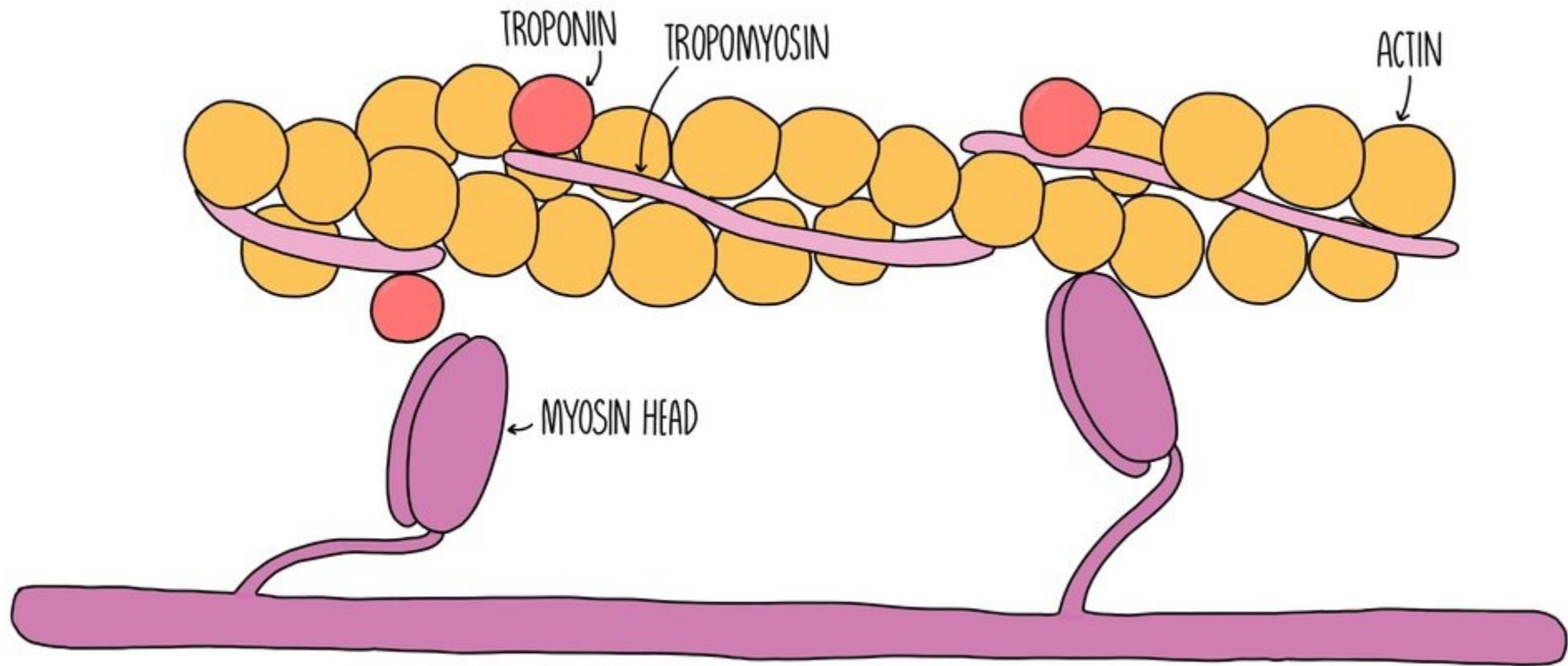


# Muscle contraction

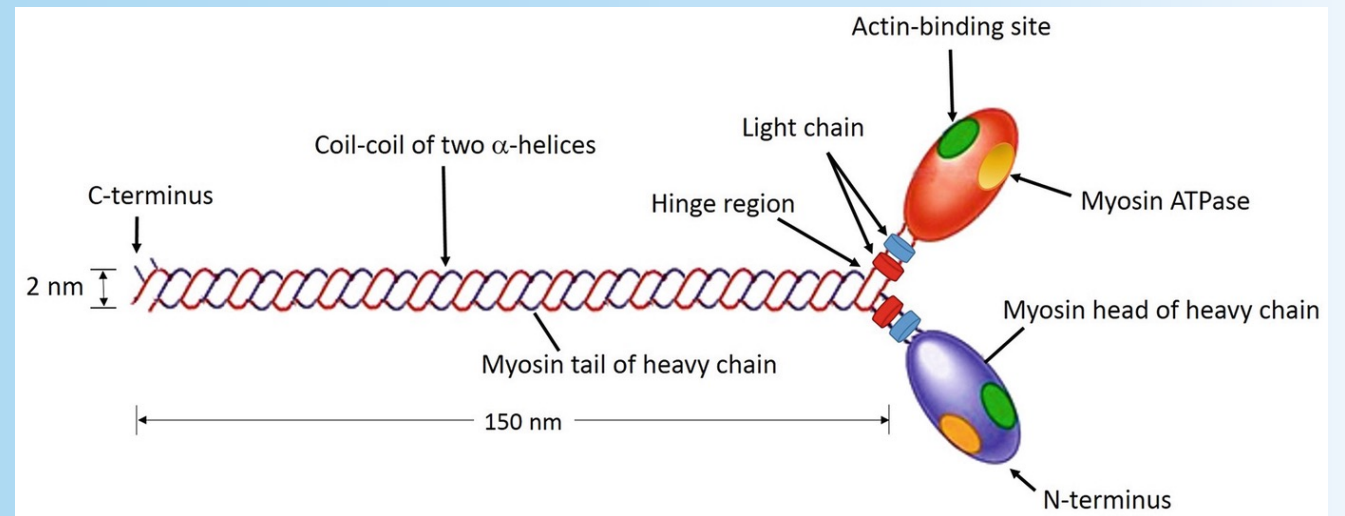
# What we are going to cover

- Thick filaments
- Thin filaments
- The sarcomere
- Transverse tubules and the sarcoplasmic reticulum
- Excitation-contraction coupling in skeletal muscle
- Excitation-contraction coupling in smooth muscle



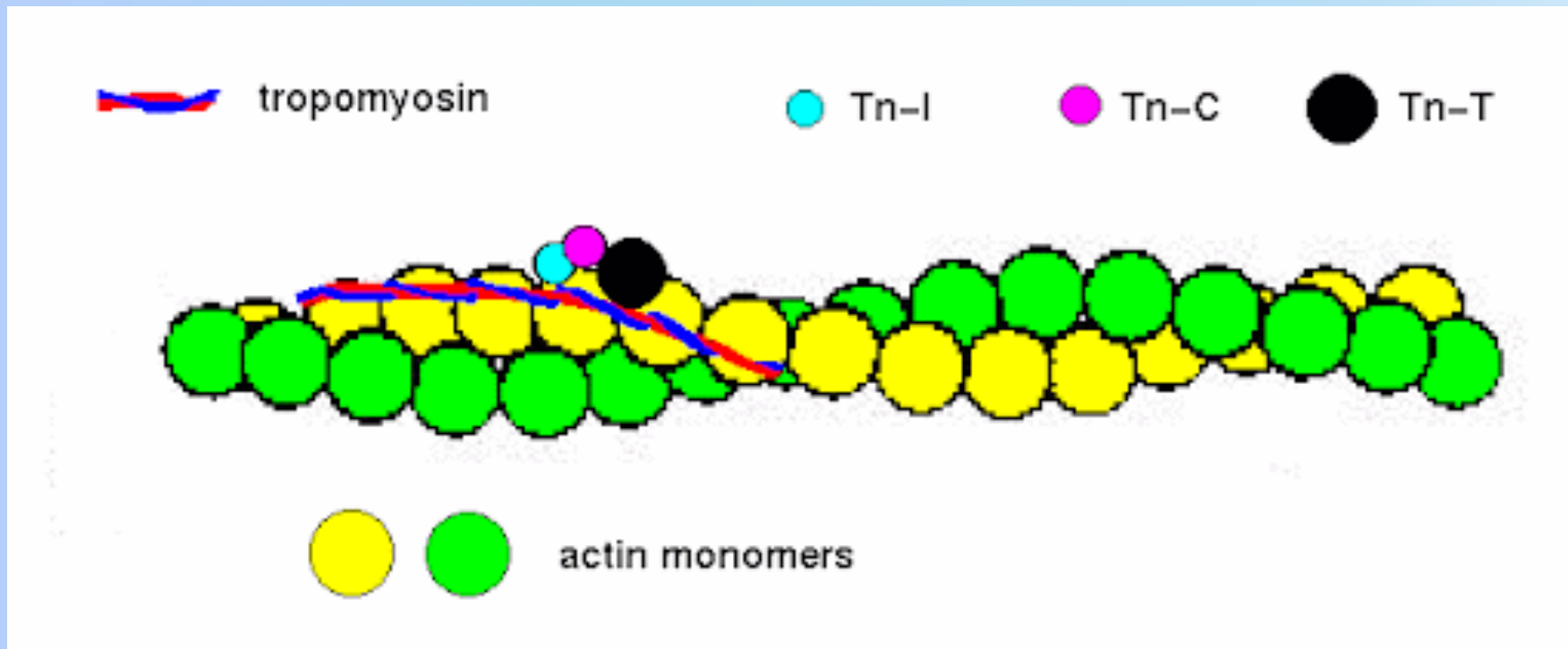
# MYOSIN

- Thick filament
- Motor protein
- Heavy chains - tail (2 chains = 1 pair)
- Light chains - head (4 chains = 2 pairs)
- Heads have actin binding sites
  - + ATP binding site



