

# BI204 CHAP 10

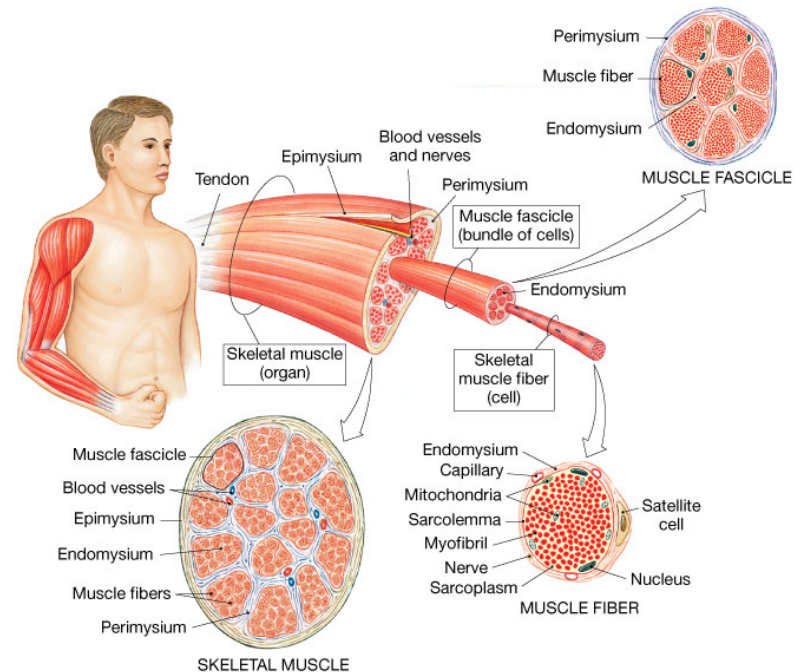
## MUSCLE Tissue - ANATOMY

# Function of Muscle Tissue

- 1) produce skeletal movement – contractions pull on tendons & move the bones
- 2) maintain posture & body position – tension in skeletal muscles maintains body posture
- 3) support soft tissues – support weight of viscera & shield internal organs
- 4) guard entrances & exits – openings of digestive & urinary tracts encircled by skeletal muscles
- 5) maintain body temperature – muscle contractions require energy some of which is converted to heat

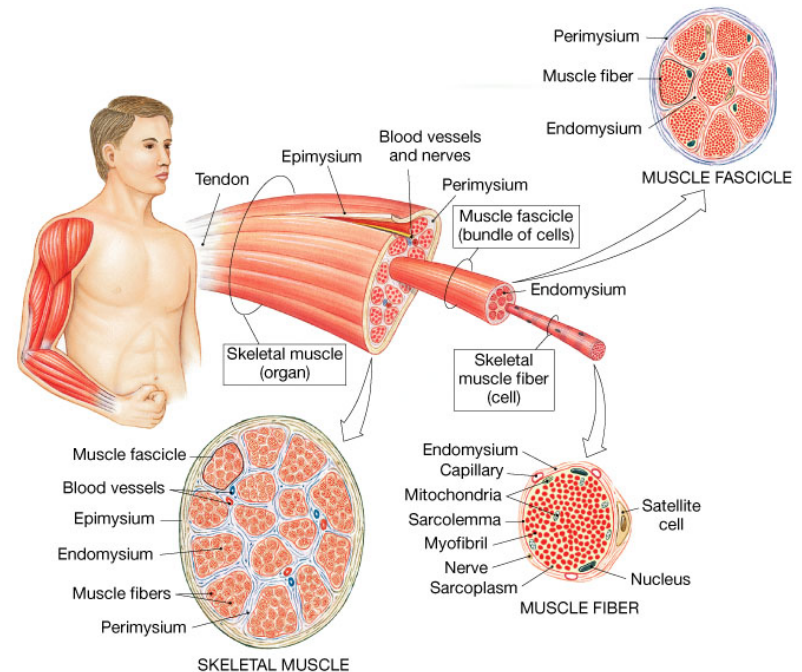
# Muscle Anatomy

- 3 layers of CT are part of each muscle – epimysium, perimysium, endomysium
- Entire muscle surrounded by epimysium – dense layer of collagen fibers which is connected to deep fascia & separates muscle from surrounding tissues & organs



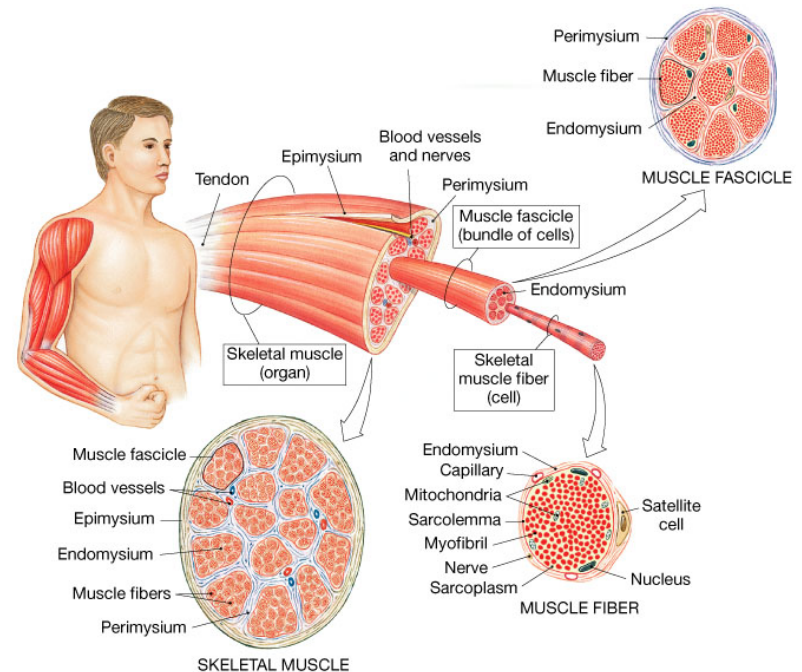
# Muscle Anatomy cont.

- Perimysium divides skeletal muscle into compartments called fascicles containing a bundle of muscle fibers. Perimysium contains collagen & elastic fibers & blood vessels & nerves.



