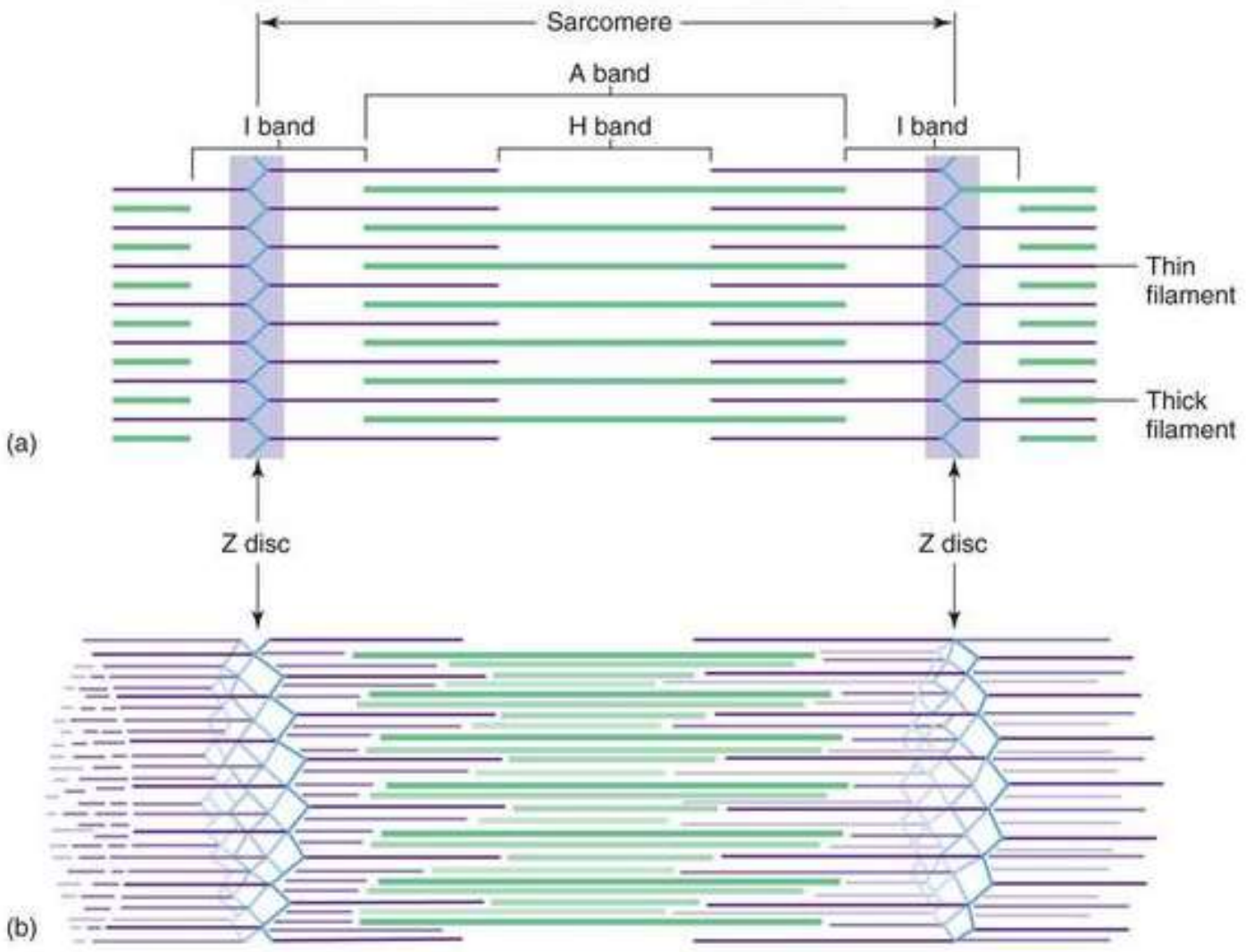
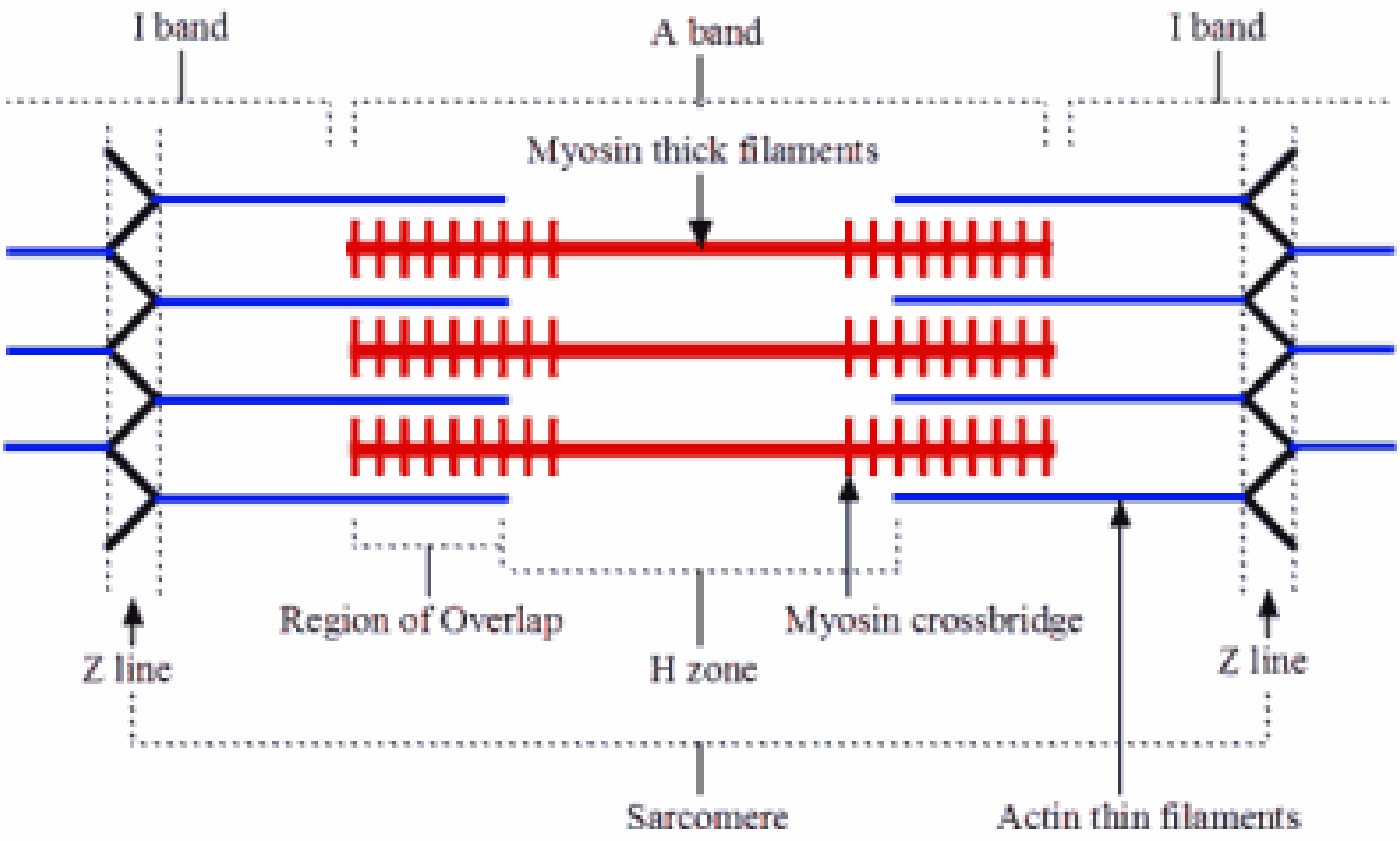
Anatomy of a Skeletal Muscle Fiber