# ACTIN

- Thin filaments: actin, tropomyosin, troponin
- Myosin binding sites



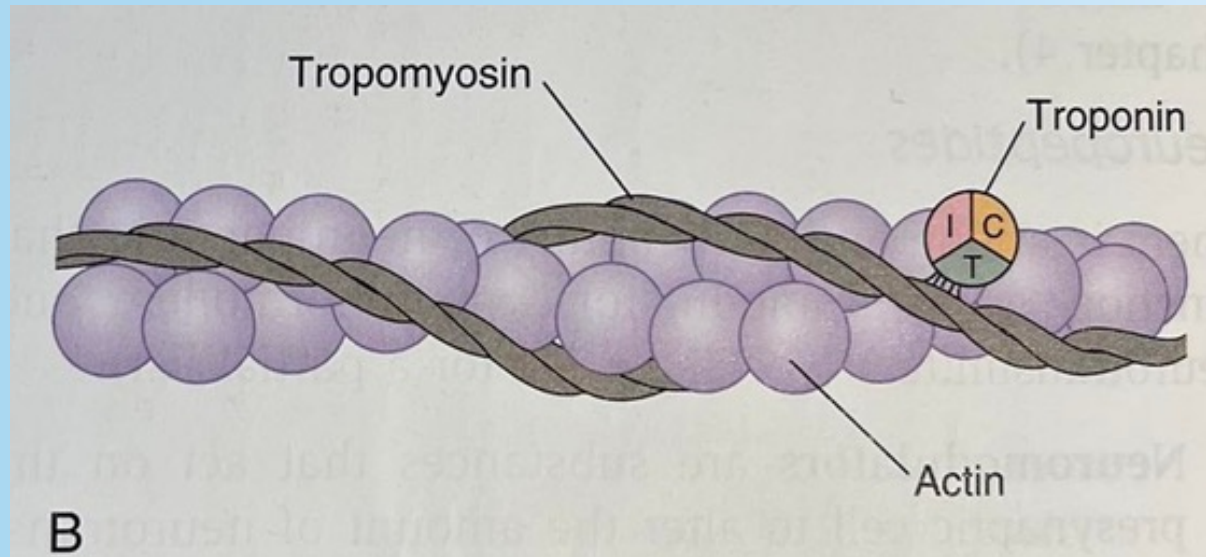
TROPONIN

TROPOMYOSIN



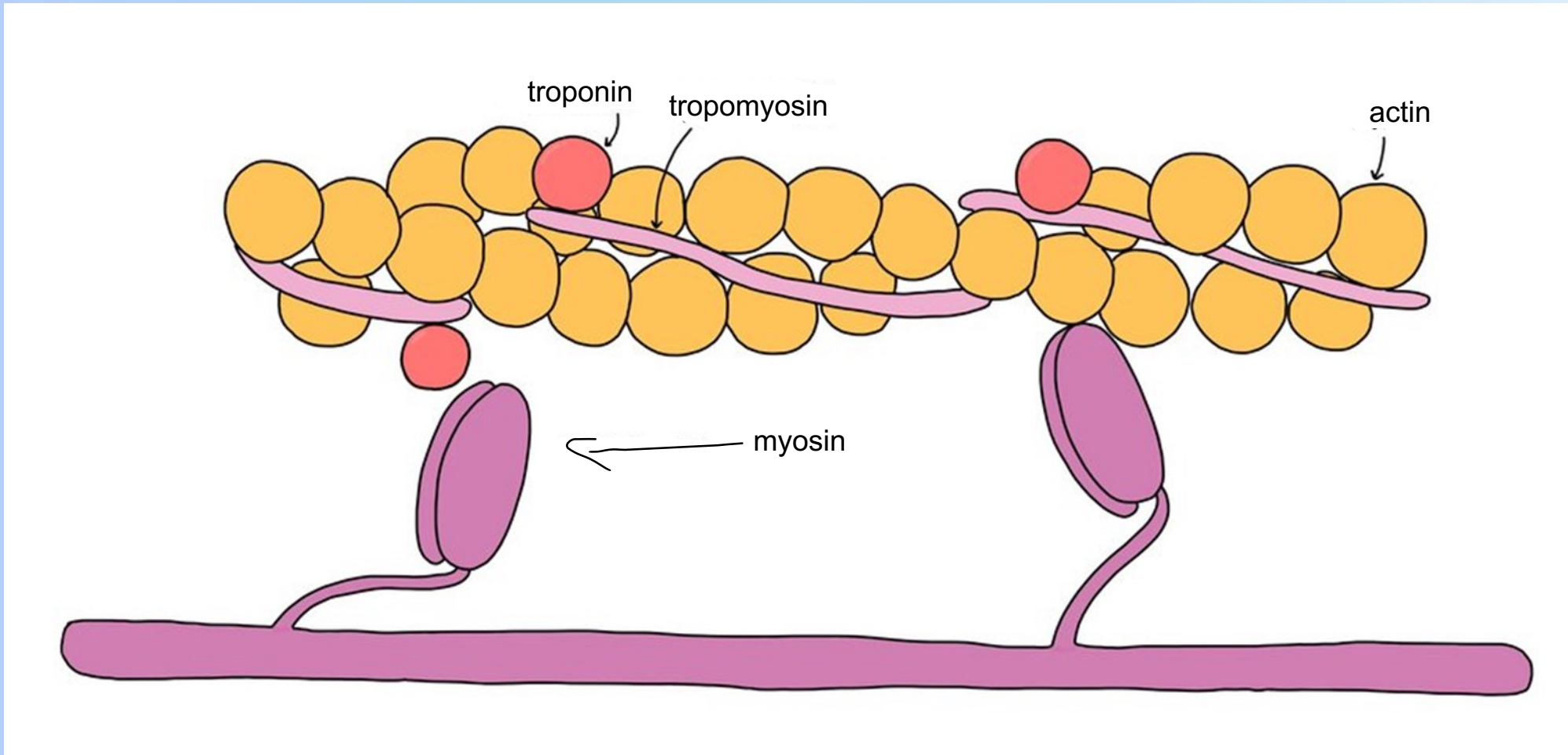
# Tropomyosin and troponin

- Coiled protein that covers myosin-binding sites at rest
- Troponin is a complex of 3 proteins, and it sits on tropomyosin
- T for tropomyosin
- I for inhibition
- C for calcium