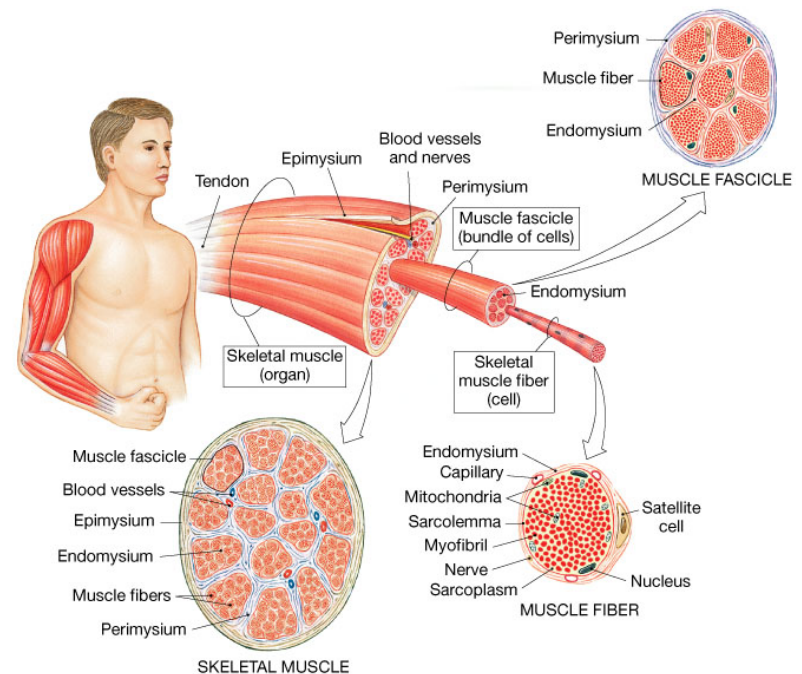
# Muscle Anatomy cont.

- Endomysium surrounds individual muscle cells or muscle fibers consists of fine delicate CT & contains capillary network supplying blood & satellite cells which are stem cells that function in repair of damaged muscle & nerve fibers that control the contraction of the muscle



# Muscle Anatomy cont.

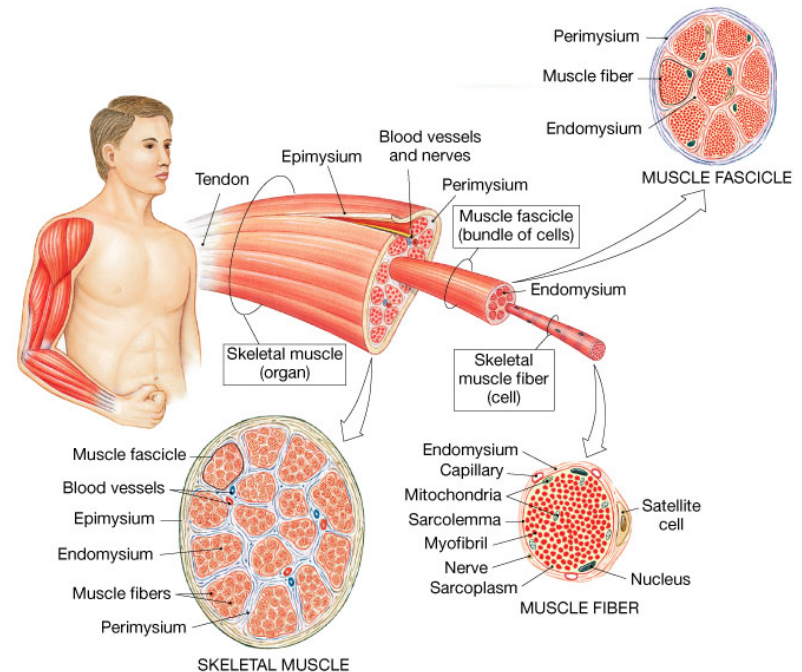
- Collagen fibers of endomysium & perimysium are interwoven & at end of muscle collagen fibers of endo-, peri-, & epimysium form a bundle called tendon or aponeurosis both of which attach skeletal muscle to bones where collagen fibers extend into bone matrix for firm attachment



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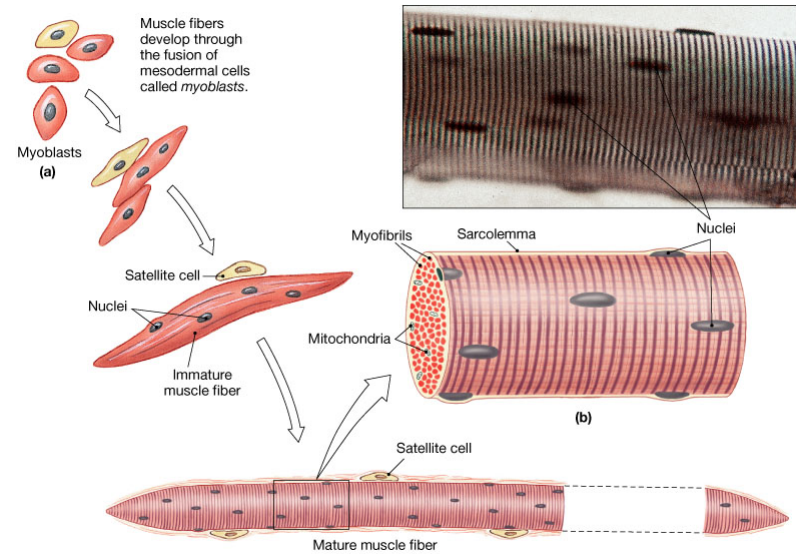
# Muscle Anatomy – Blood Vessels & Nerves

- CT of epi- & perimysium contain blood vessels & nerve fibers blood vessels bring nutrients & oxygen & carry away wastes & nerve fibers are absolutely necessary for contraction as skeletal muscles are voluntary but some are controlled at subconscious level



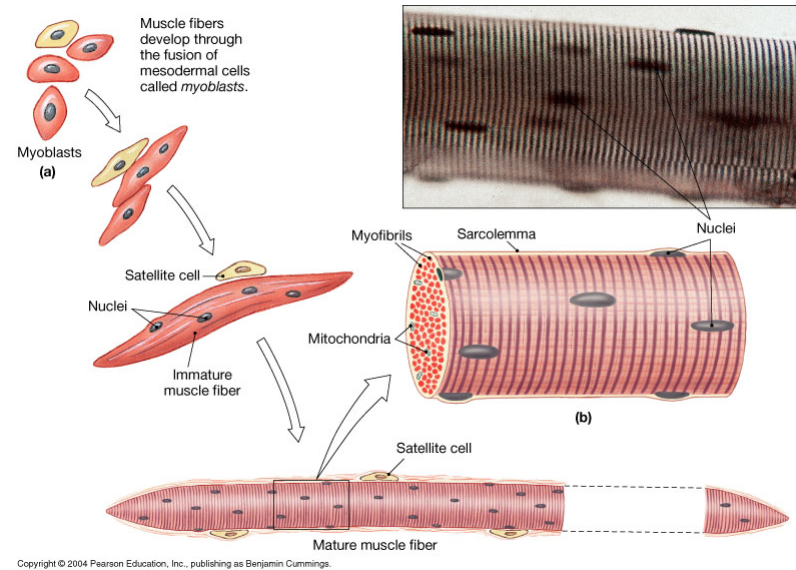
# Muscle Microanatomy

- Skeletal muscle fibers or cells are very large – 100 micrometers in diameter & up to 12” in length- and multinucleate because metabolic turnover is very rapid in skeletal muscle fibers