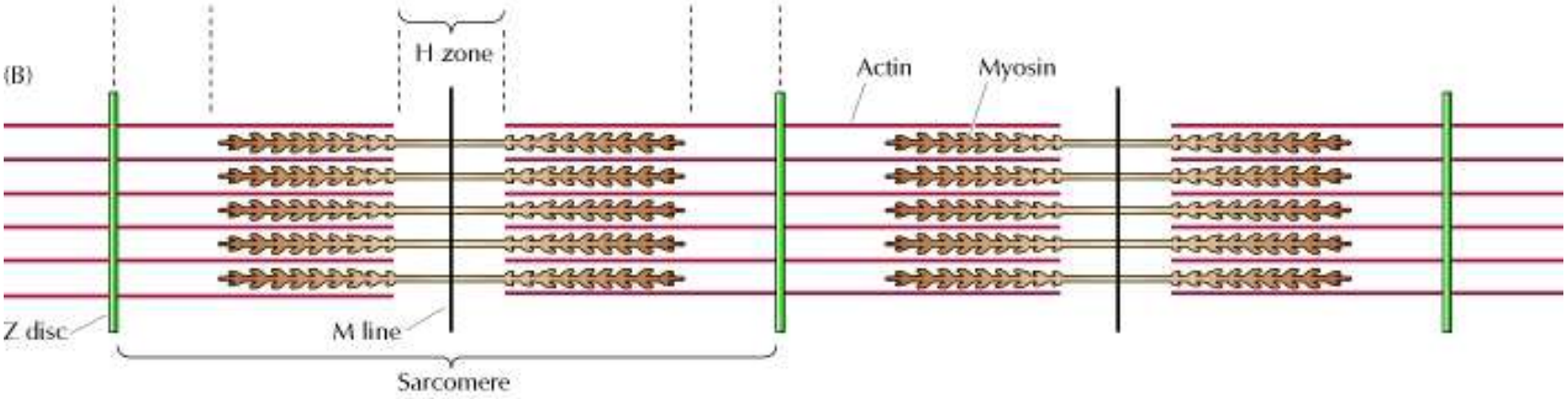
- The skeletal muscle fiber is a cell.
- The **Sarcolemma** is the plasma membrane.
- It has multiple inward extensions which form a set of **T Tubules** (the T stands for transverse).
- The **Sarcoplasm** is the cytoplasm & the **Sarcoplasmic Reticulum** is the endoplasmic reticulum. The Sarcoplasmic reticulum is responsible for controlling the release of Calcium ions.
- **Myofibrils** are the cylindrical organelles found inside a muscle fiber.
- **Myofilaments** are the filaments of a myofibril.
- Myofilaments are organized into repeating units called **Sarcomeres**.

Kinesiology: Bio-mechanistic processes involved in movement, Muscle Contraction-relaxation

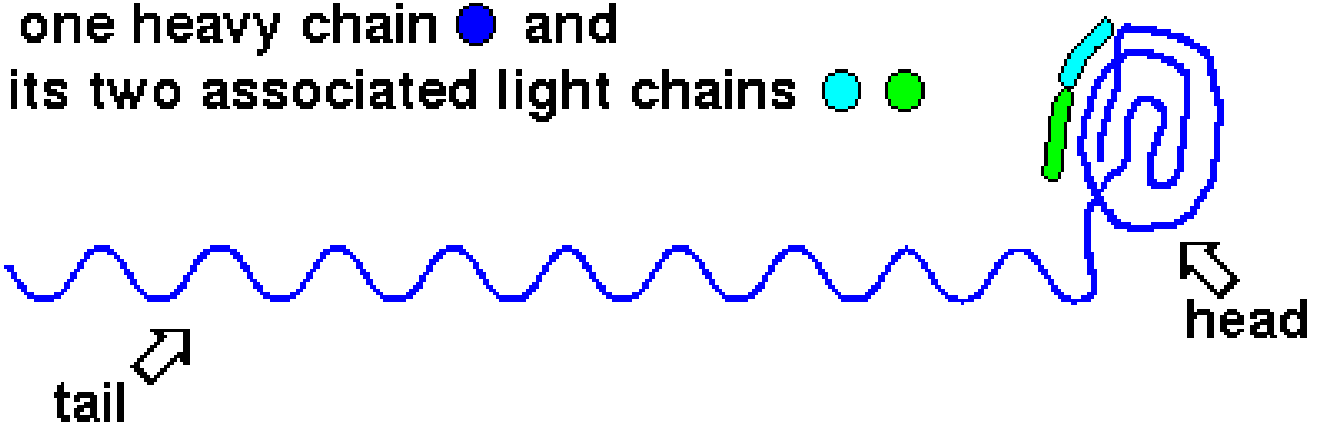
Part 2


Sarcomere
A band
I band
H band
I band
Thin filament
Thick filament
(a)
Z disc
Z disc
(b)

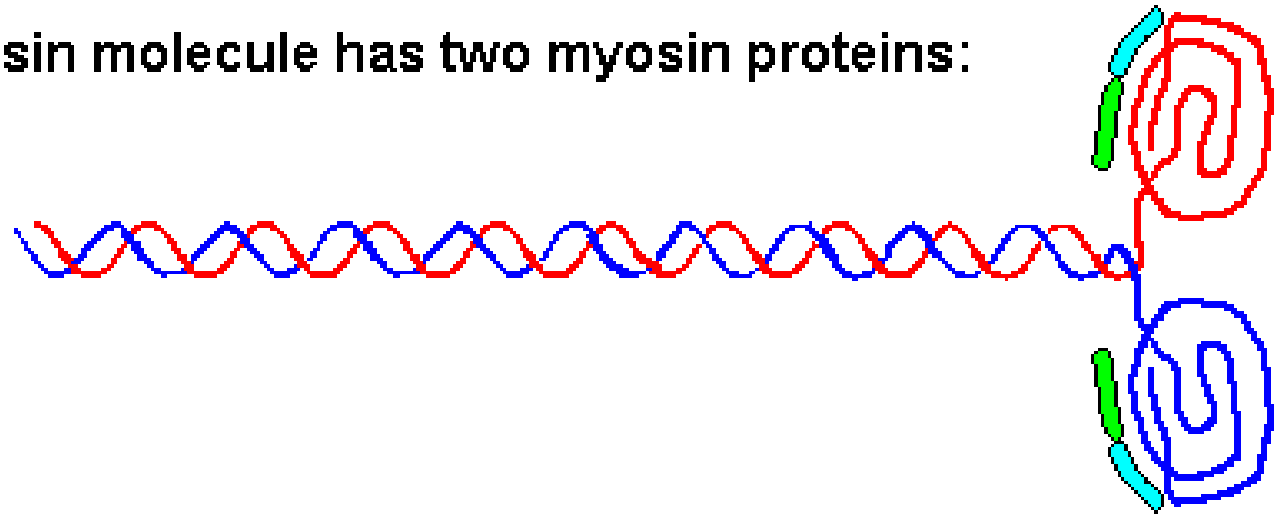

I band
A band
I band
Myosin thick filaments
Region of Overlap
H zone
Myosin crossbridge
Z line
Z line
Sarcomere
Actin thin filaments

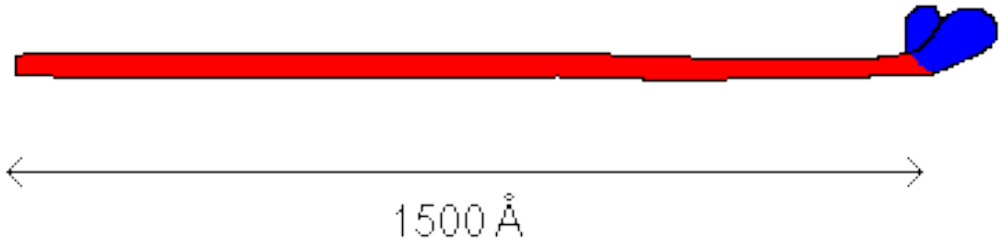

(B)
H zone
Actin
Myosin
Z disc
M line
Sarcomere

One myosin protein is made up of
one heavy chain ● and
its two associated light chains ● ●