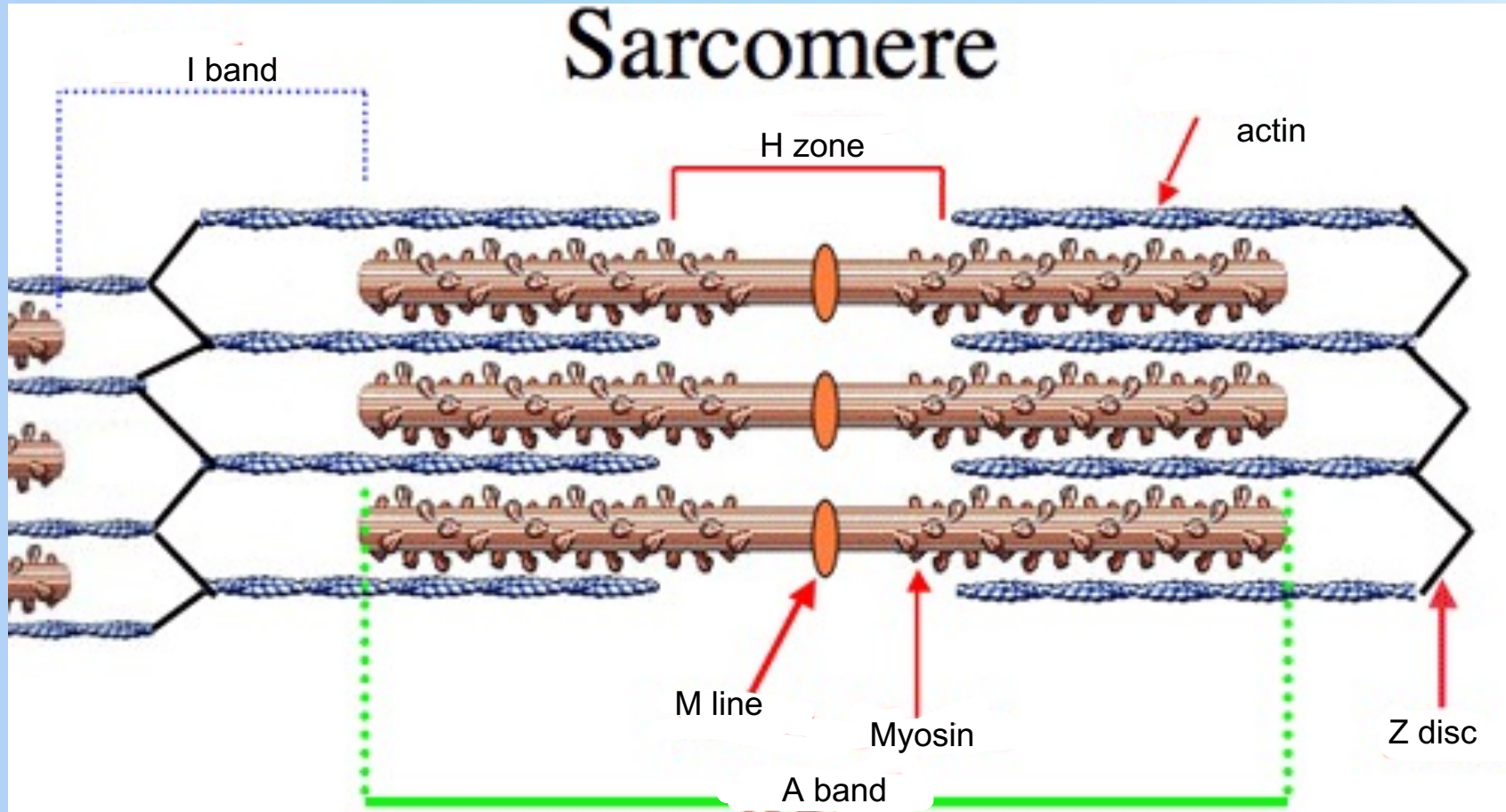


# Muscle filaments

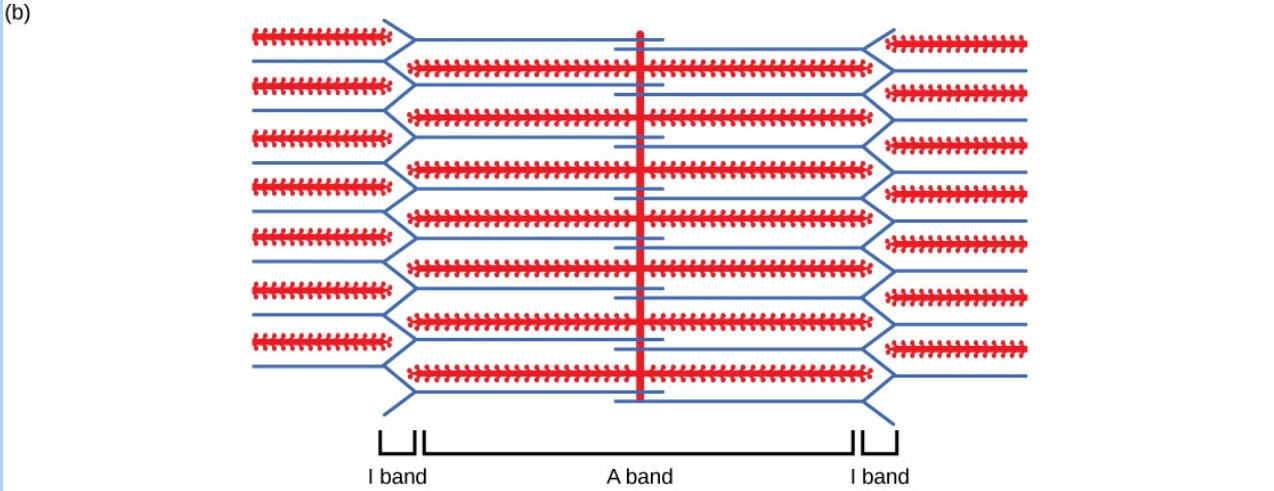
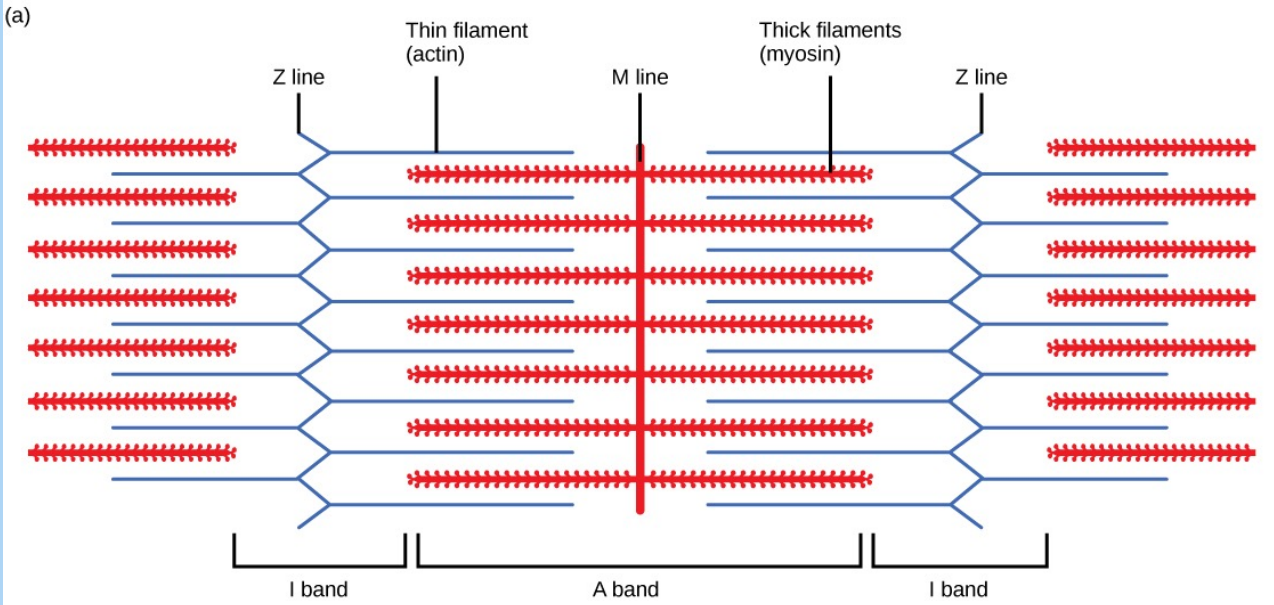




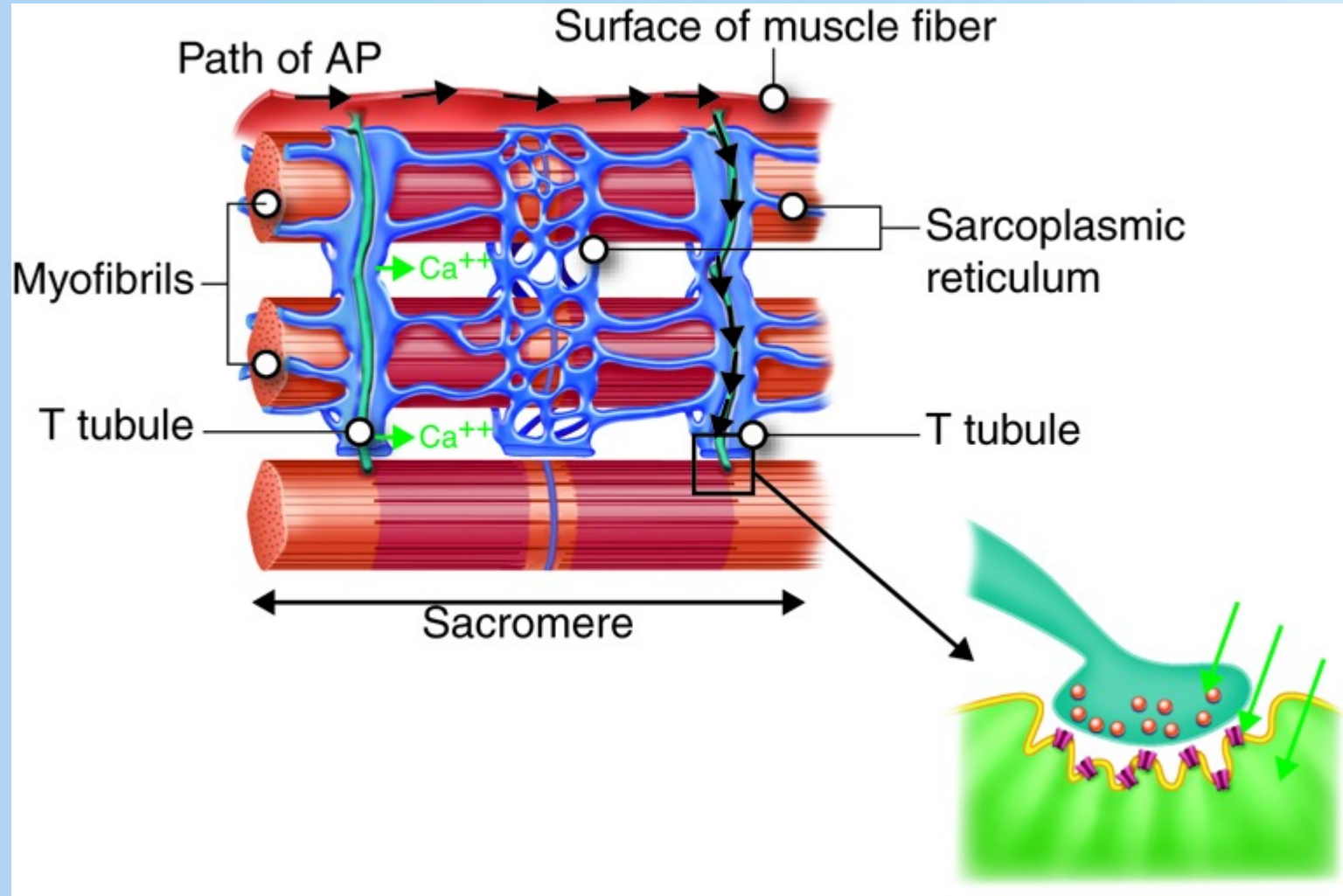
# Sarcomere - the basic contractile unit