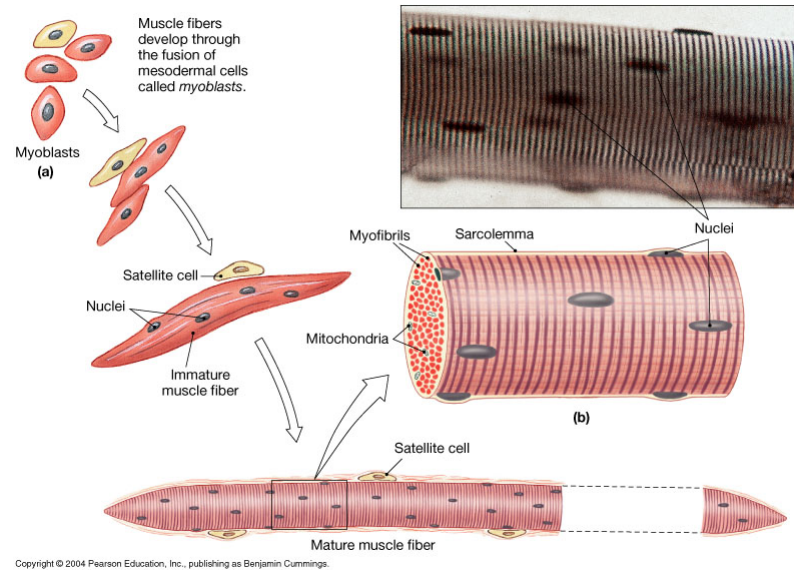
# Muscle Microanatomy

- In development embryonic myoblasts fuse forming skeletal muscle fibers so each nucleus comes from a single myoblast
- Other myoblasts do not fuse but become satellite cells in adult where can fuse with injured muscle cells & help with repair



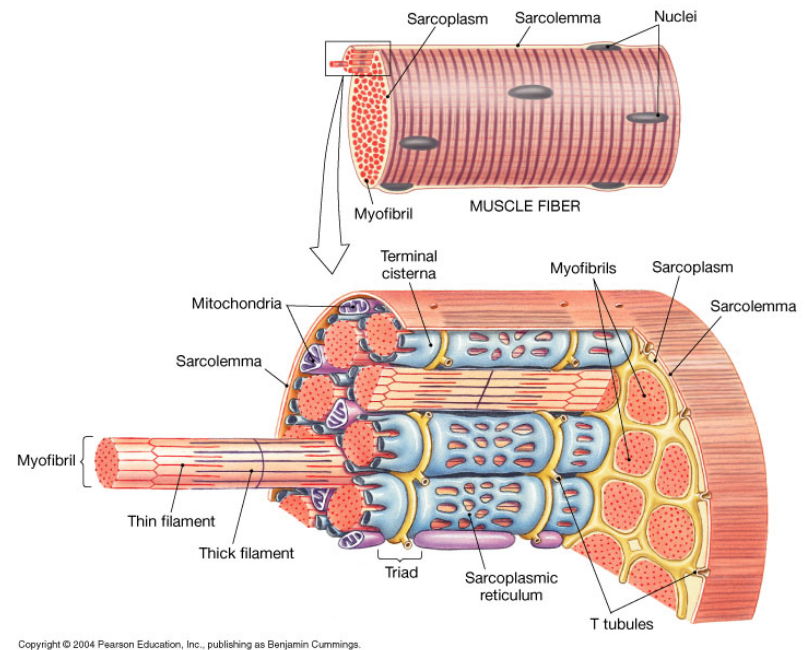
# Muscle Microanatomy cont.

- Sarcolemma – cell membrane of muscle cell surrounds sarcoplasm – cytoplasm of muscle cell
- Sarcolemma has transmembrane potential across the membrane due to unequal distribution of + & - charges across membrane



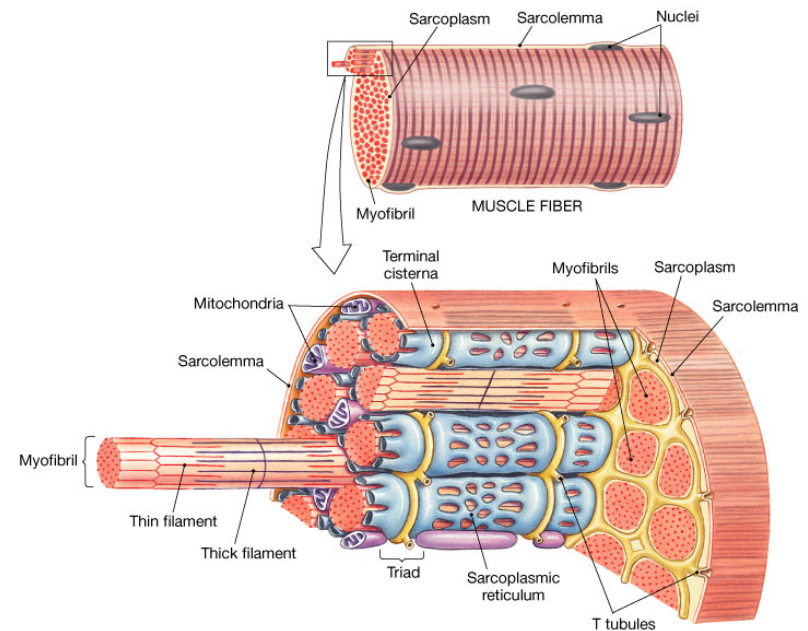
# Muscle Microanatomy cont.