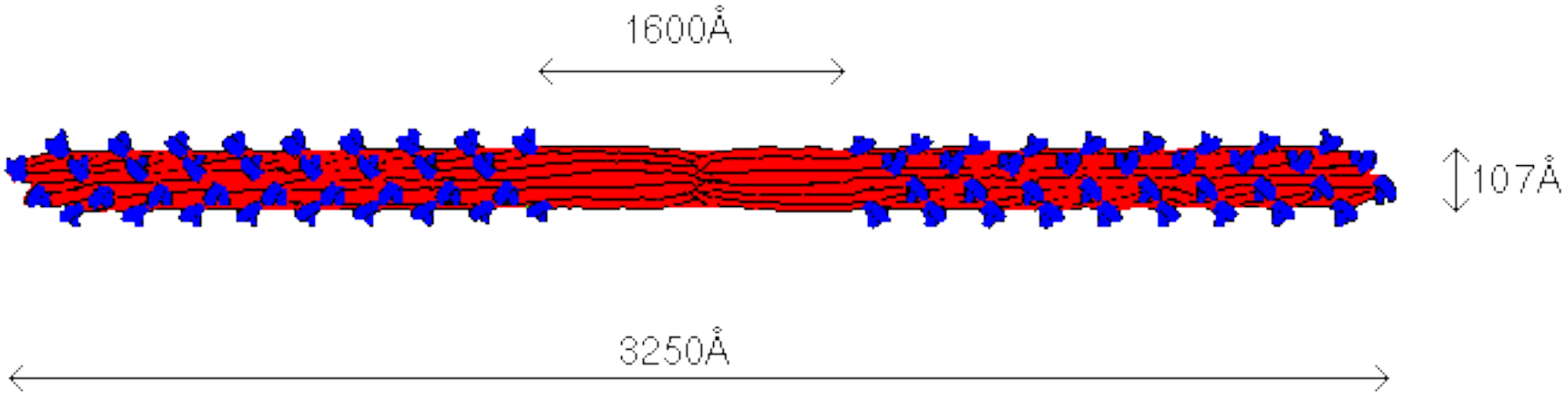


A myosin molecule has two myosin proteins:





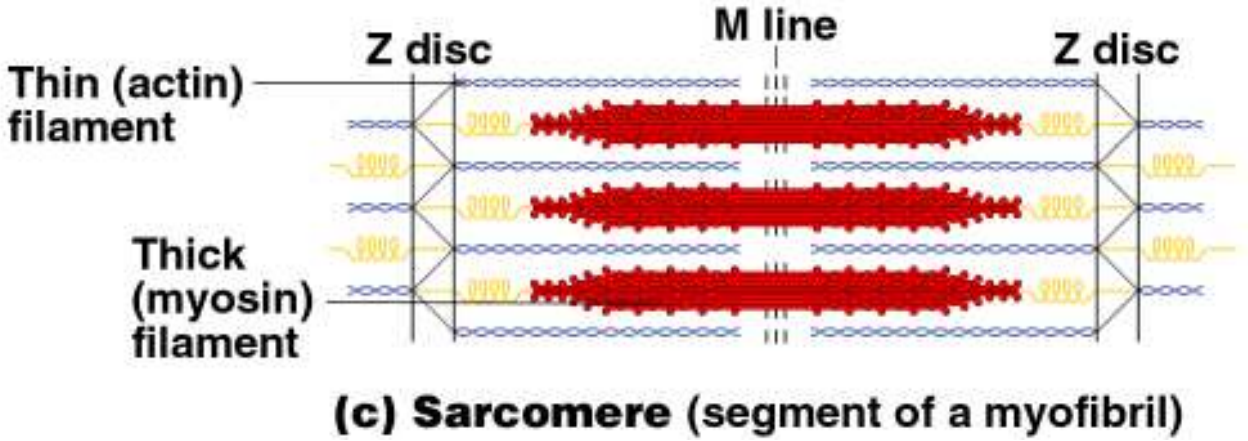
A single myosin molecule



A myosin thick filament (after Pollard, 1981)

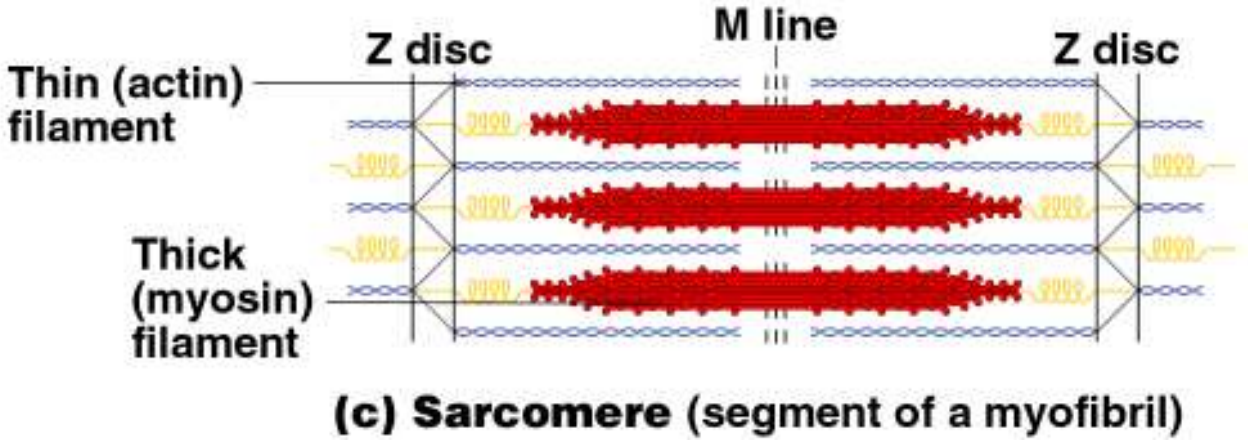
Microscopic Anatomy of Skeletal Muscle

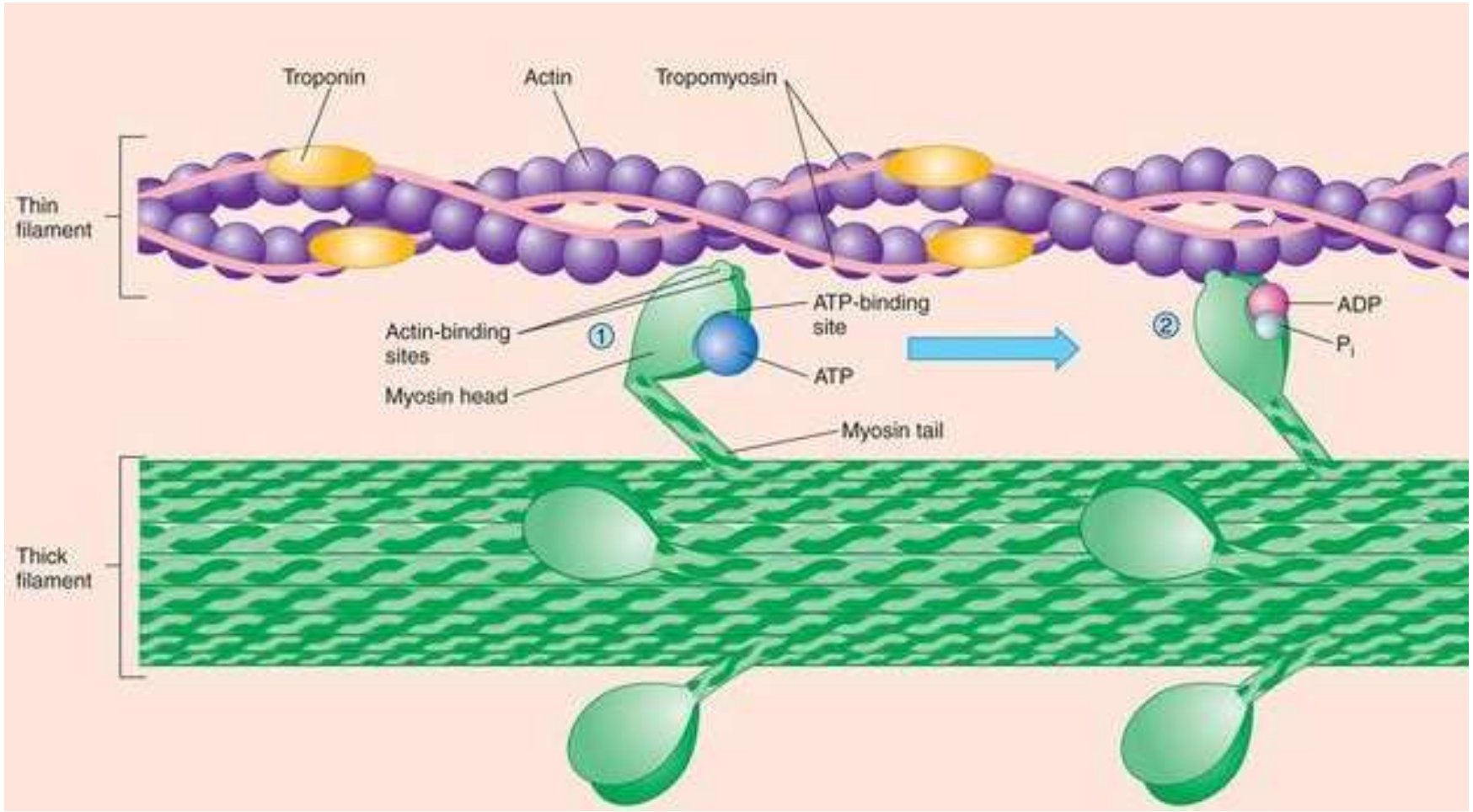
- Organization of the sarcomere
  - Thick filaments = myosin filaments
    - Composed of the protein myosin
    - Has ATPase enzymes