# Sarcomere

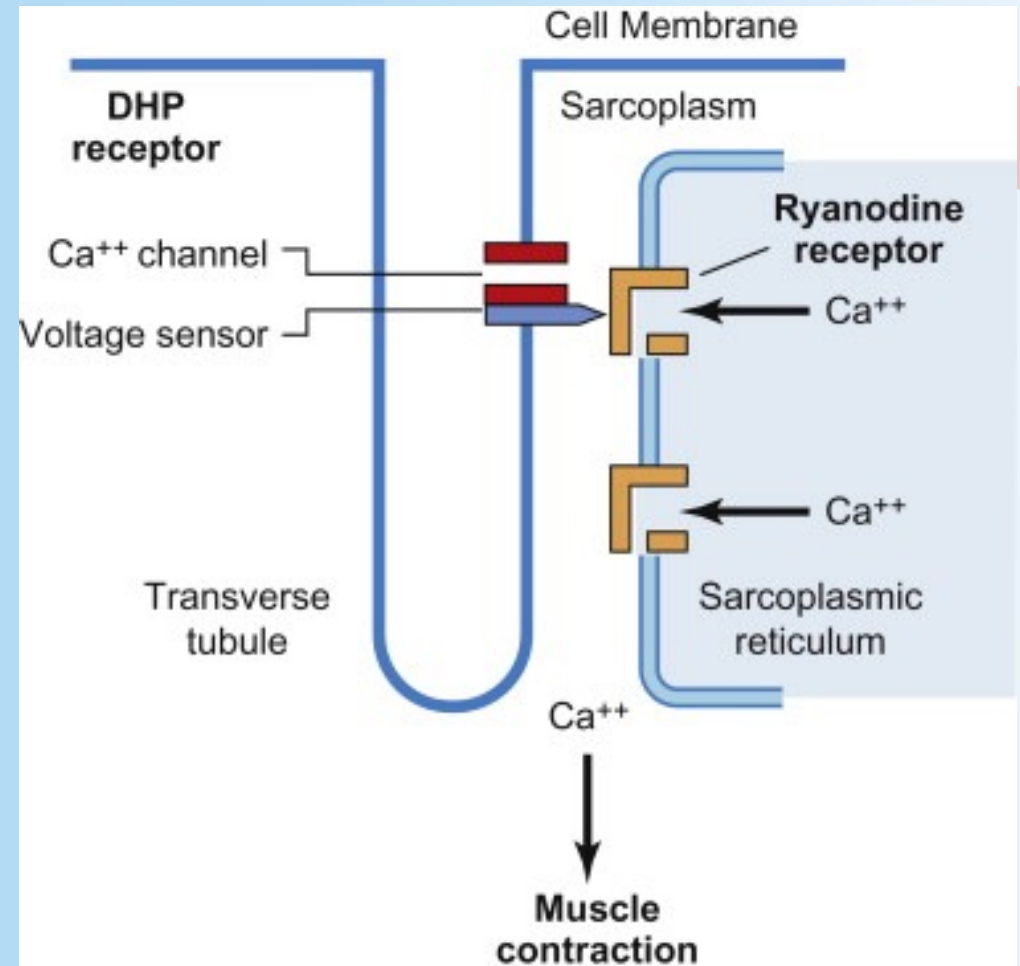


# T tubules

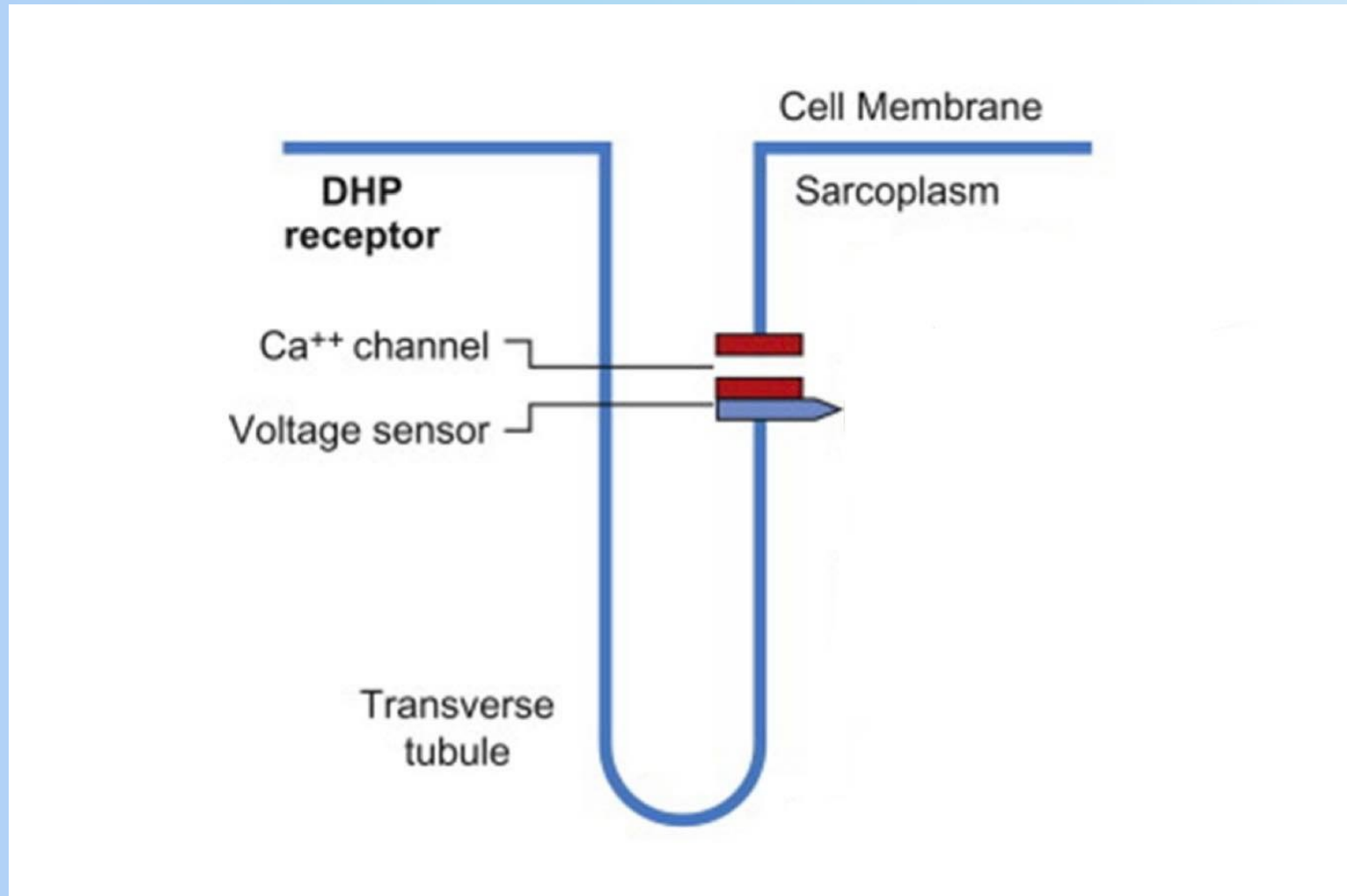


# T tubules and sarcoplasmic reticulum

- T tubules make direct contact with SR
- DHP receptors (t tubules)
- SR storage and release of calcium
- Ryanodine receptor (SR)
- Calcium ATPase (SERCA)