- All regions of large muscle cell must contract at same time so signal to contract must be distributed rapidly – done by transverse or T tubules – narrow tubes continuous with sarcolemma & extending into sarcoplasm at right angles T tubules filled with extracellular fluid & have same properties as sarcolemma so conduct impulses



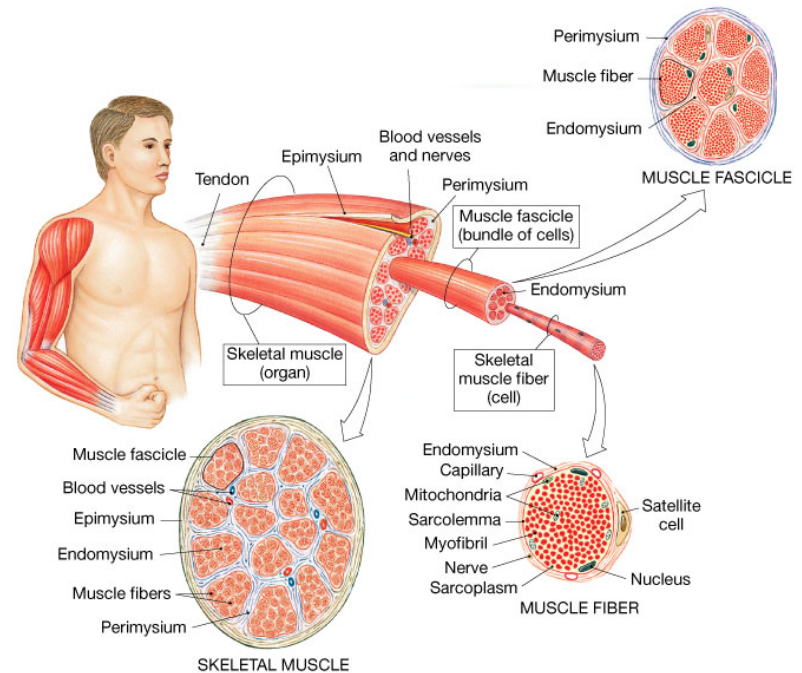
# Muscle Microanatomy cont.

- Myofibrils – cylindrical structures as long as the cell
- Consist of bundles of myofilaments – protein filaments composed of thin & thick filaments



# Muscle Microanatomy cont.

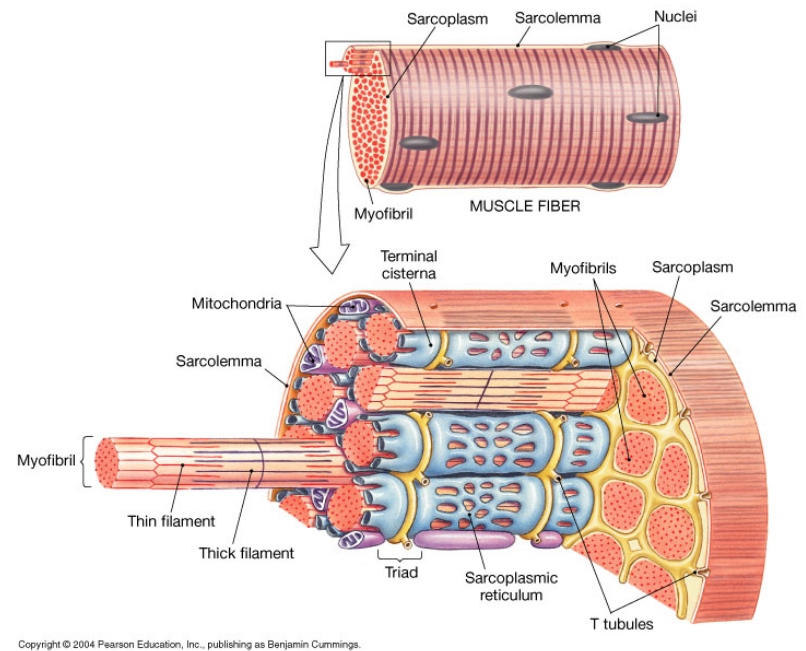
- Actin forms the bulk of the thin filaments & myosin forms thick filaments
- Myofibrils anchored to inner surface of sarcolemma at the ends of muscle cell and outer surface attached to collagen fibers of tendon or aponeurosis so when myofibrils contract muscle cell shortens



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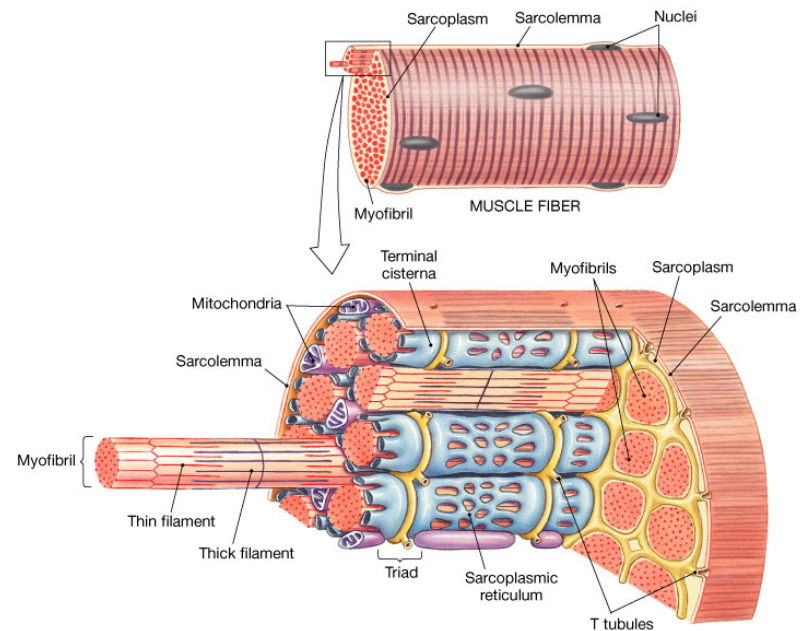
# Muscle Microanatomy cont.