Microscopic Anatomy of Skeletal Muscle

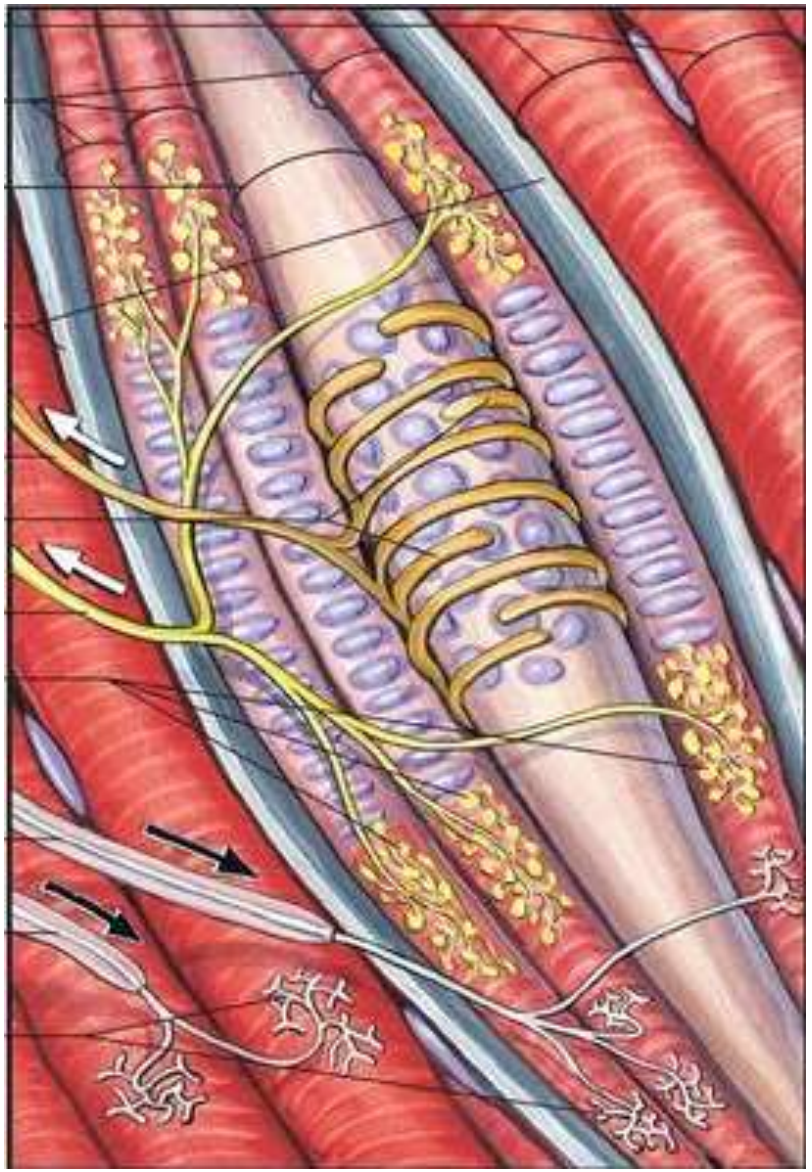
- Organization of the sarcomere
  - Thin filaments = actin filaments
    - Composed of the protein actin




Troponin
Actin
Tropomyosin
Thin filament
Actin-binding sites
ATP-binding site
ADP
P_i
ATP
Myosin head
Myosin tail
Thick filament
1
2

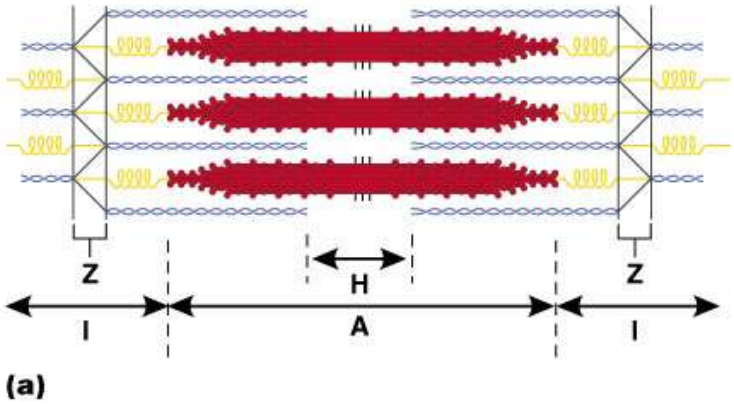
Nerve Stimulus to Muscles

- Neuromuscular junctions – association site of nerve and muscle

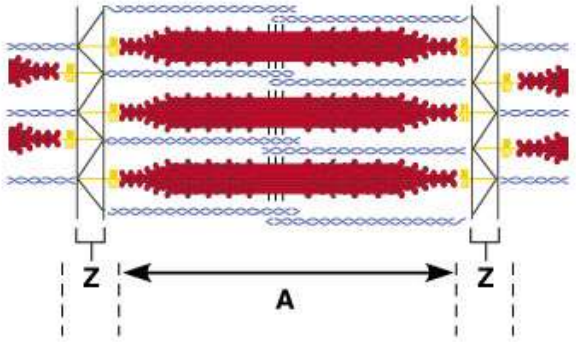


The Sliding Filament Theory of Muscle Contraction

- Activation by nerve causes myosin heads (crossbridges) to attach to binding sites on the thin filament
- Myosin heads then bind to the next site of the thin filament



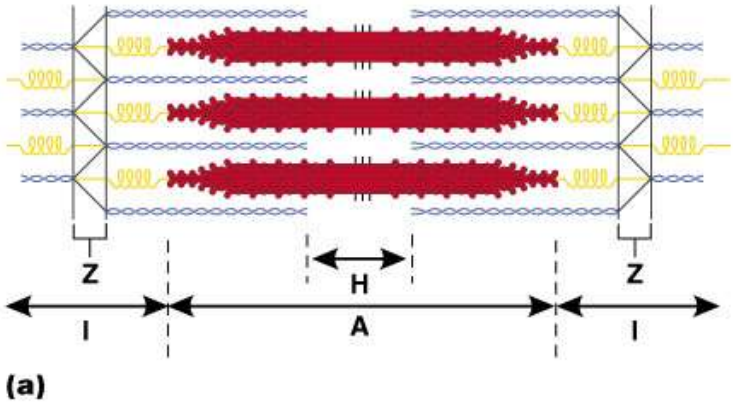
(a)

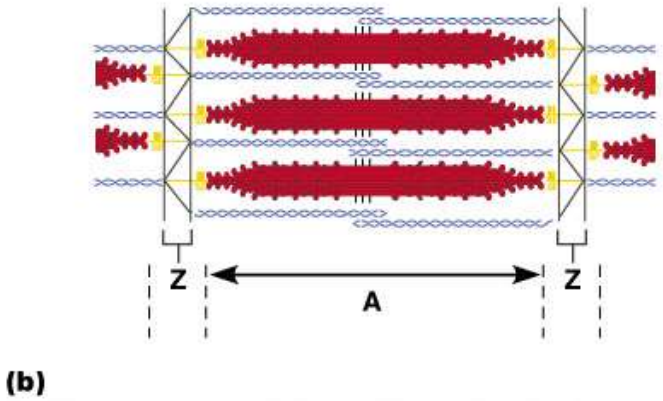


(b)