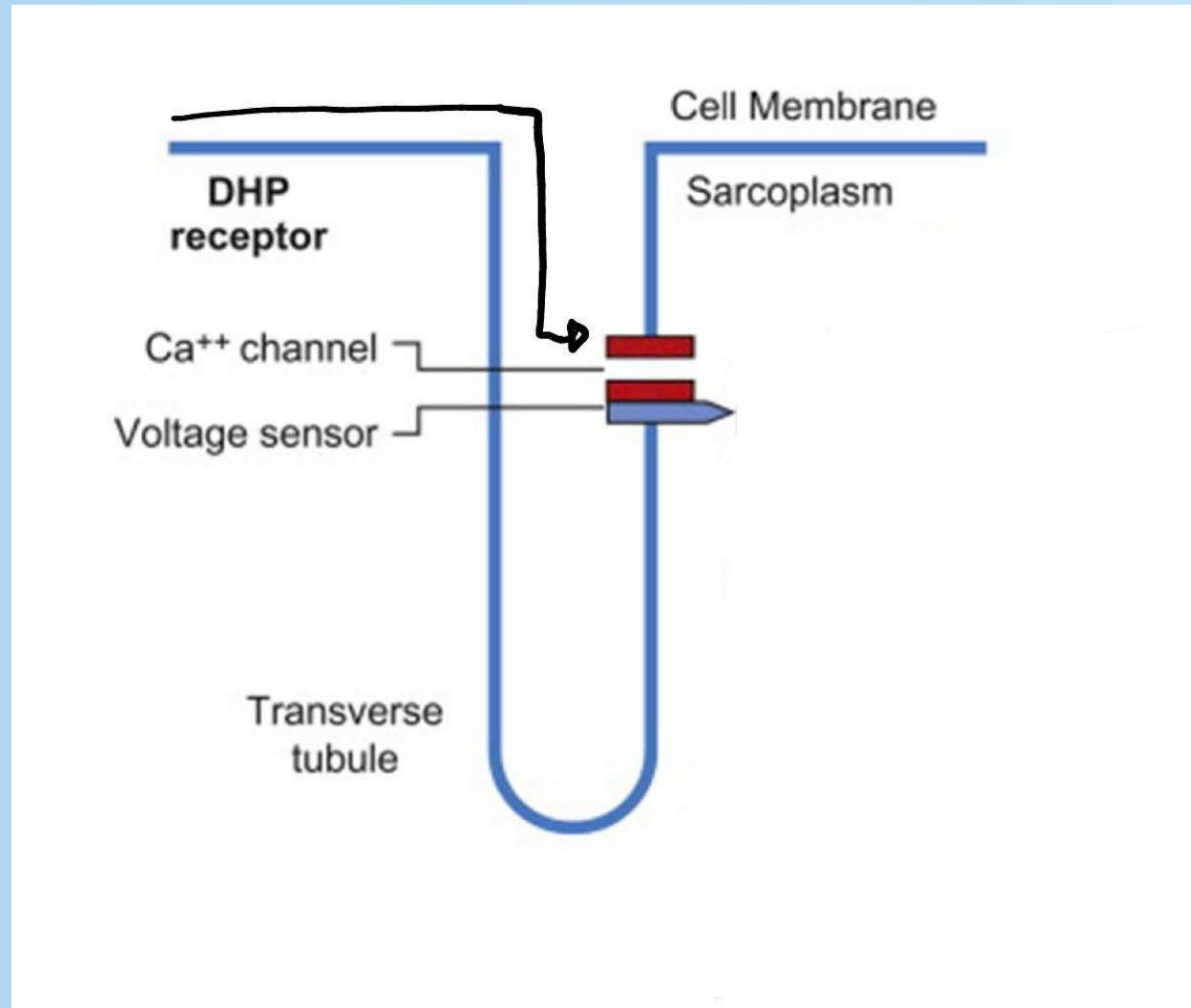


# Excitation-Contraction Coupling

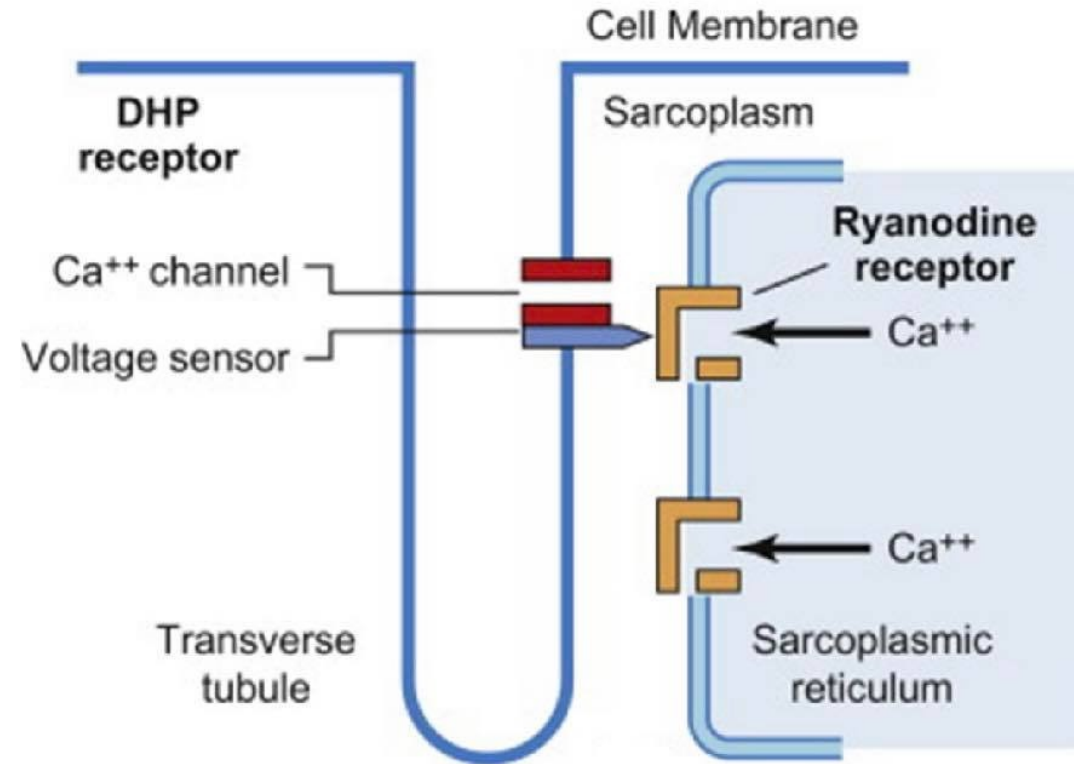




# Excitation-Contraction Coupling

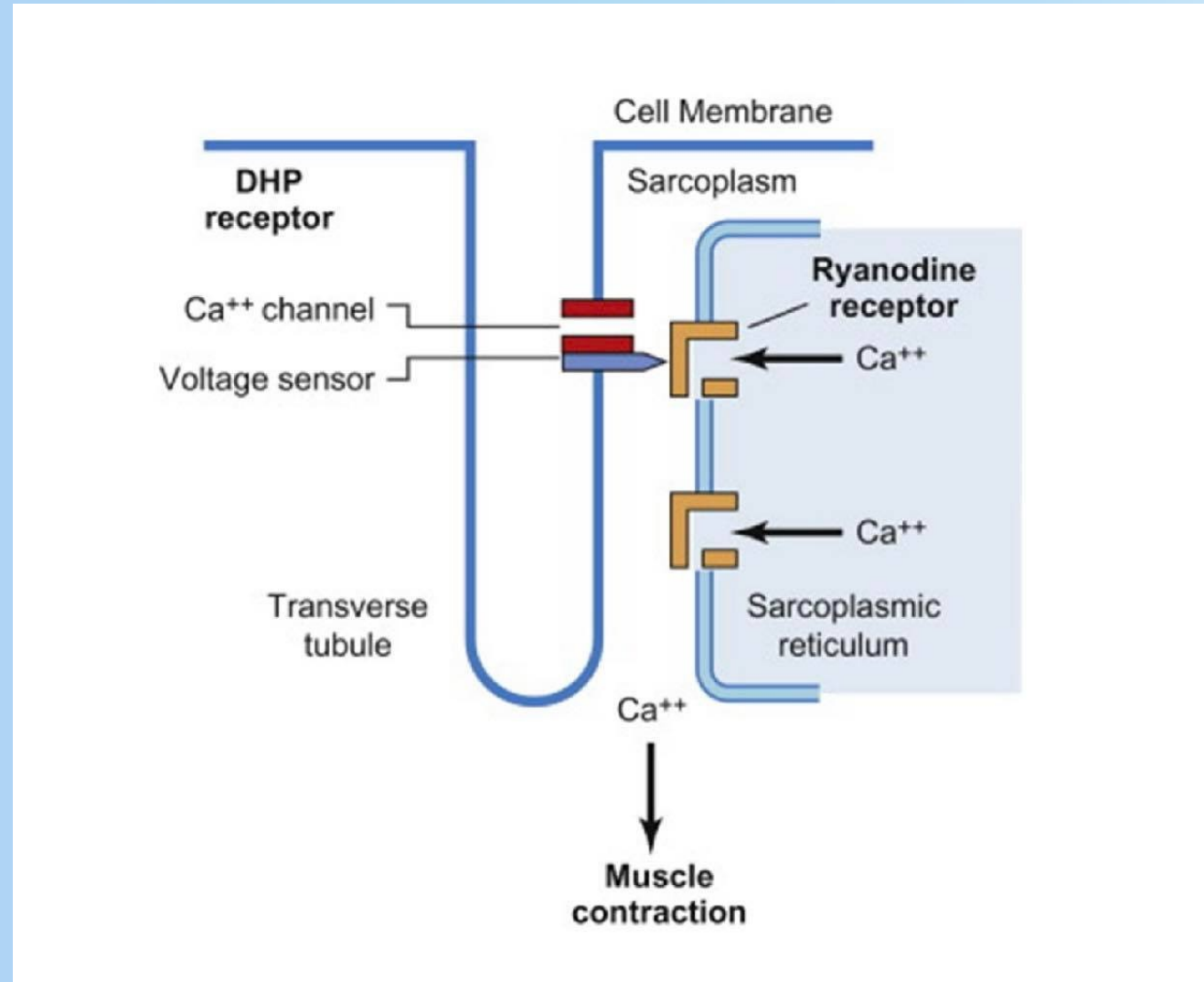


# Excitation-Contraction coupling



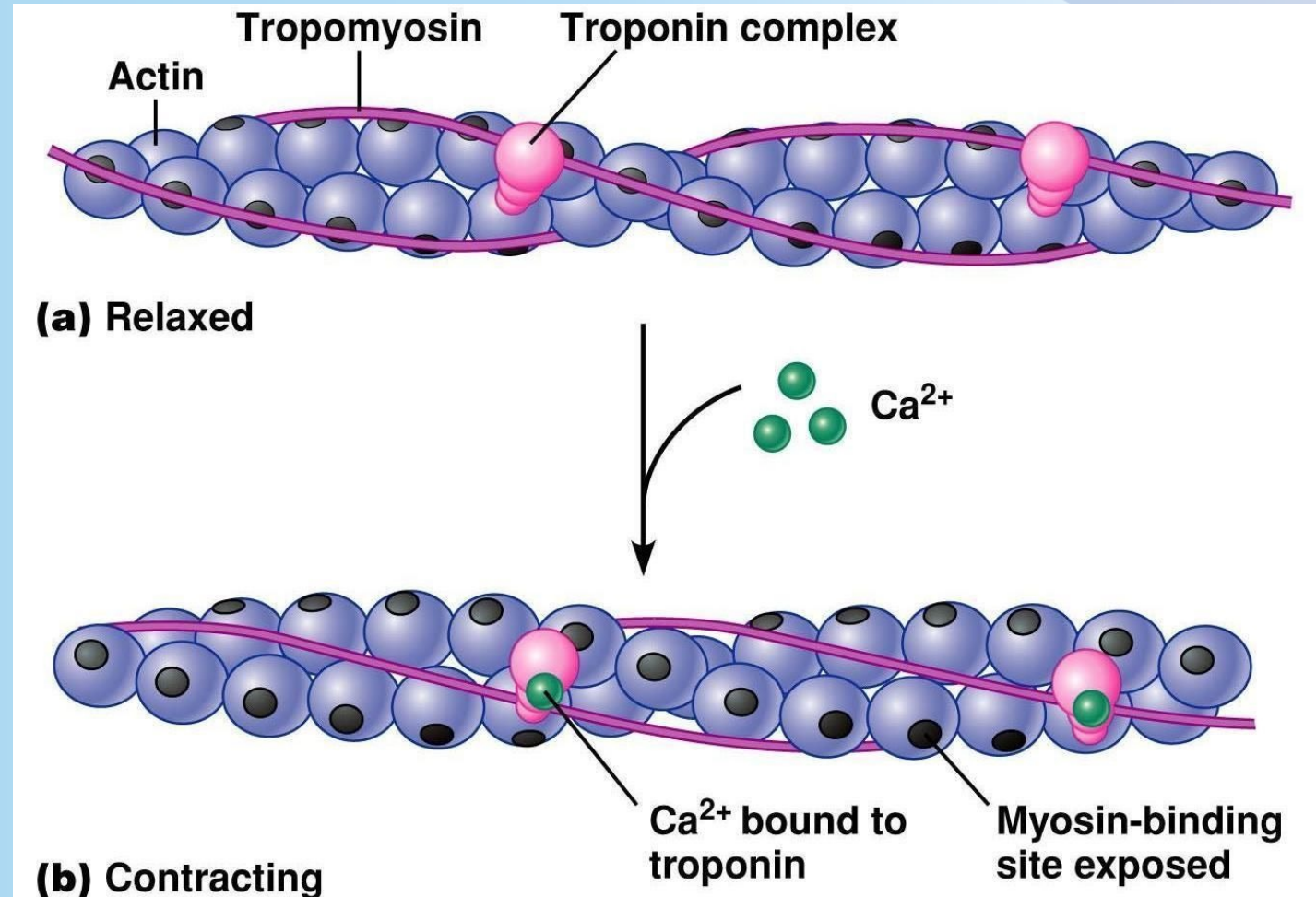


# Excitation-Contraction Coupling

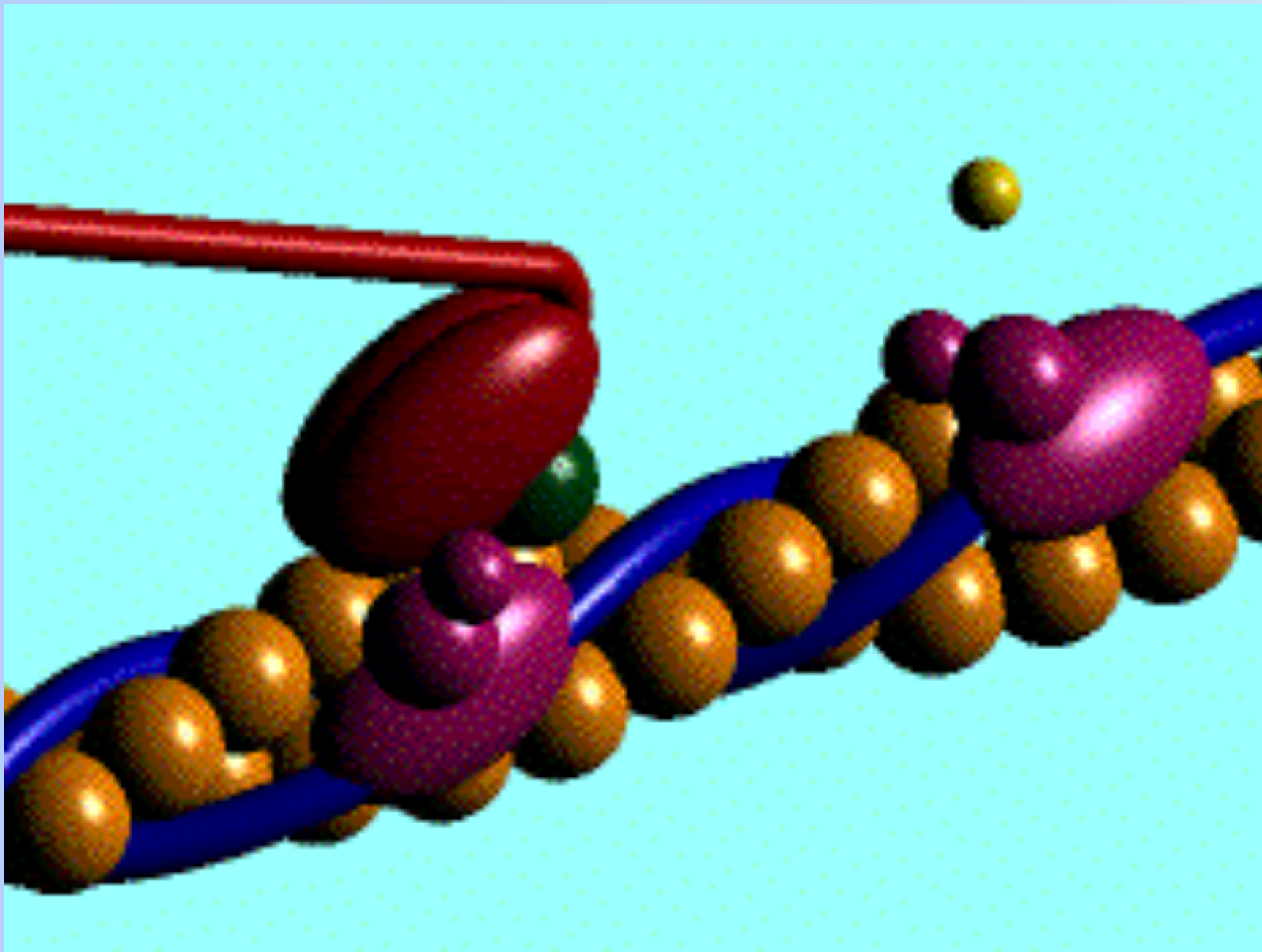


# Excitation-Contraction Coupling

- Calcium binds to troponin C