- Muscle cells also have mitochondria & granules of glycogen scattered around myofibrils
- When a T tubule circles a myofibril, the T tubule is bound to the membranes of the sarcoplasmic reticulum – a membrane complex similar to smooth endoplasmic reticulum



# Muscle Microanatomy cont.

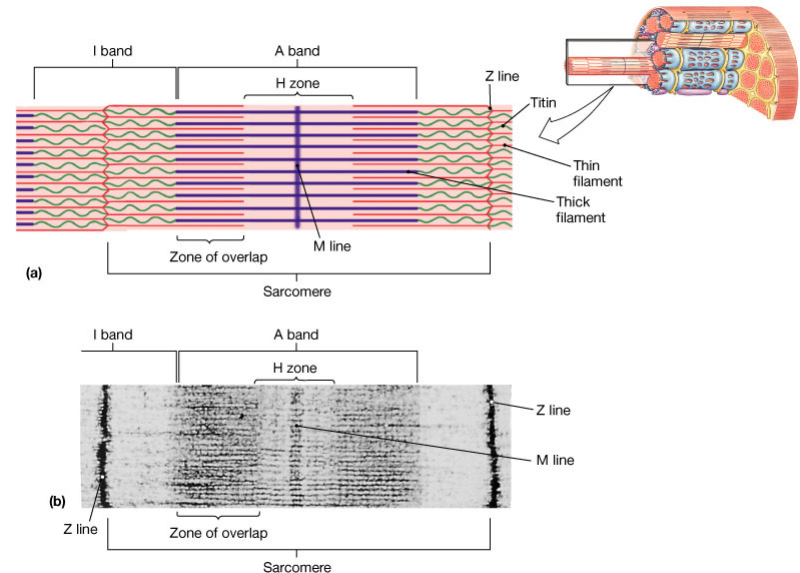
- SR forms tubular network around every myofibril & on either side of T tubule the tubule of the SR enlarge, fuse, & form expanded chambers called terminal cisternae & combination of pair of terminal cisternae & a T tubule called a triad where fluid compartments are separate



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# Muscle Microanatomy cont.

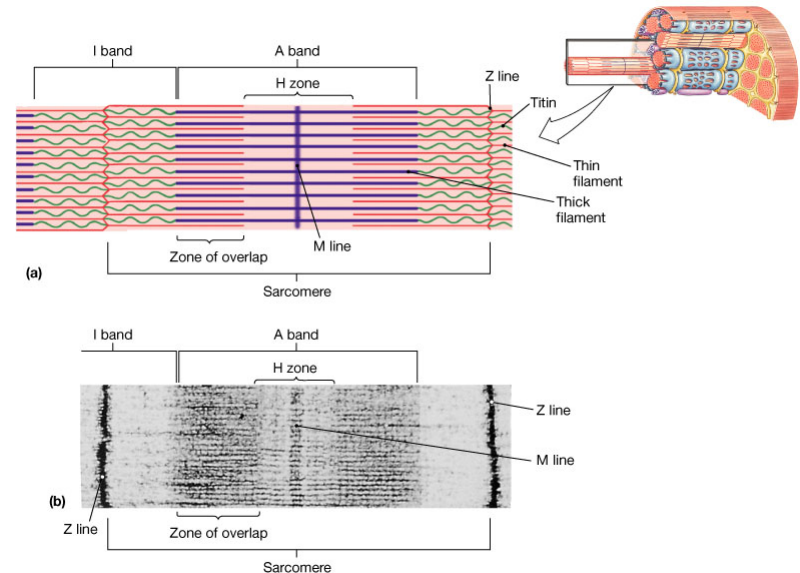
- Muscle cell pumps calcium ion out of sarcoplasm into terminal cisternae of SR which also has protein called calsequestrin which reversibly binds calcium ion
- Muscle contraction begins when stored calcium ion released into sarcoplasm & diffuse into contractile units called sarcomeres



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# Muscle Microanatomy cont.

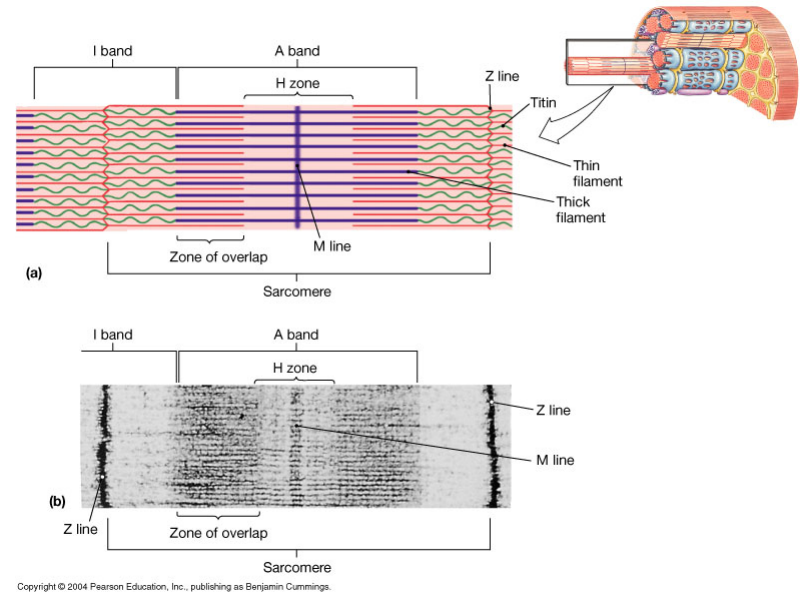
- Sarcomeres – repeating functional units of thick & thin filaments responsible for muscle contraction
- Sarcomere contains thick filaments, thin filaments, proteins that regulate interaction between thin & thick filaments
- Differences in size, density, & distribution of thick & thin filaments accounts for banded appearance



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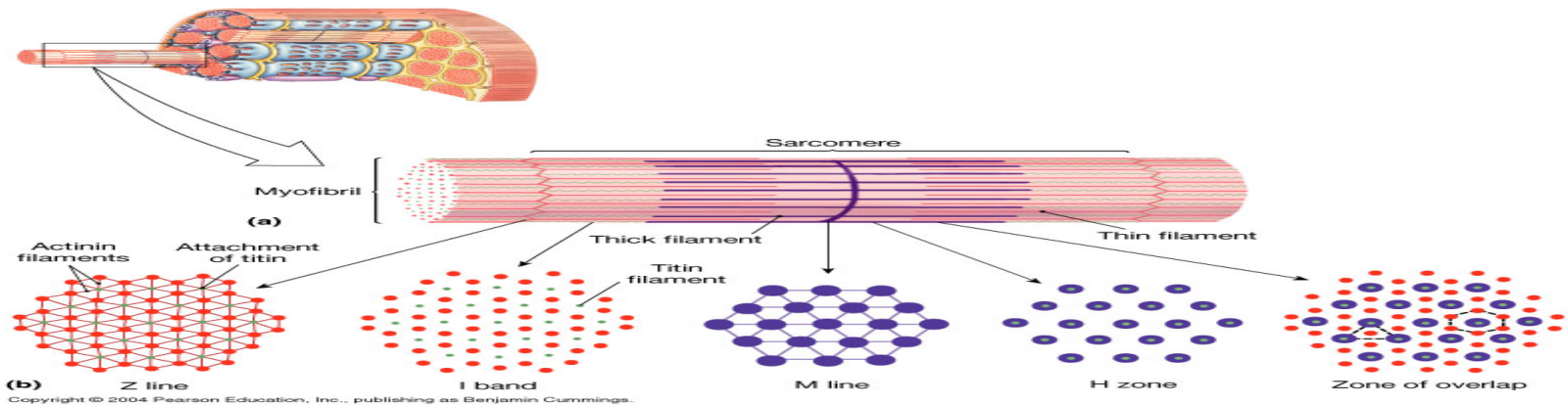
# Muscle Microanatomy cont.