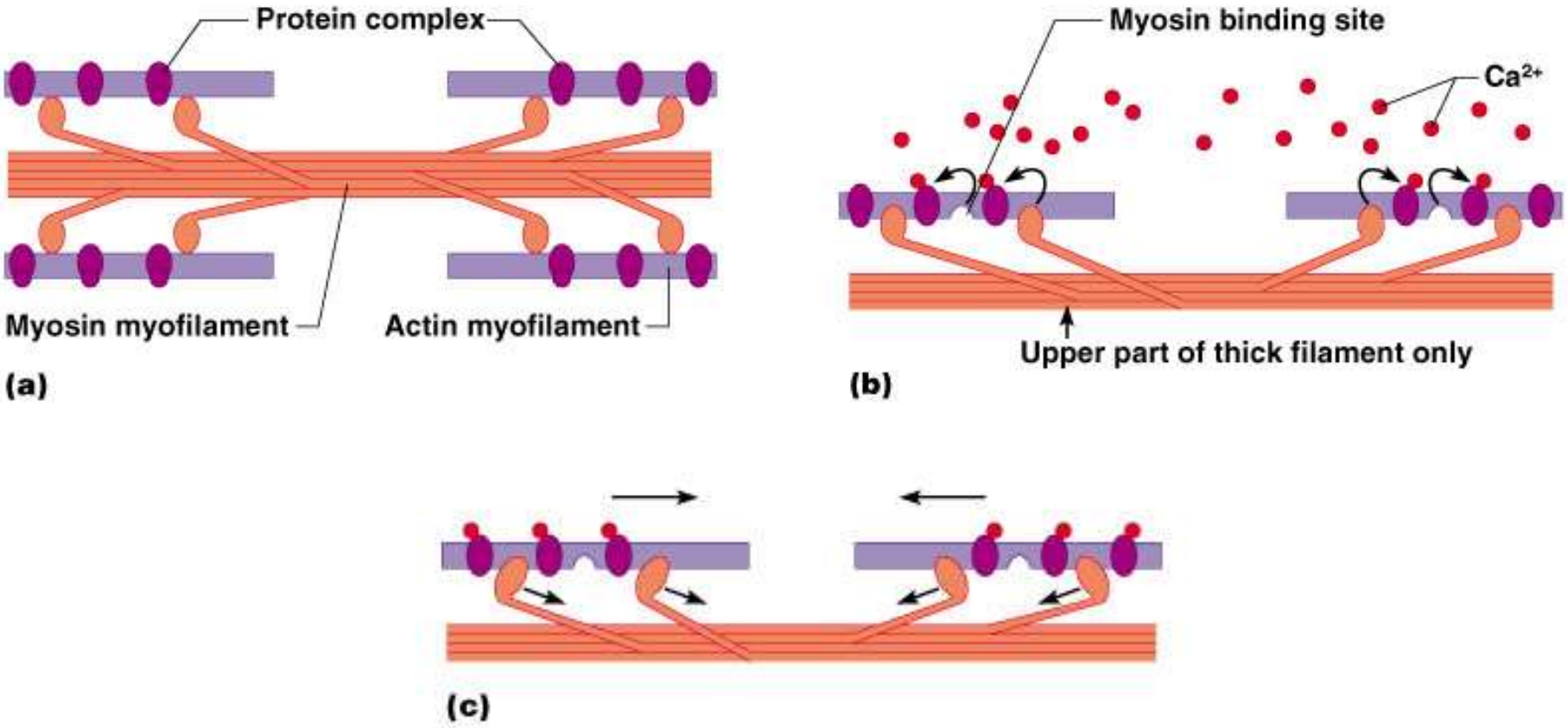
The Sliding Filament Theory of Muscle Contraction

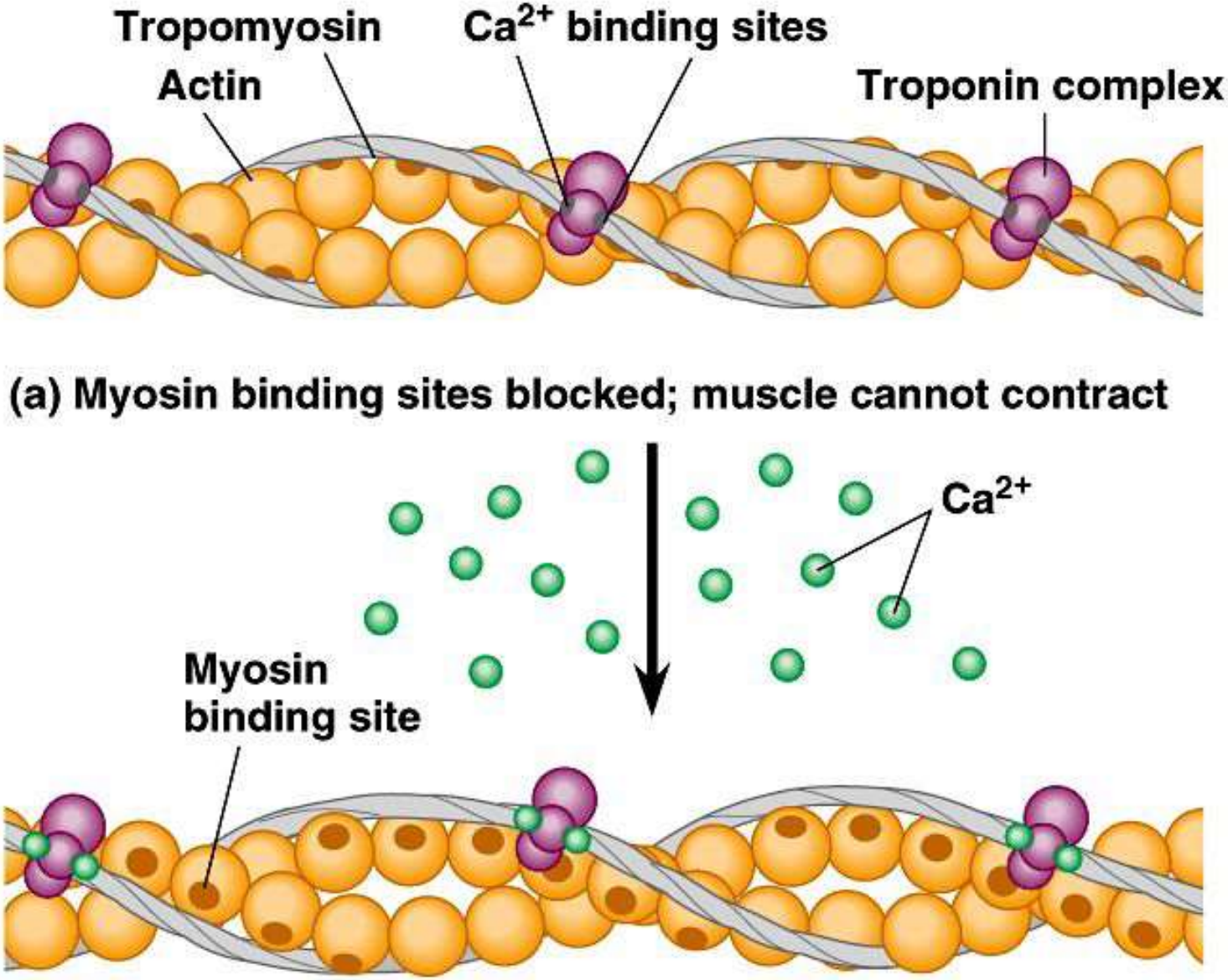
- This continued action causes a sliding of the myosin along the actin
- The result is that the muscle is shortened (contracted)