- Changes the troponin complex
- Tropomyosin is lifted from the myosin binding sites
- Myosin needs some help from ATP

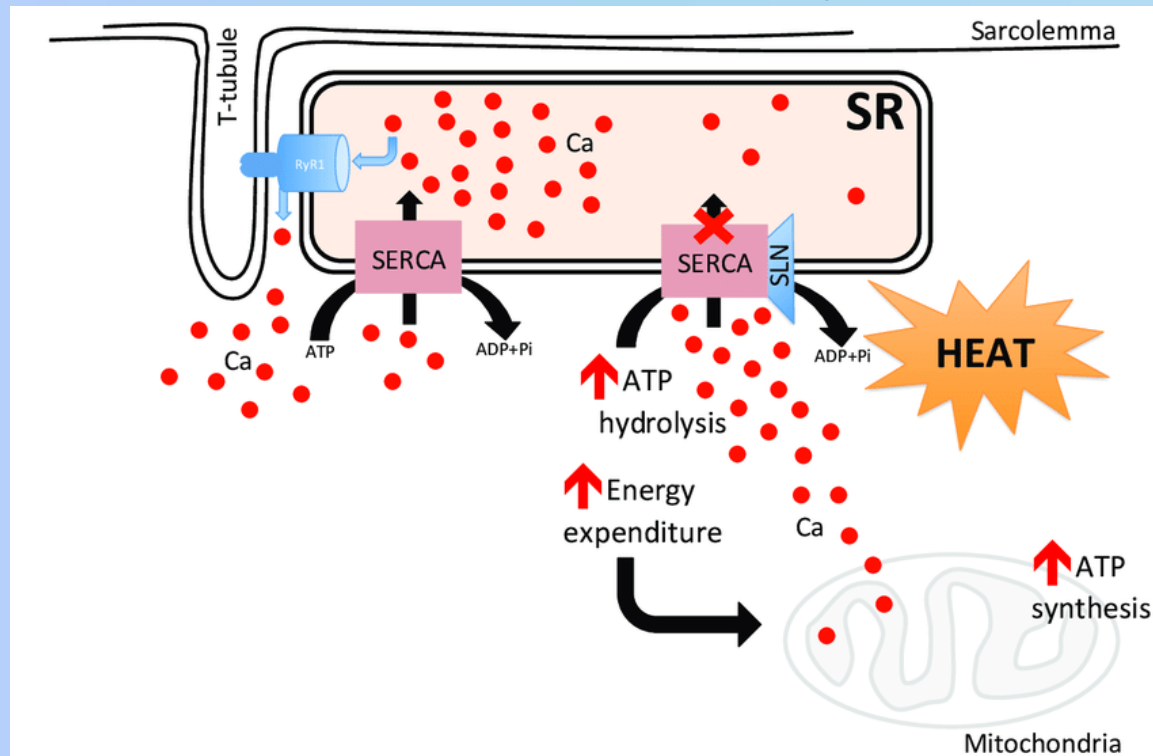






# Excitation-Contraction Coupling

- The contraction continues as long as there is enough calcium to occupy the troponin
- Calcium is reaccumulated by SERCA



# Rigor Mortis

- Myosin needs ATP to detach from the actin
- A dead person does not produce more ATP
