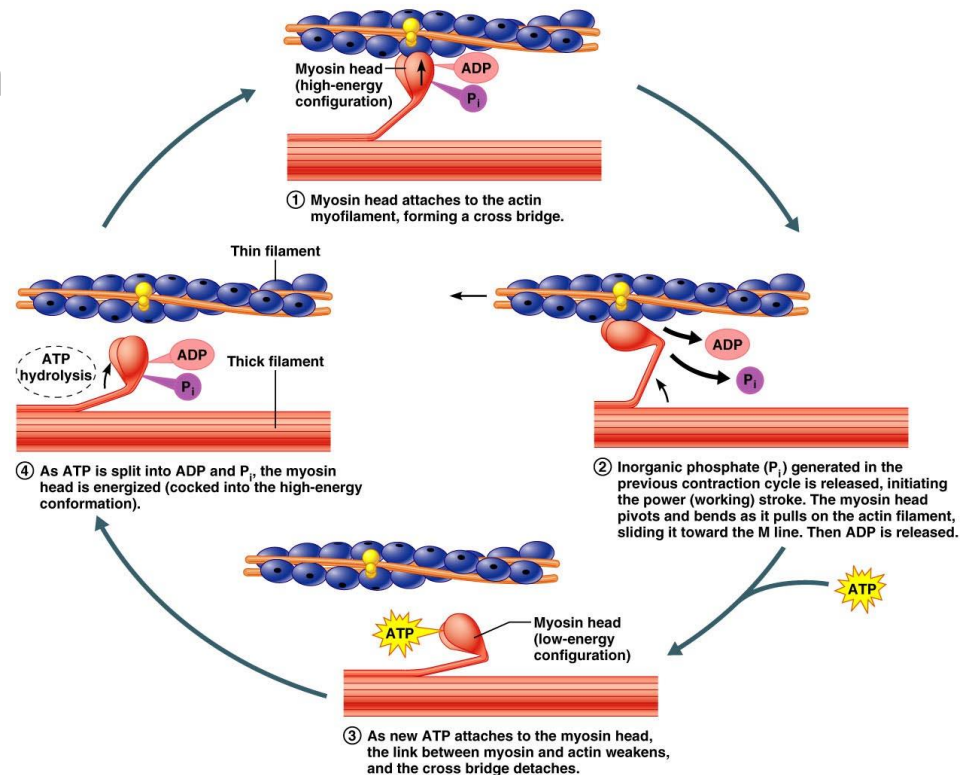


# Skeletal Muscle Fiber Contraction

3. Impulse reaches the sarcoplasmic reticulum

4. Calcium ions diffuse from the SER into the sarcoplasm

5.  $\text{Ca}^{+2}$  bind to troponin (on actin)  $\rightarrow$  changes shape

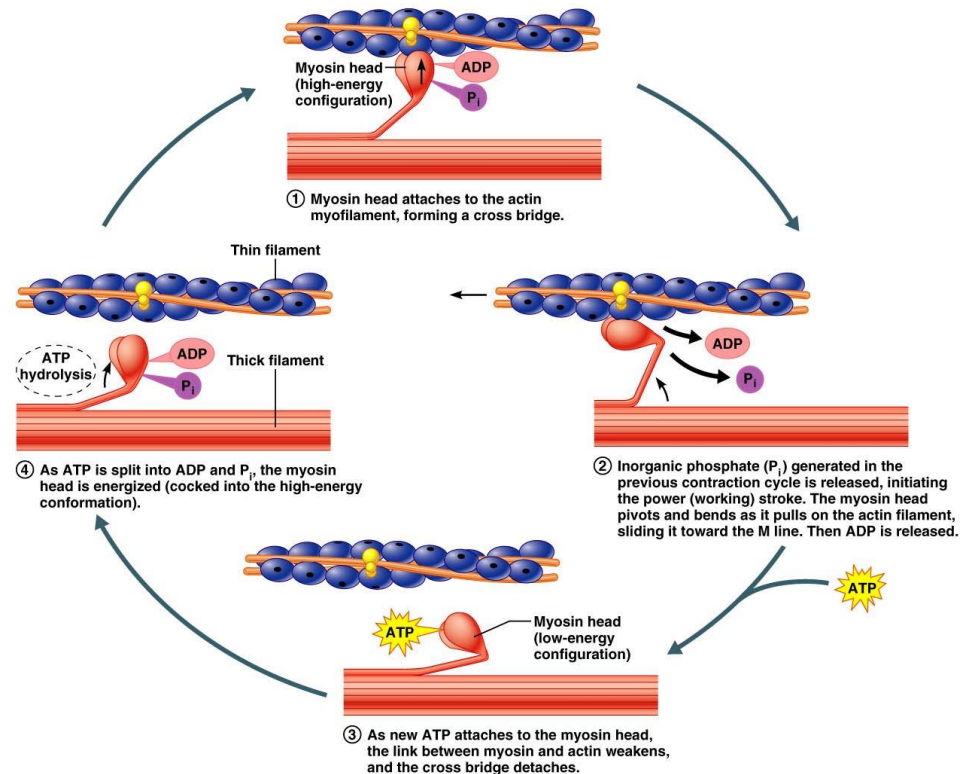


# Skeletal Muscle Fiber Contraction

6. The active site on actin is exposed

7. Actin and myosin filaments form a cross-bridge

8. Release the phosphate group (from hydrolyzed ATP)

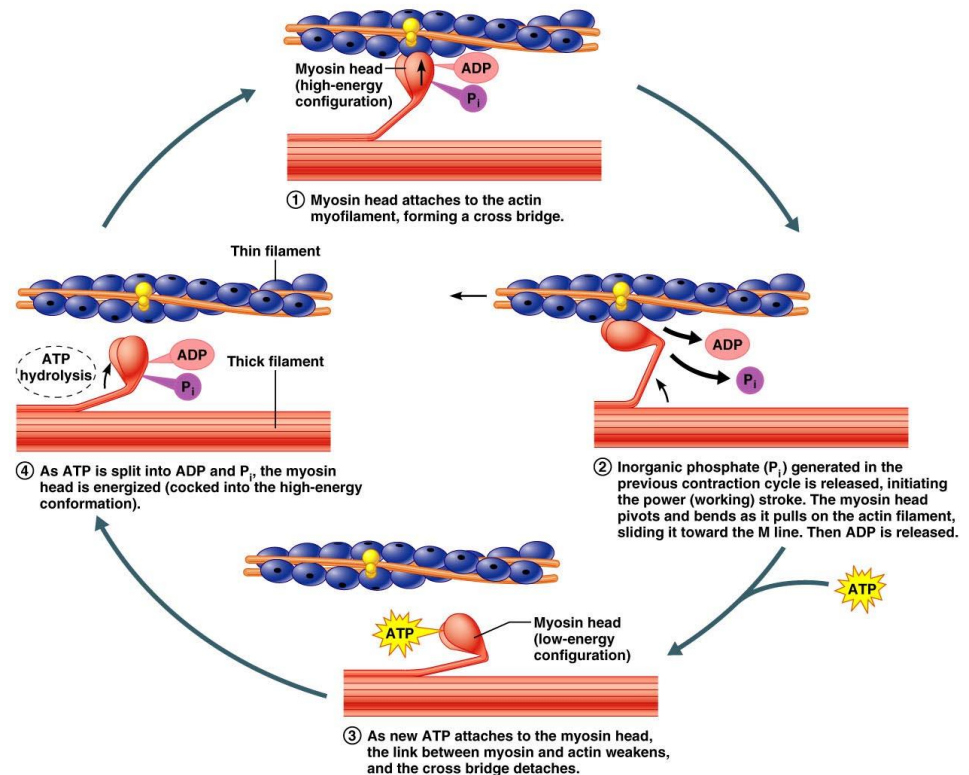


# Skeletal Muscle Fiber Contraction

9. Myosin heads pull actin filaments inward → myosin head falls down

10. ADP is released.

11. ATP Binds to myosin

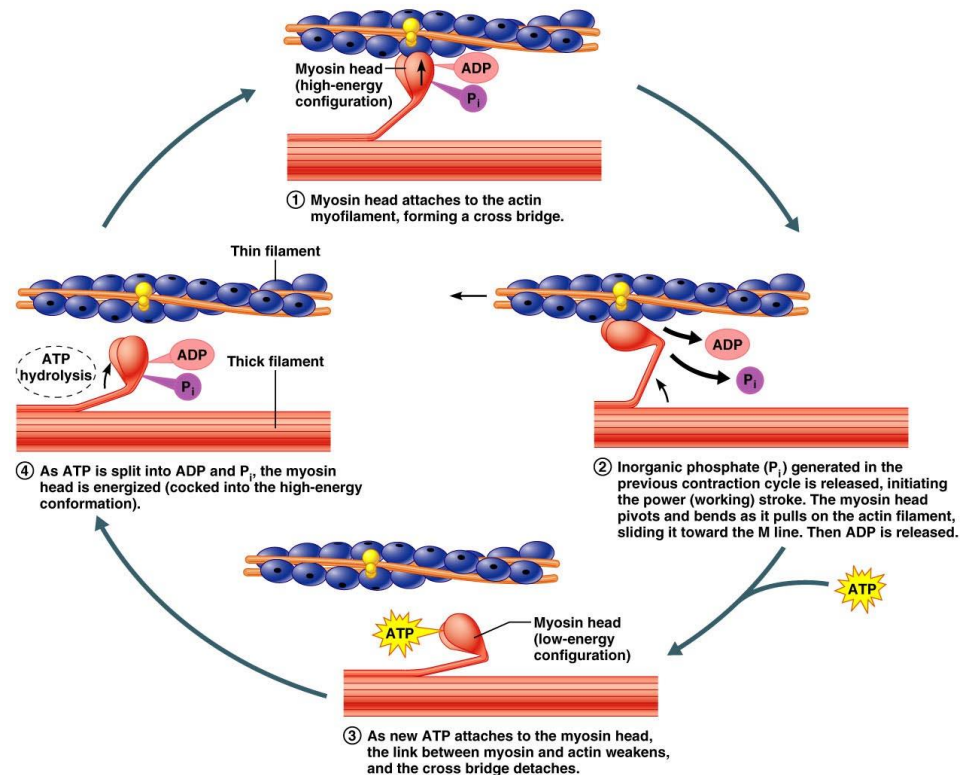


# Skeletal Muscle Fiber Contraction

12. Cross-bridge (myosin) releases