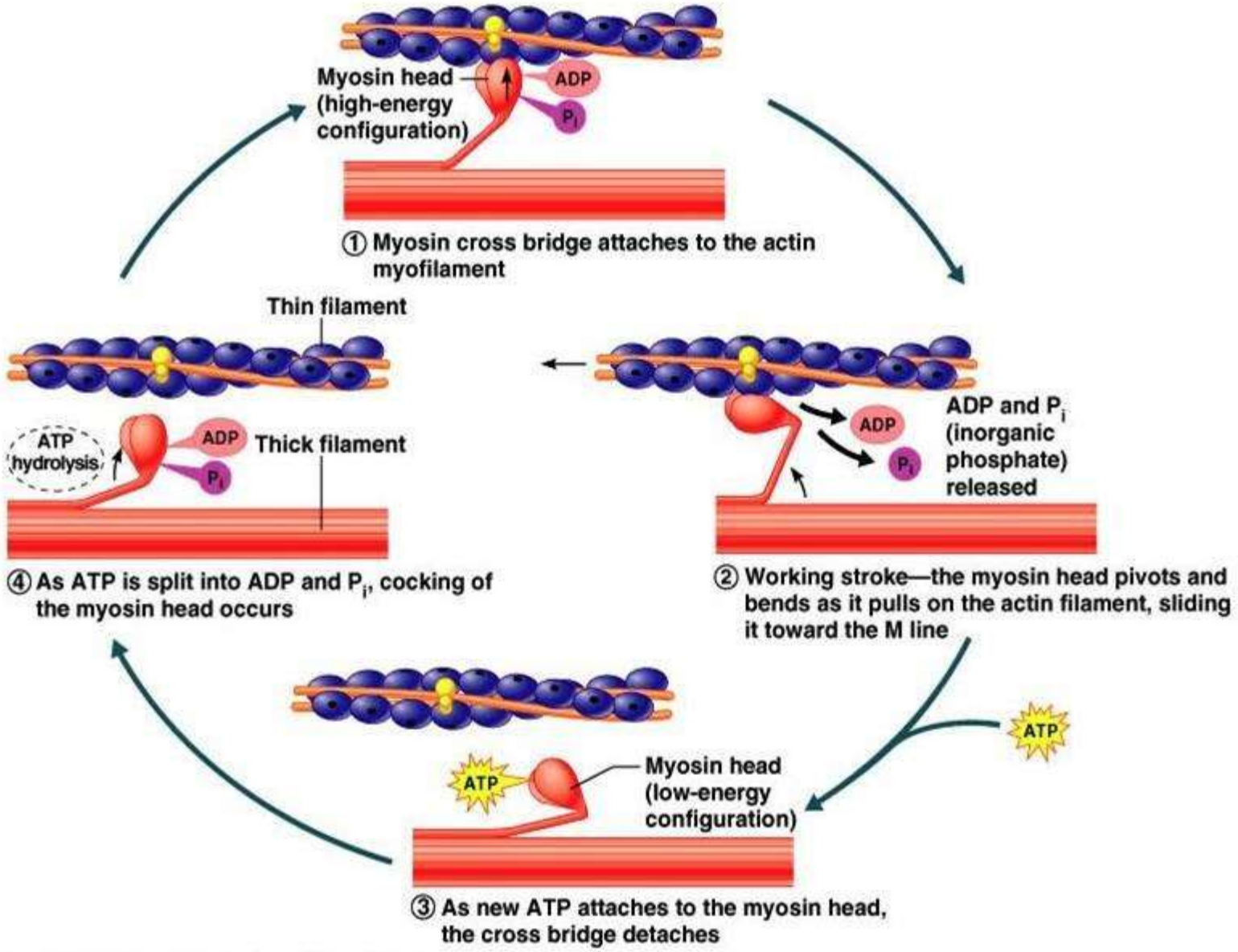




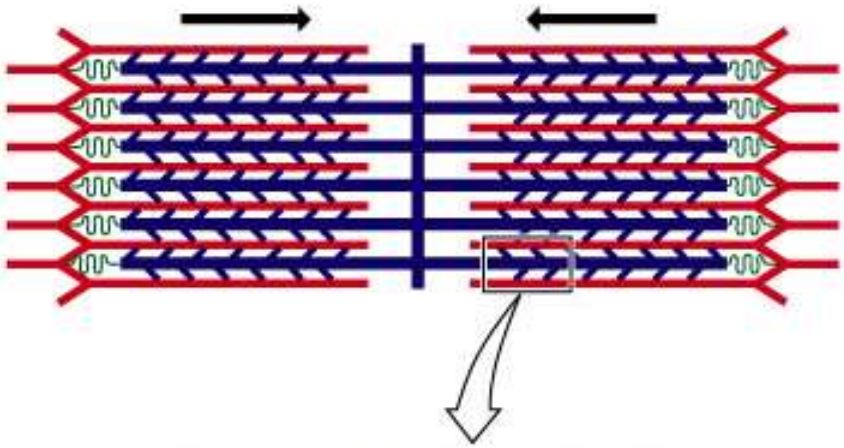
The Sliding Filament Theory

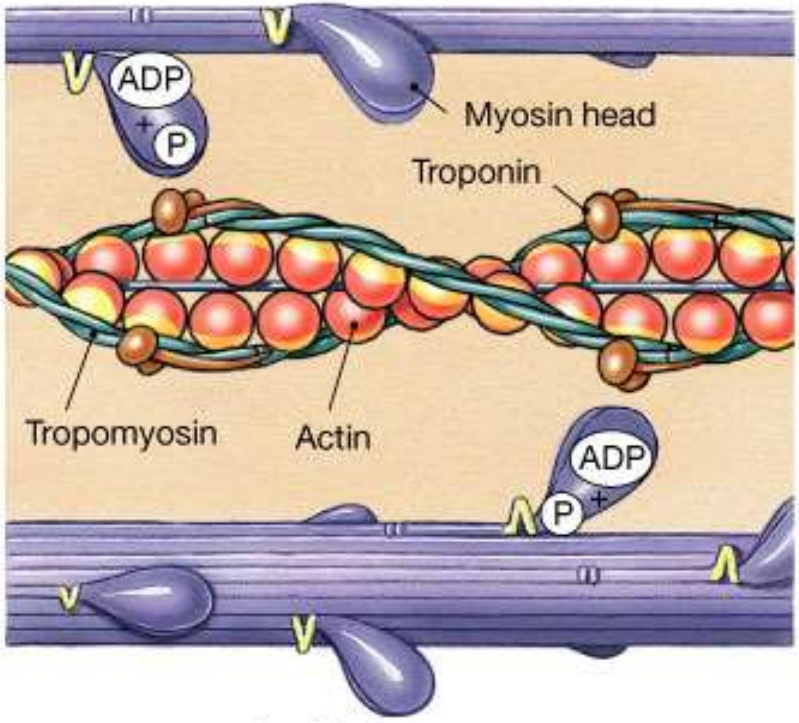




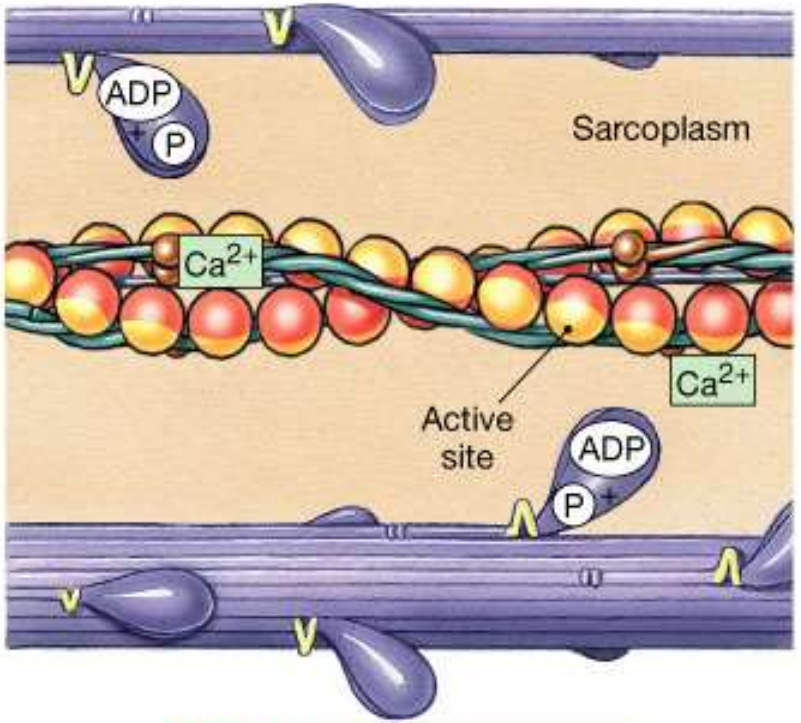

Myosin head
(high-energy
configuration)
ADP
P_i
① Myosin cross bridge attaches to the actin myofilament
ADP and P_i
(inorganic
phosphate)
released
② Working stroke—the myosin head pivots and bends as it pulls on the actin filament, sliding it toward the M line
ATP
Myosin head
(low-energy
configuration)
ATP
③ As new ATP attaches to the myosin head, the cross bridge detaches
Thin filament
ATP
hydrolysis
ADP
P_i
Thick filament
④ As ATP is split into ADP and P_i, cocking of the myosin head occurs

Calcium attaches to troponin/ tropomyosin; they roll away, exposing the active site on actin.