- Therefore the muscles will stay contracted for some hours



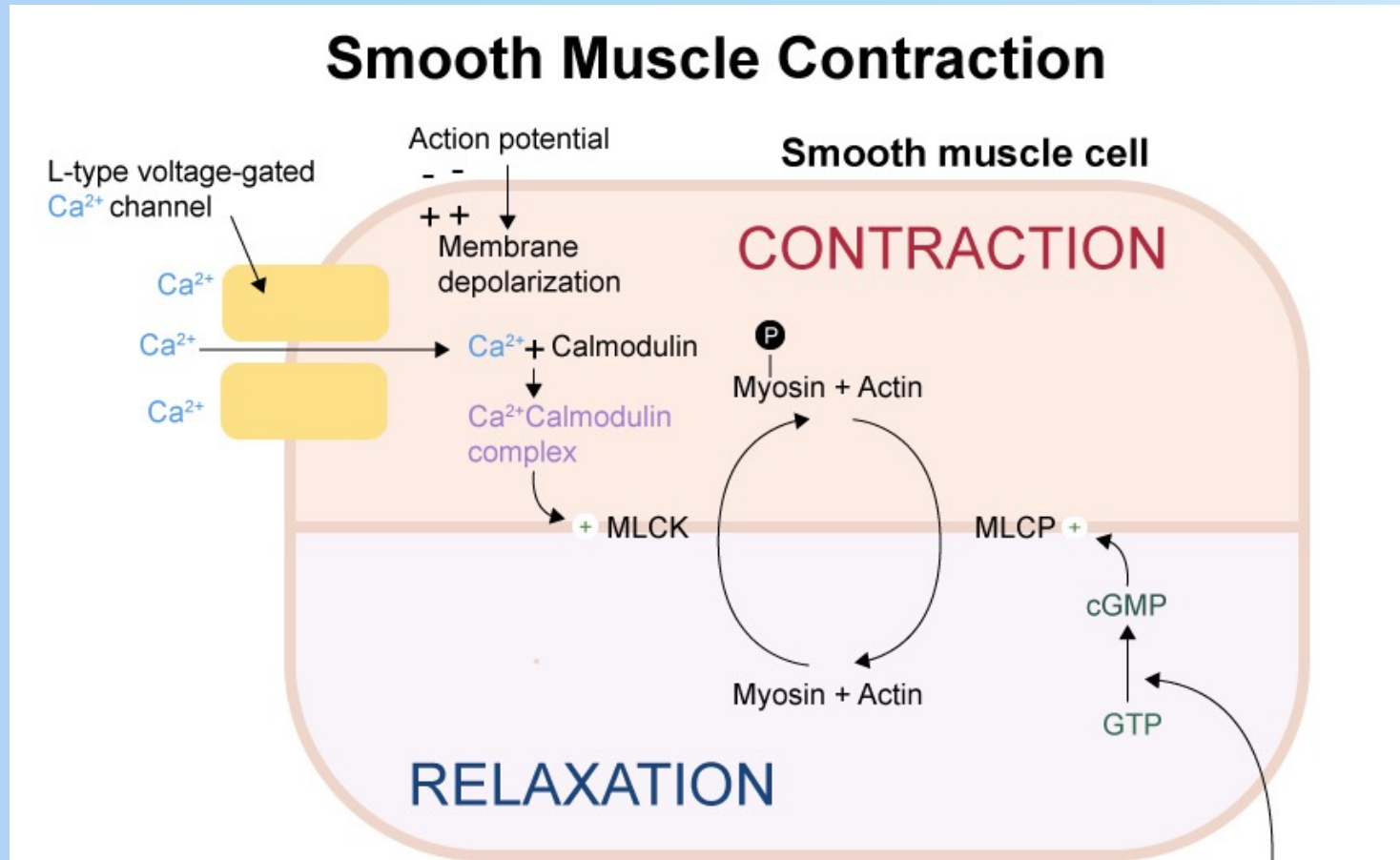


# Smooth muscle

- Depolarization leads to opening of voltage gated calcium channels which induce release of calcium from sarcoplasmic reticulum = calcium induced calcium release
- Tonic vs phasic contraction
- Additional mechanisms that increase calcium - hormone and neurotransmitters