- Sarcomere has dark or A bands & light or I bands
- A band – in center of sarcomere & contains 3 subdivisions – M line – proteins of M line connect central portion of each thick filament H zone - on either side of M line containing thick filaments but no thin filaments



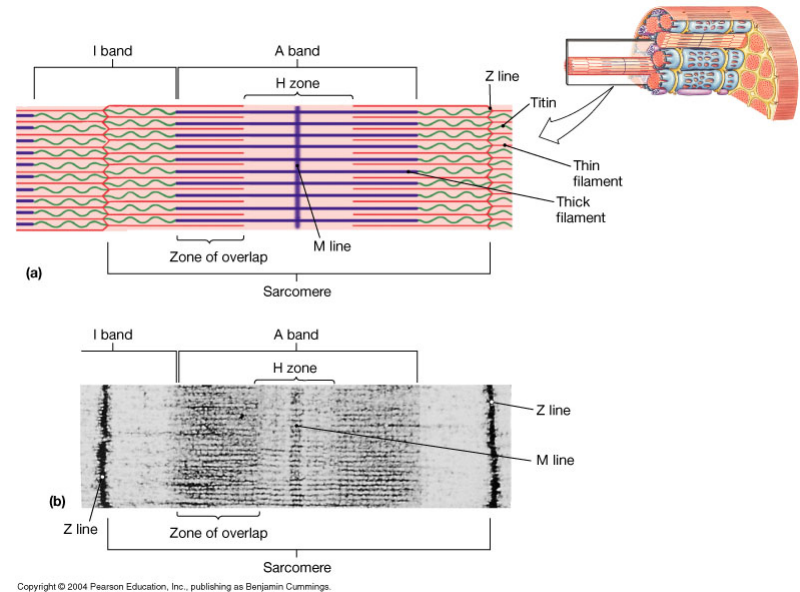
# Muscle Microanatomy cont.

- Sarcomere also has Zone of Overlap where thin filaments are situated between 3 thick filaments & each thick filament surrounded by 6 thin filaments



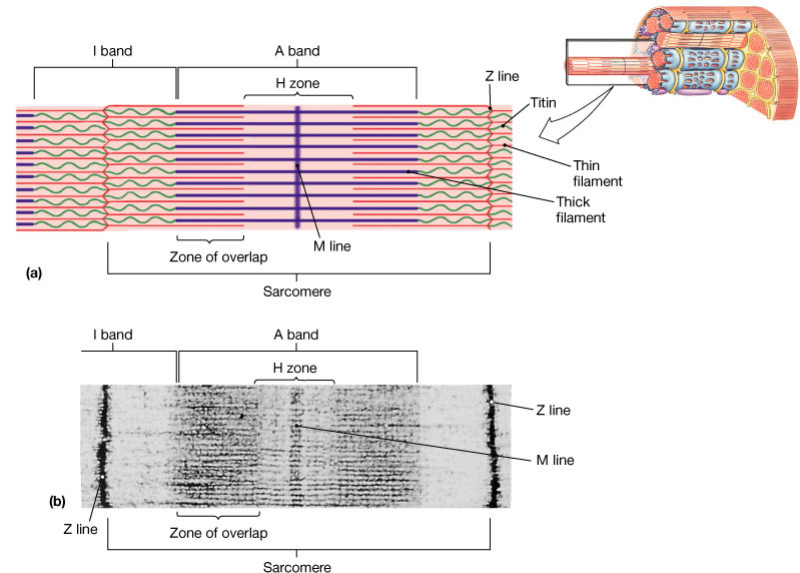
# Muscle Microanatomy cont.

- I band – contains thin but not thick filaments & extends from A band of 1 sarcomere to A band of next sarcomere & Z lines mark boundary between sarcomeres
- Z line consists of proteins called actinins which interconnect thin filaments of adjacent sarcomeres



# Muscle Microanatomy cont.

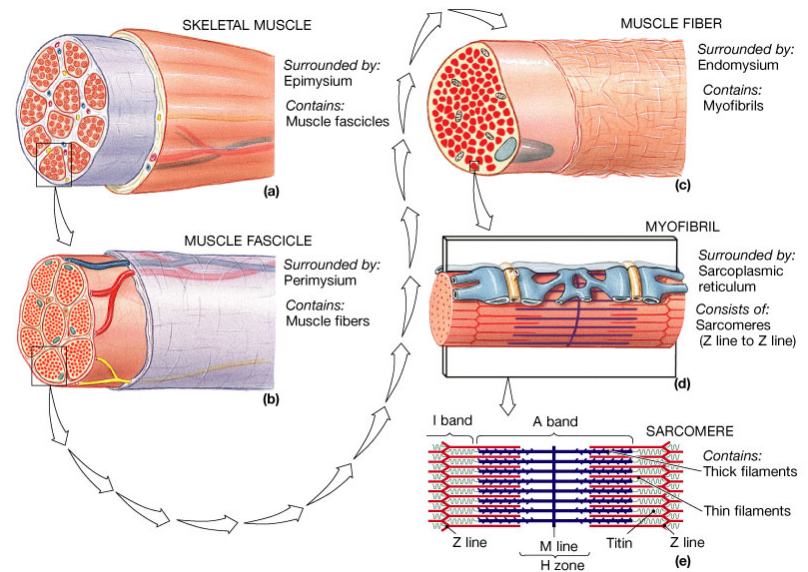
- From Z line thin filaments extend to M line & into zone of overlap & strands of the protein titin extend from tips of thick filaments to attachment sites at Z line & function to keep thick & thin filaments aligned & helps muscle fiber resist extreme stretch