13. ATP on the myosin is hydrolyzed to ADP and a phosphate group

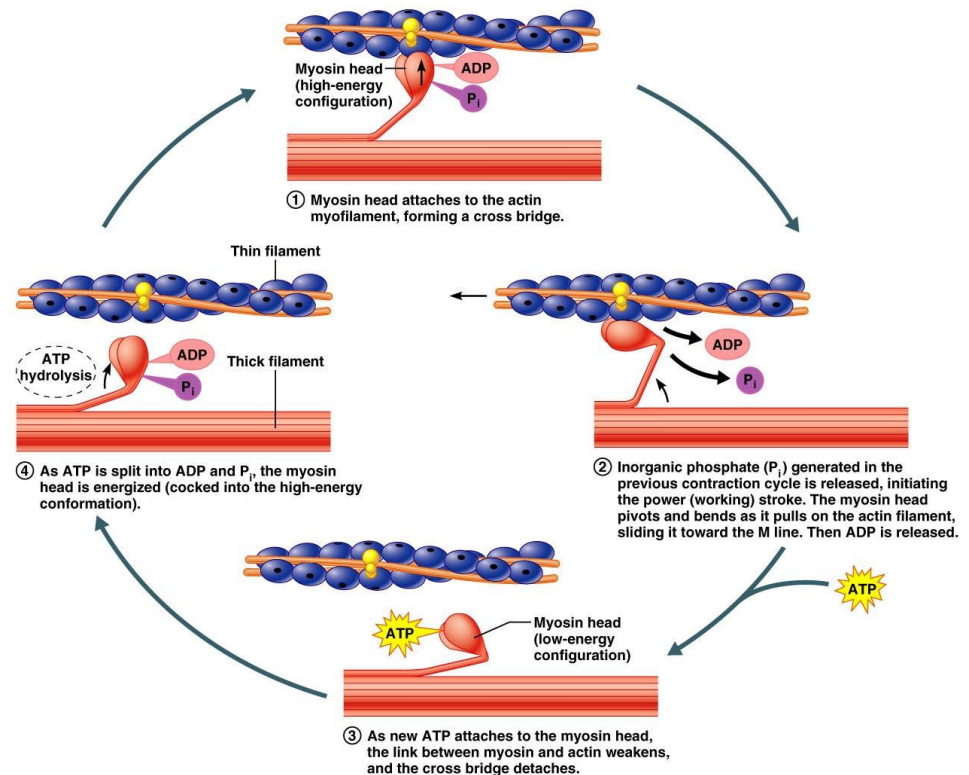
14. Myosin head lifts to attach to actin



# Skeletal Muscle Fiber Contraction

15. Continues until  
**Calcium supply is cut off**

16. The muscle fiber shortens as contraction occurs



# Skeletal Muscle Fiber Relaxation

1. Calcium ions are transported into SER
2. ATP causes cross-bridge between actin and myosin filaments to break apart
3. The binding sites on actin are blocked (there is no calcium)



# Skeletal Muscle Fiber Relaxation



4. Muscle fiber releases.

5. ATP breakdown “cocks” myosin cross-bridges.

6. Muscle fiber is ready for further stimulation



# Muscle Contraction Videos

- <http://www.youtube.com/watch?v=83yNoEJyP6g>
- <http://www.youtube.com/watch?v=WRxsOMenNQ>  
[M](http://www.youtube.com/watch?v=WRxsOMenNQ)
- Day 2
- <http://www.youtube.com/watch?v=mWPmUqRZYIs>
- <http://www.youtube.com/watch?NR=1&v=CbfK1Gi-aCk>

- <http://www.youtube.com/watch?v=0kFmbrRJq4w>
- <http://www.youtube.com/watch?v=EdHzKYDxrKc>
- <http://www.youtube.com/watch?v=mWPmUqRZYIs>
- <http://www.youtube.com/watch?v=kvMFdNw35L0>
- <http://www.youtube.com/watch?v=Vlchs4omFDM>



# Rigor Mortis

- After death, calcium ions start to leak out of SER
- Causes muscle contraction cycle to start
- ATP synthesis has stopped → cell runs out of ATP
- Crossbridges can't break apart → muscles in a state of contraction
- Starts about 3-4 hours after death
- Lasts about 24 hours  
(crossbridges are broken down)