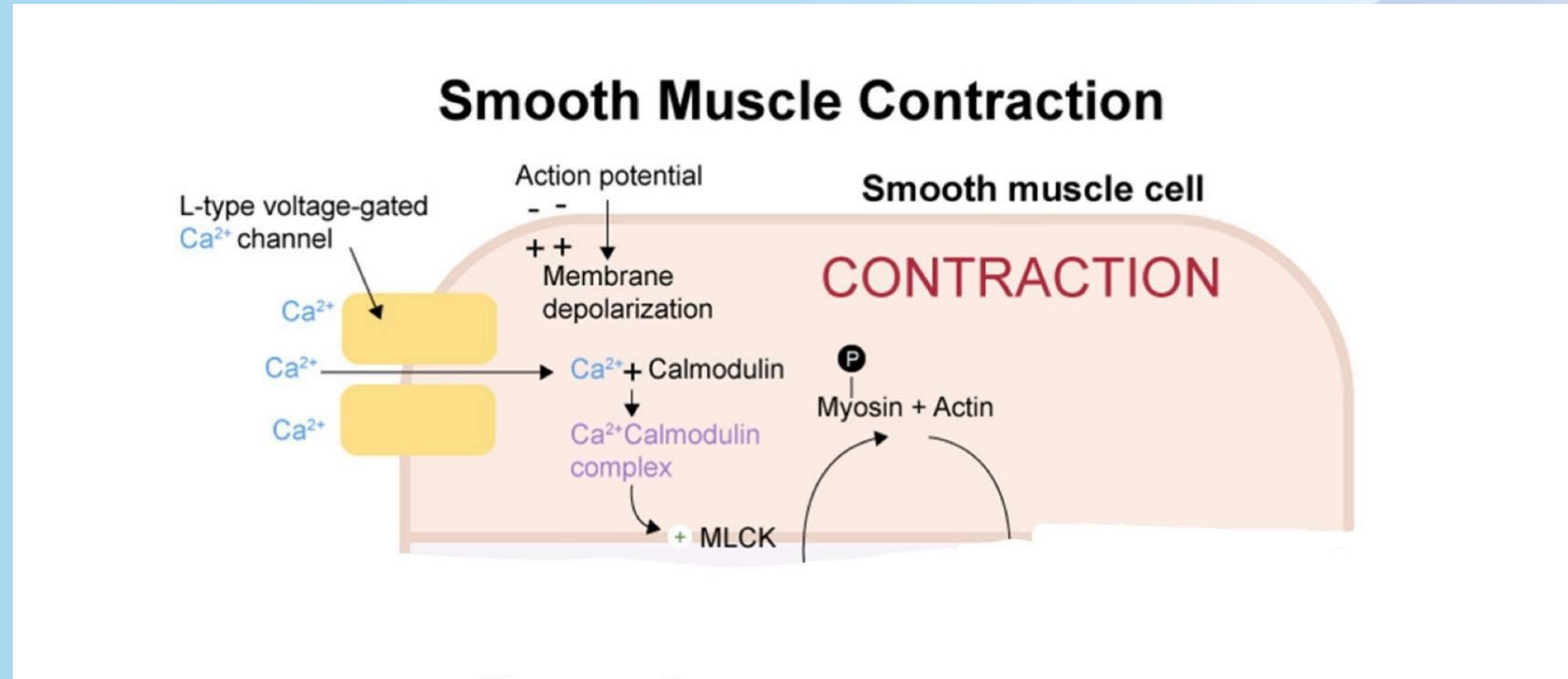
# Smooth muscle contraction



- MLCK = Myosin light chain kinase
- MLCP = Myosin light chain phosphatase
- GTP = Guanosine triphosphate
- cGMP = Cyclic guanosine monophosphate

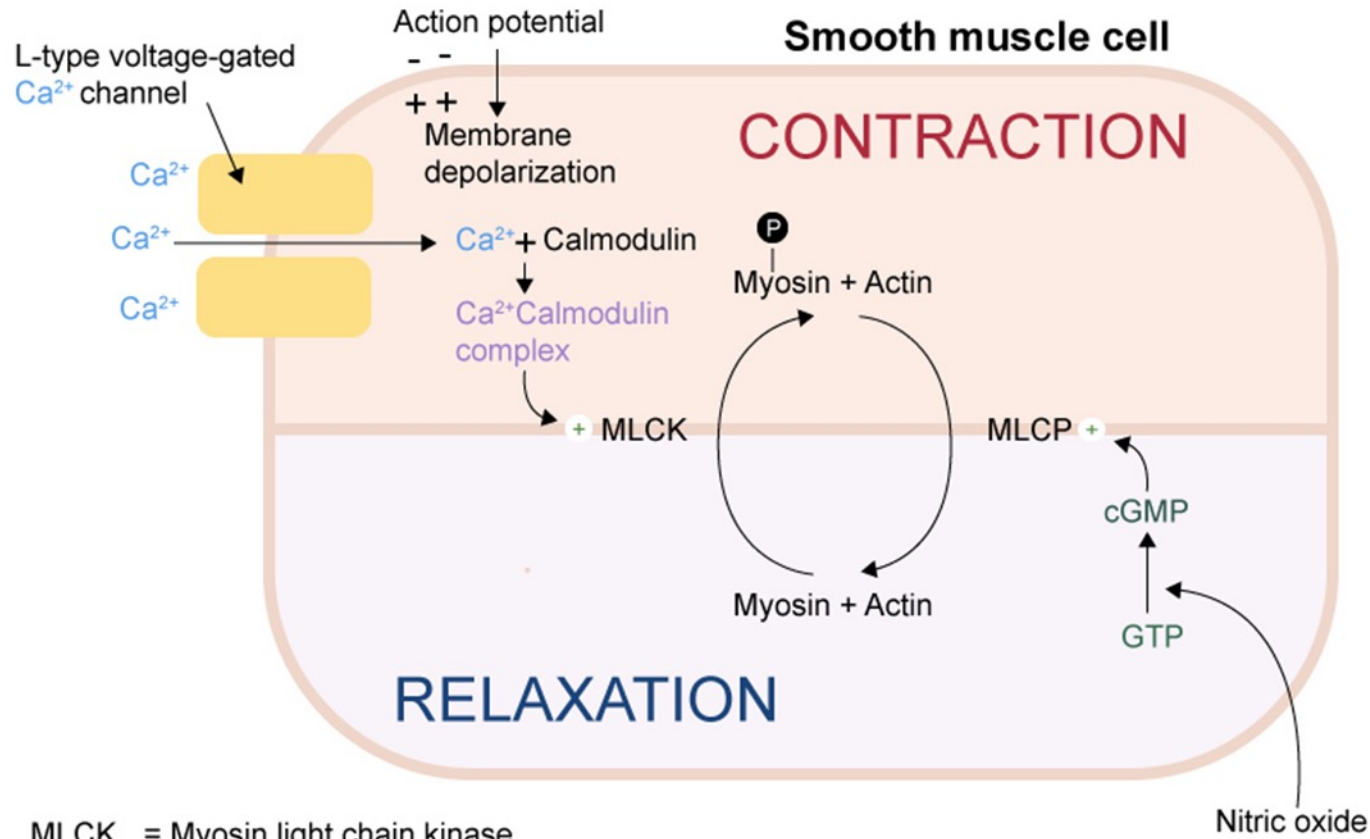
# Smooth muscle contraction

- Calcium influx
- Calcium binds calmodulin
- Activates MLCK
- Phosphorylates myosin light chain
- Cross-bridges form = contraction



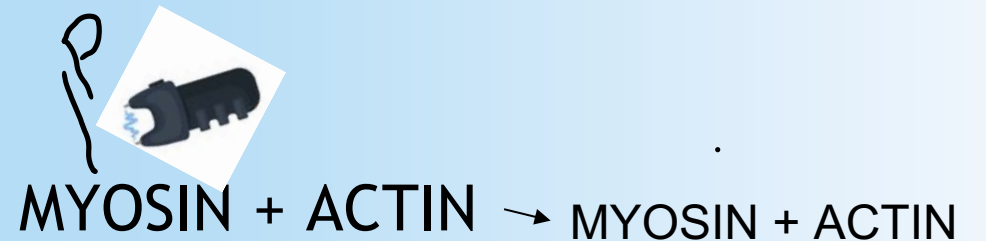
# Smooth muscle relaxation

## Smooth Muscle Contraction



MLCK = Myosin light chain kinase  
 MLCP = Myosin light chain phosphatase  
 GTP = Guanosine triphosphate  
 cGMP = Cyclic guanosine monophosphate

- NO activates guanylyl cyclase, catalyzing cGMP
- cGMP activates MLCP
- Removes phosphate group = no more crossbridges



# Questions



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