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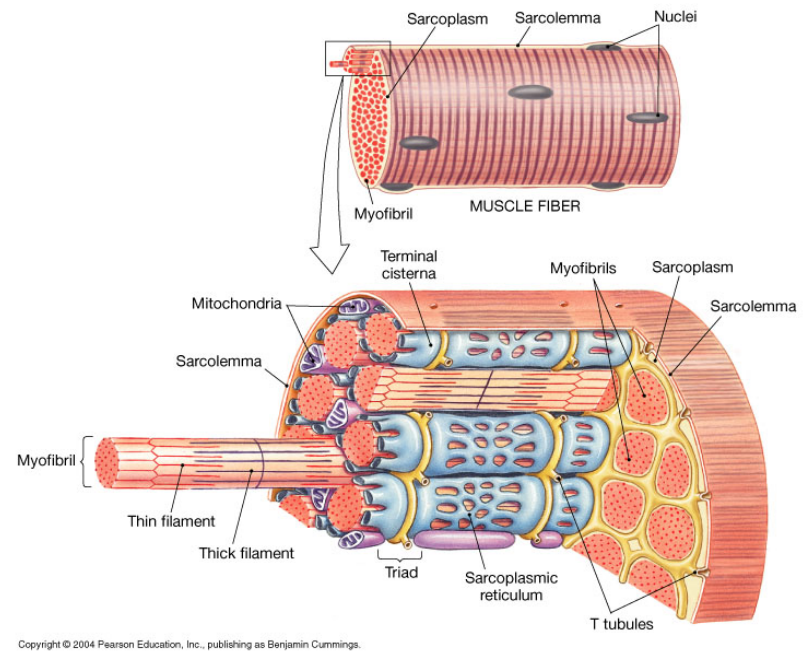
# Muscle Microanatomy cont.

- 2 T tubules encircle each sarcomere & triads located on each side of M line at zone of overlap so calcium ion gets released by SR onto regions where thick & thin filaments interact



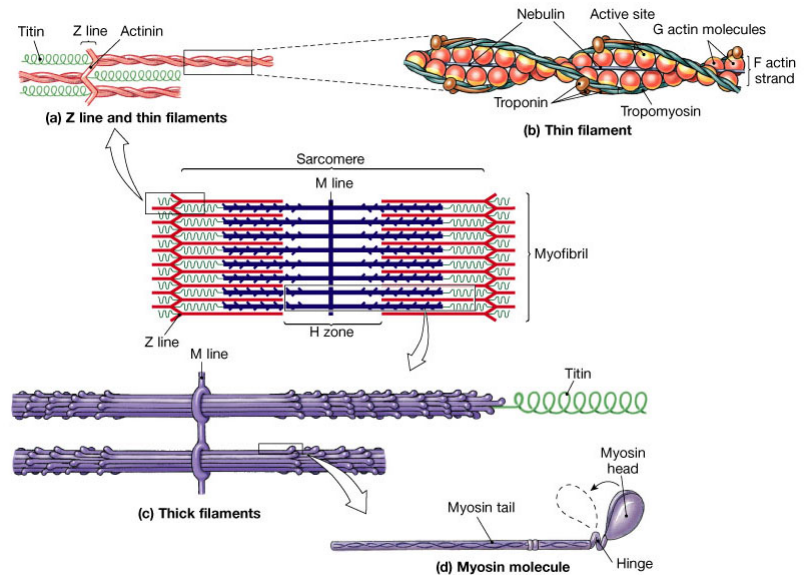
# Muscle Microanatomy cont.

- Z lines surrounded by meshwork of intermediate filaments that connect adjacent myofibrils & myofibrils closest to sarcolemma are bound to attachment sites inside plasma membrane & all Z lines of all myofibrils aligned in same way so see banding pattern called striations



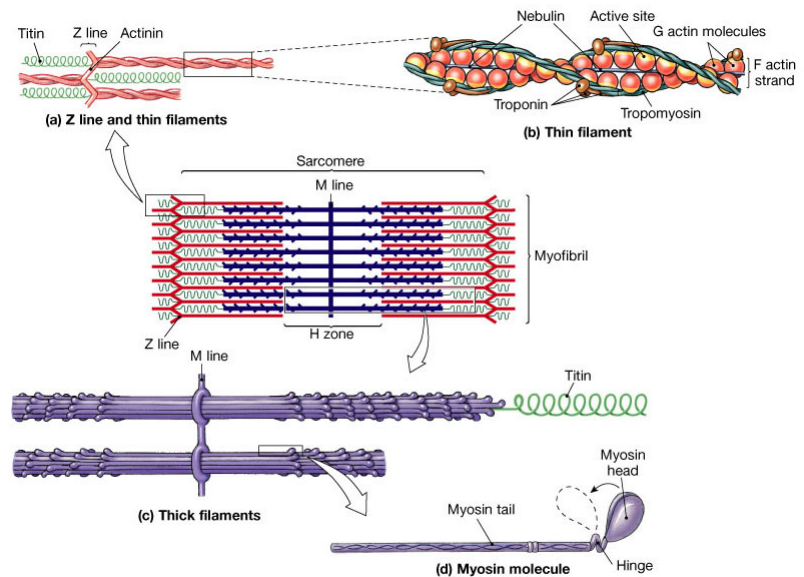
# Muscle Microanatomy cont.

- Thin filaments – contains 4 proteins – F actin, nebulin, tropomyosin, troponin complex  
F actin – several hundred globular molecules of G actin & strand of nebulin spirals the F actin in the groove between G actin molecules & holds the G actin molecules together



# Muscle Microanatomy cont.

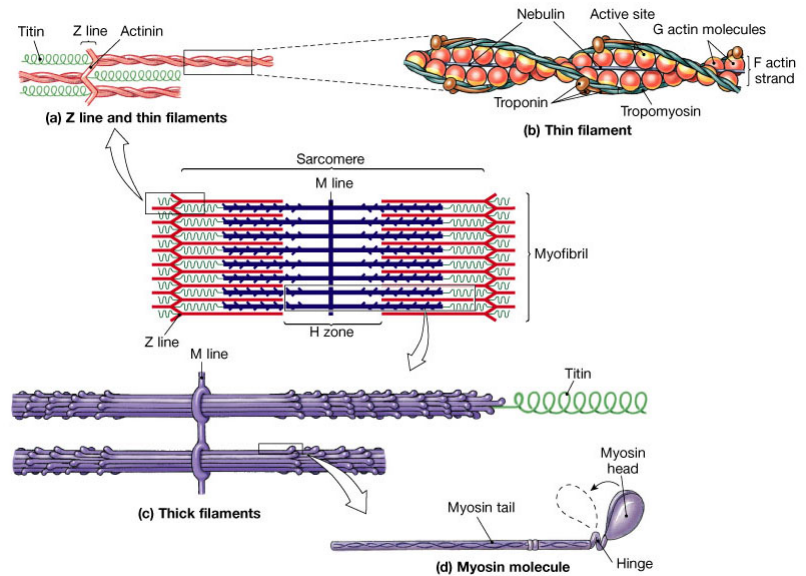
- G actin molecules have an active binding site for myosin but in resting condition the site is blocked by tropomyosin – double stranded protein covers 7 active sites & prevents binding & is attached to troponin at mid point



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# Muscle Microanatomy cont.