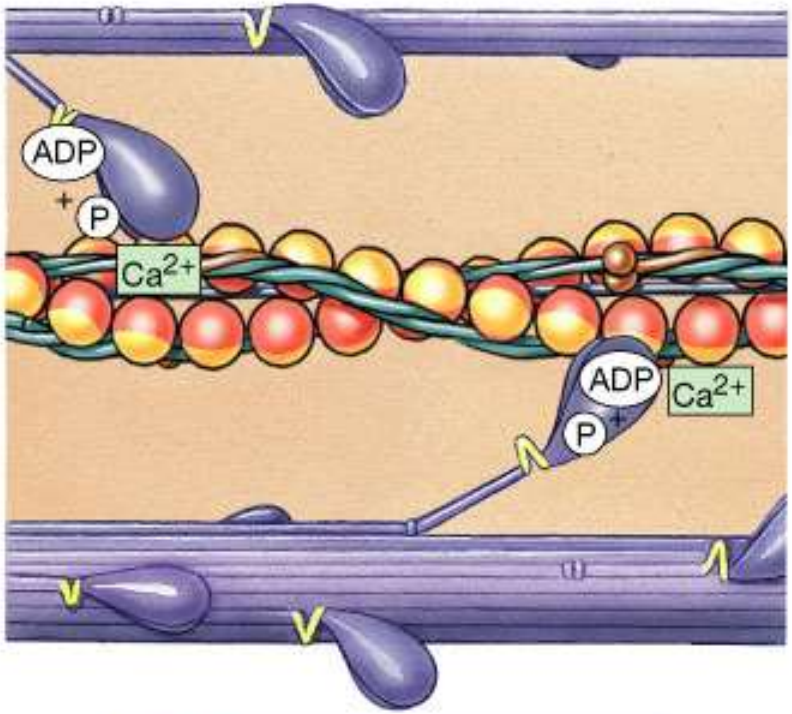
Resting sarcomere



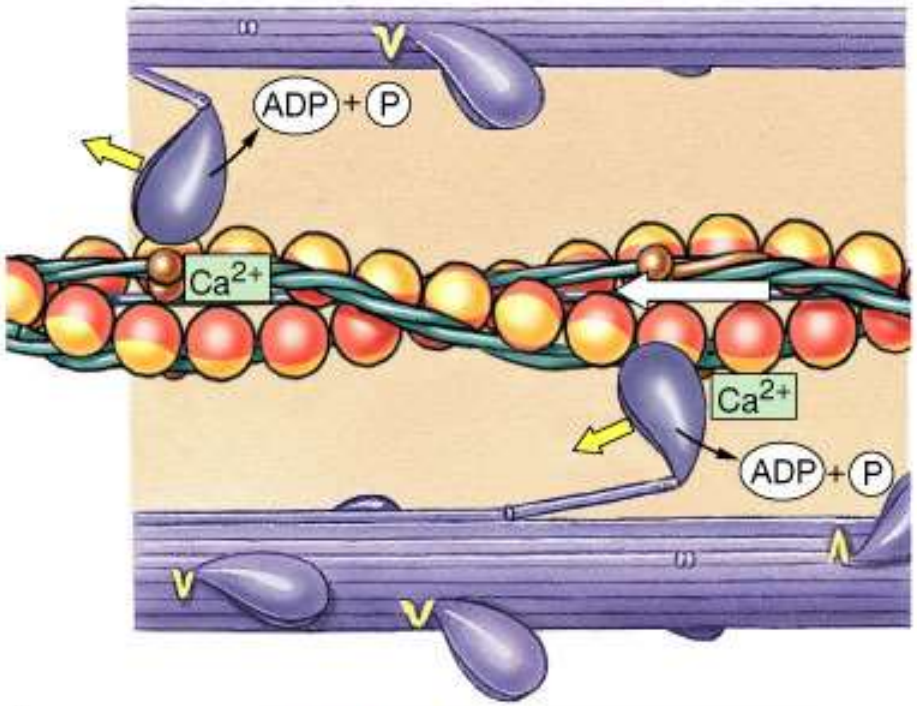
STEP 1: Active-site exposure

Myosin cross-bridges attach to active site on actin.

After attachment, the cross-bridges pivot, pulling the thin filaments.



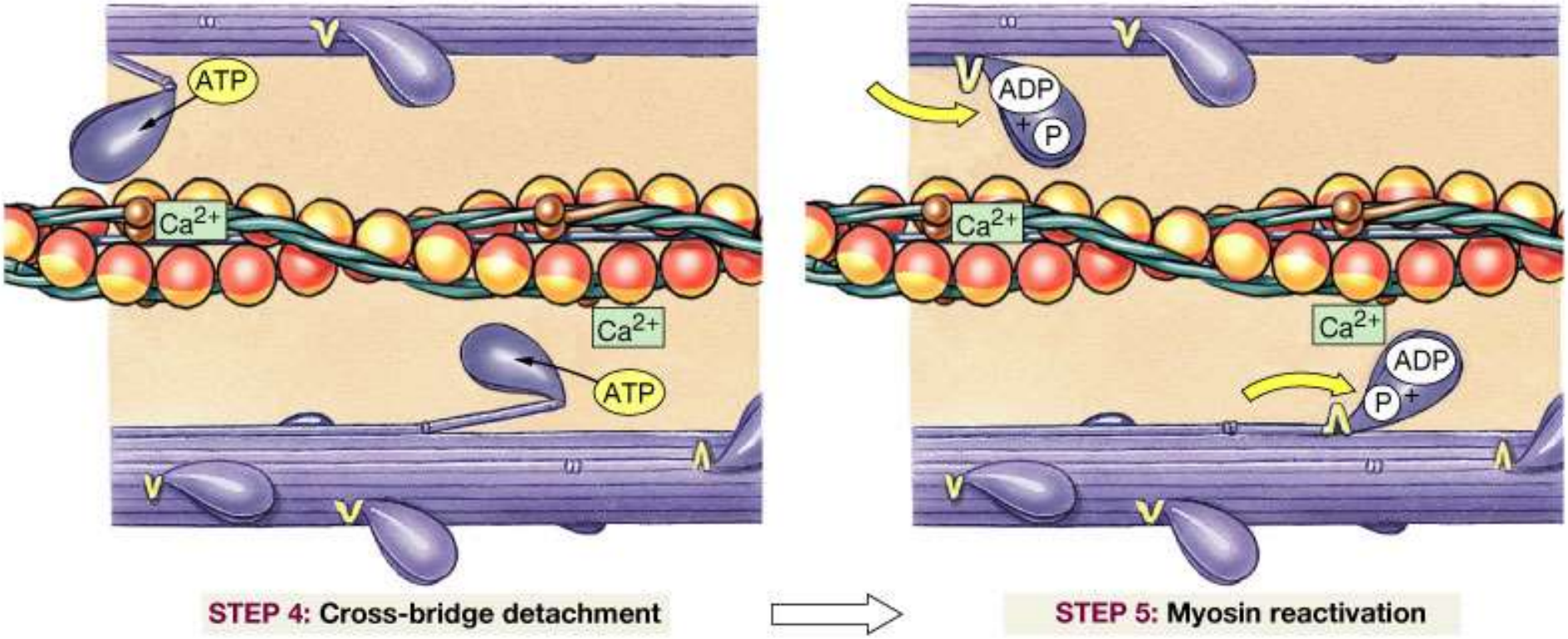
STEP 2: Cross-bridge attachment

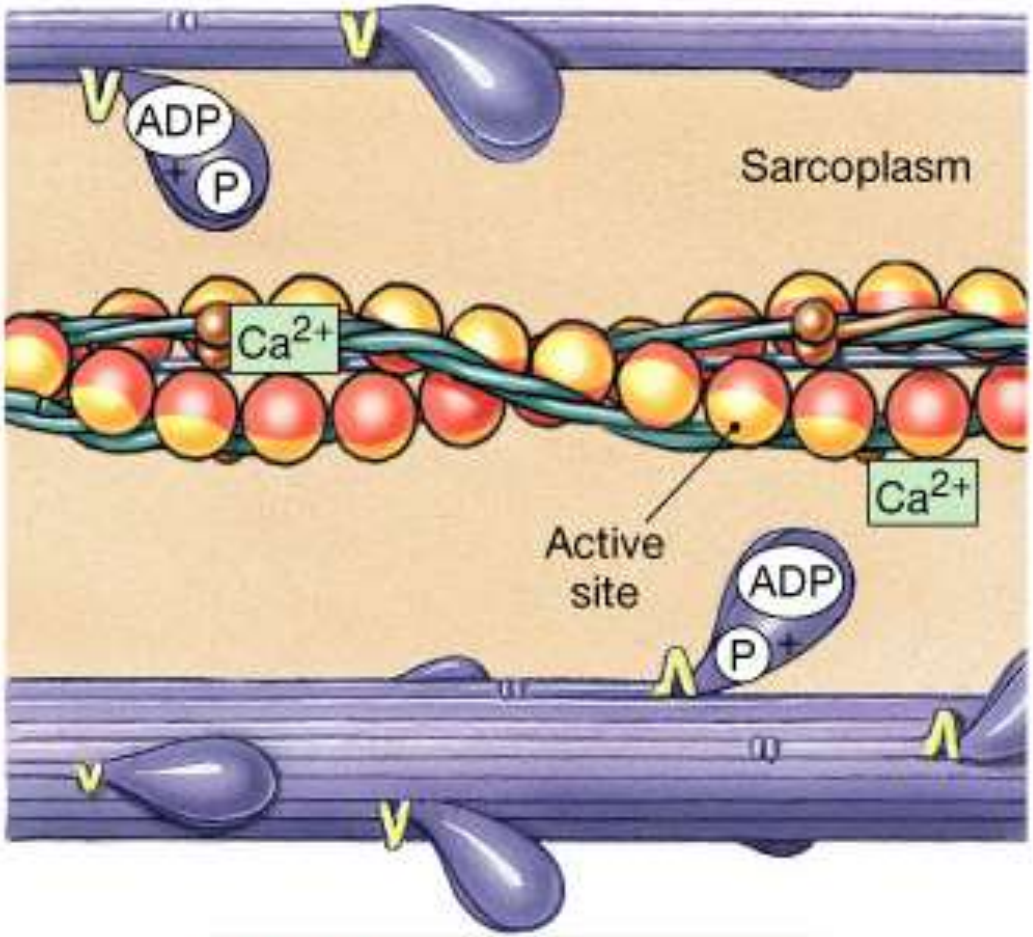


STEP 3: Pivoting of myosin head

A fresh ATP replaces the ADP+P_i, allowing myosin and actin to detach.

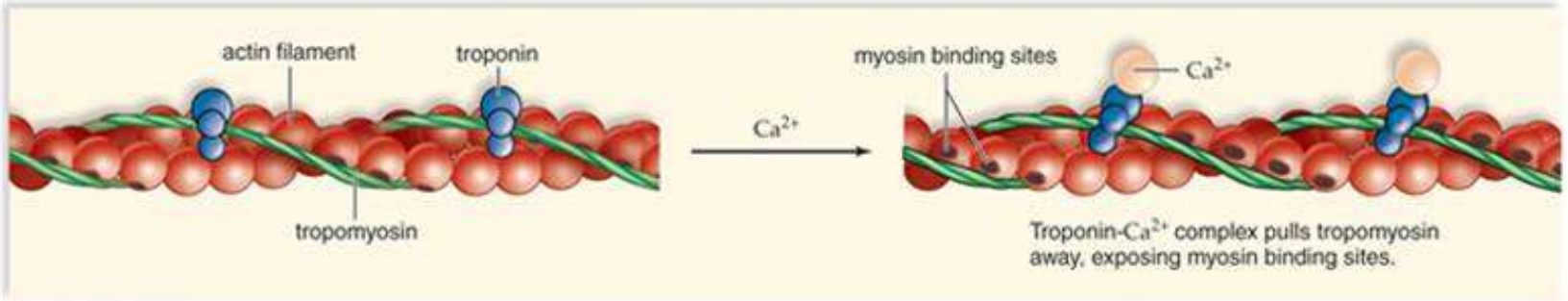
Energy from the splitting of the fresh ATP allows repositioning of the myosin head.



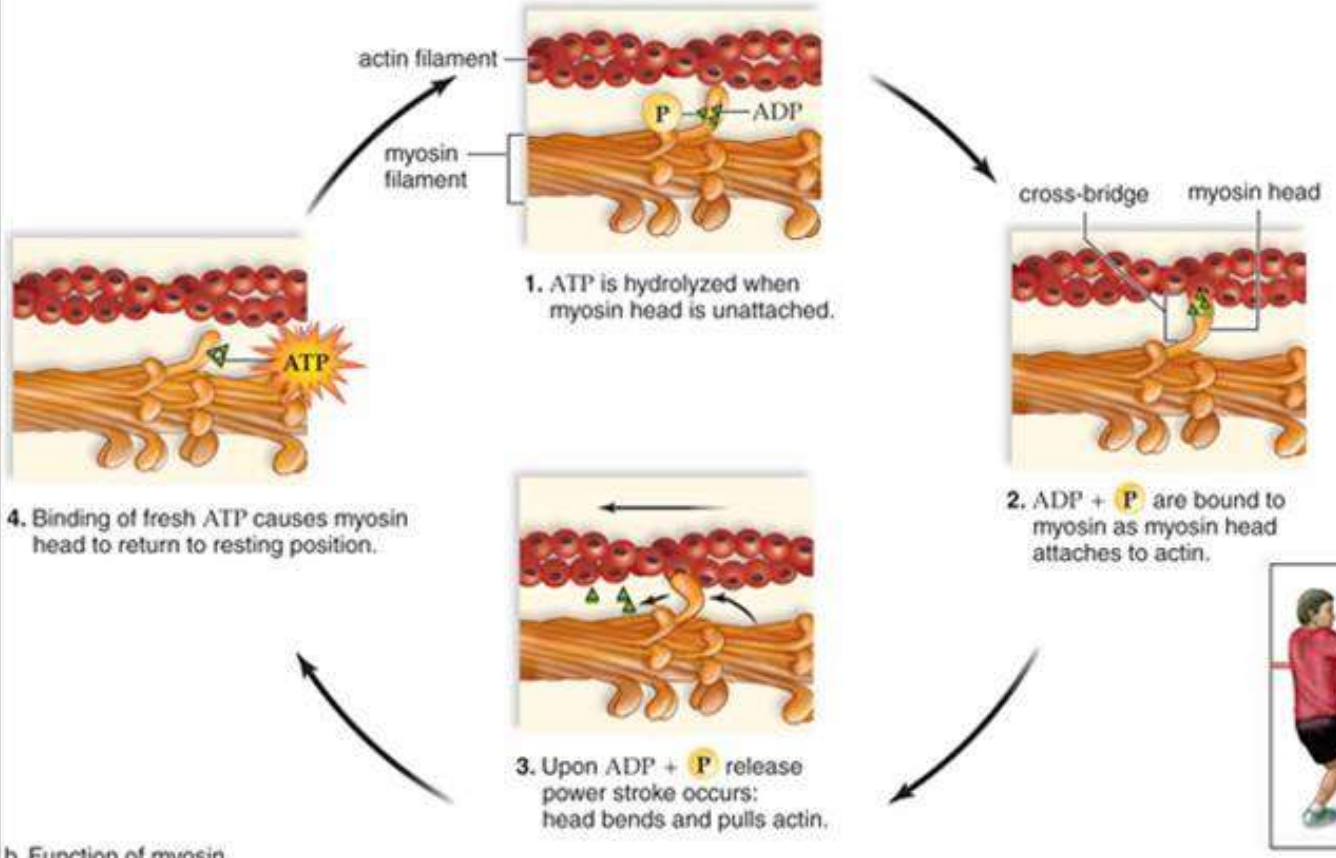


STEP 1: Active-site exposure

This leads back to Step 1, which continues the cycle as long as calcium ions are attached to troponin/tropomyosin.



a. Function of Ca^{2+}



b. Function of myosin