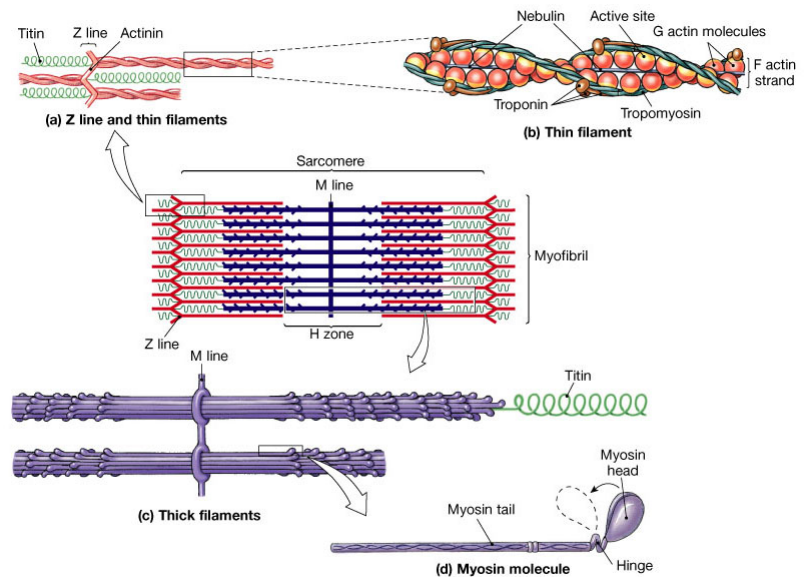
- Troponin – consists of 3 globular subunits - 1 binds to tropomyosin forming troponin-tropomyosin complex 2<sup>nd</sup> binds to a G actin holding complex in place & 3<sup>rd</sup> binds calcium ions & binding site is empty in resting muscle



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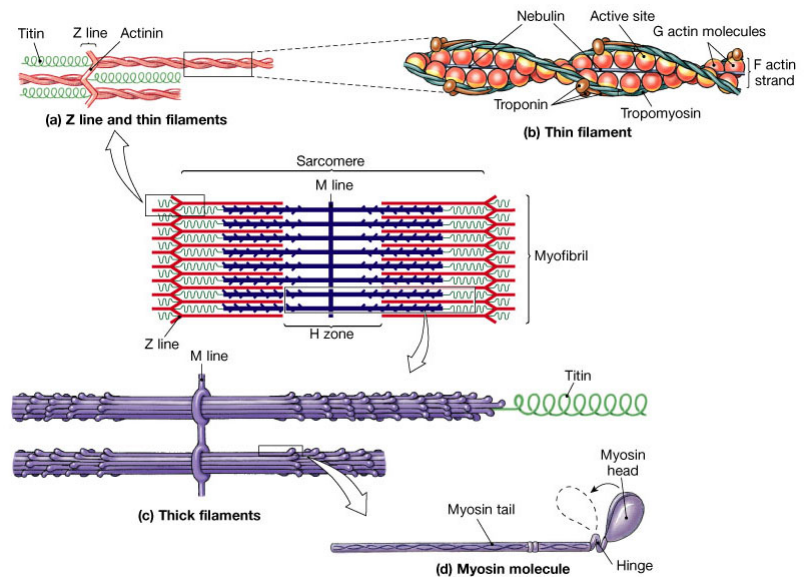
# Muscle Microanatomy cont.

- Contraction occurs only when position of T-T complex changes exposing active binding sites & change occurs when calcium ion binds to troponin



# Muscle Microanatomy cont.

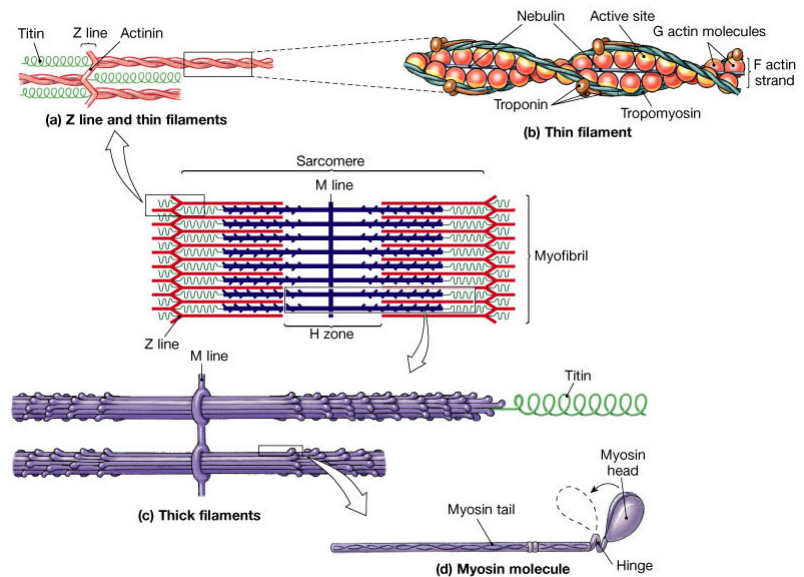
- Thick filaments – contains myosin molecules consisting of 2 myosin subunits twisted together the long tails are bound together in the thick filament & the globular head projects out toward the nearest thin filament & consists of 2 protein subunits myosin heads interact with thin filaments during contraction & are called cross-bridges & the connection between the head & tail acts as a hinge



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# Muscle Microanatomy cont.

- Tails of myosin molecules arranged toward M line & H zone includes central region without myosin heads
- Each thick filament has a core of titin which goes from M line to Z line & is elastic in region of I band in resting sarcomere titin is relaxed



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