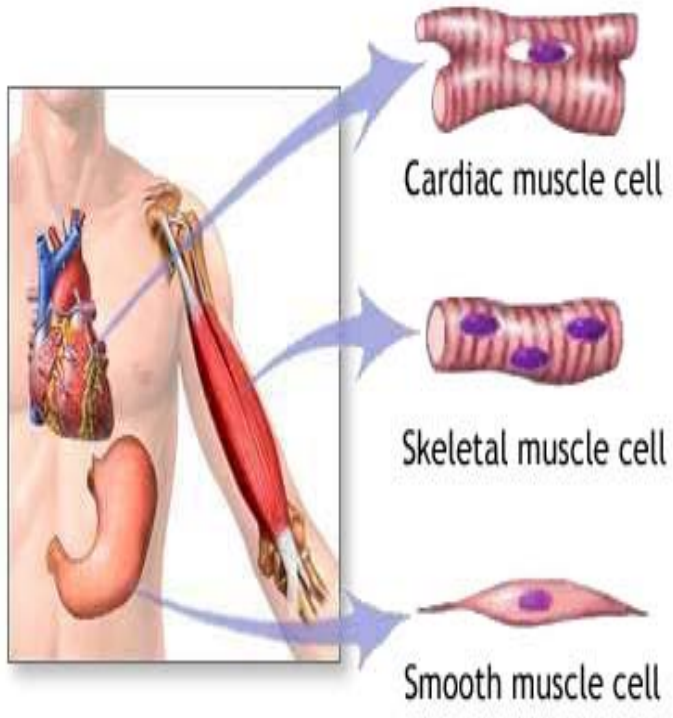
Muscular tissue

- It is one of the four basic types of tissues.
- Responsible for locomotion and movement of the various body parts.

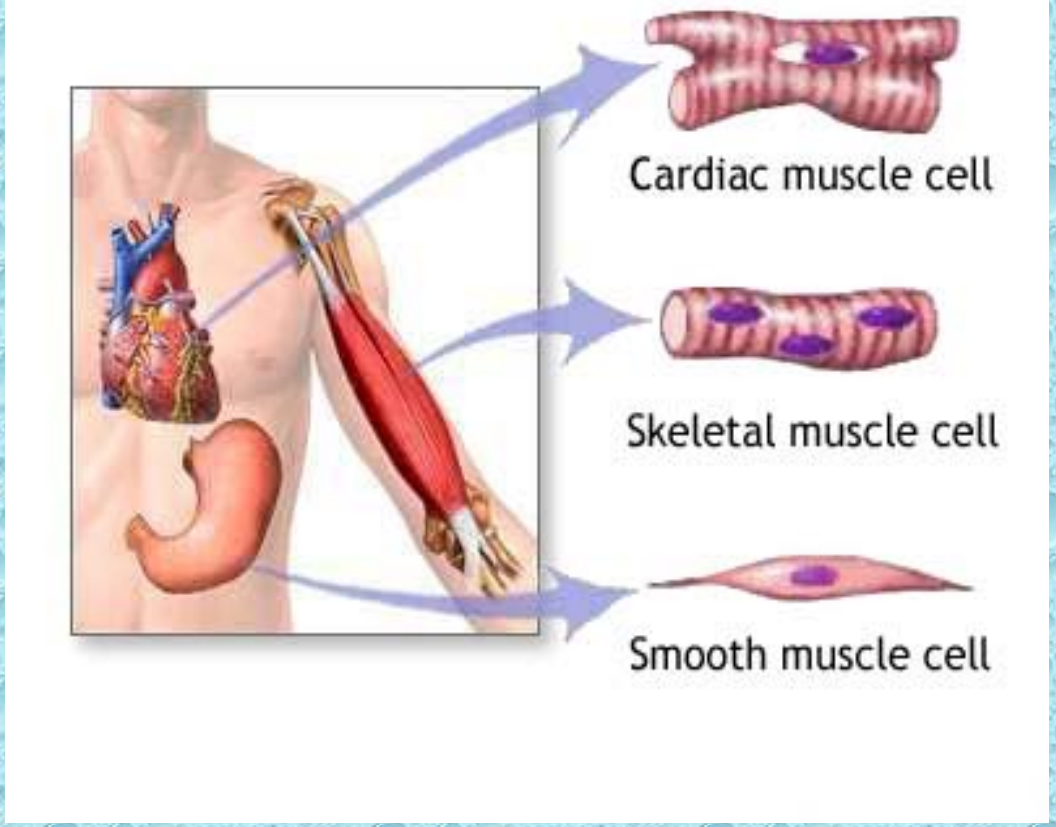
General features

- The structural and functional units of muscles are formed of special elongated cells called muscle fiber.
- Its cell membrane is called sarcolemma, and its cytoplasm is called sarcoplasm.
- The sarcoplasm contains contractile elements called myofibrils.
- The myofibrils are formed of myofilaments (thin actin and thick myosin).



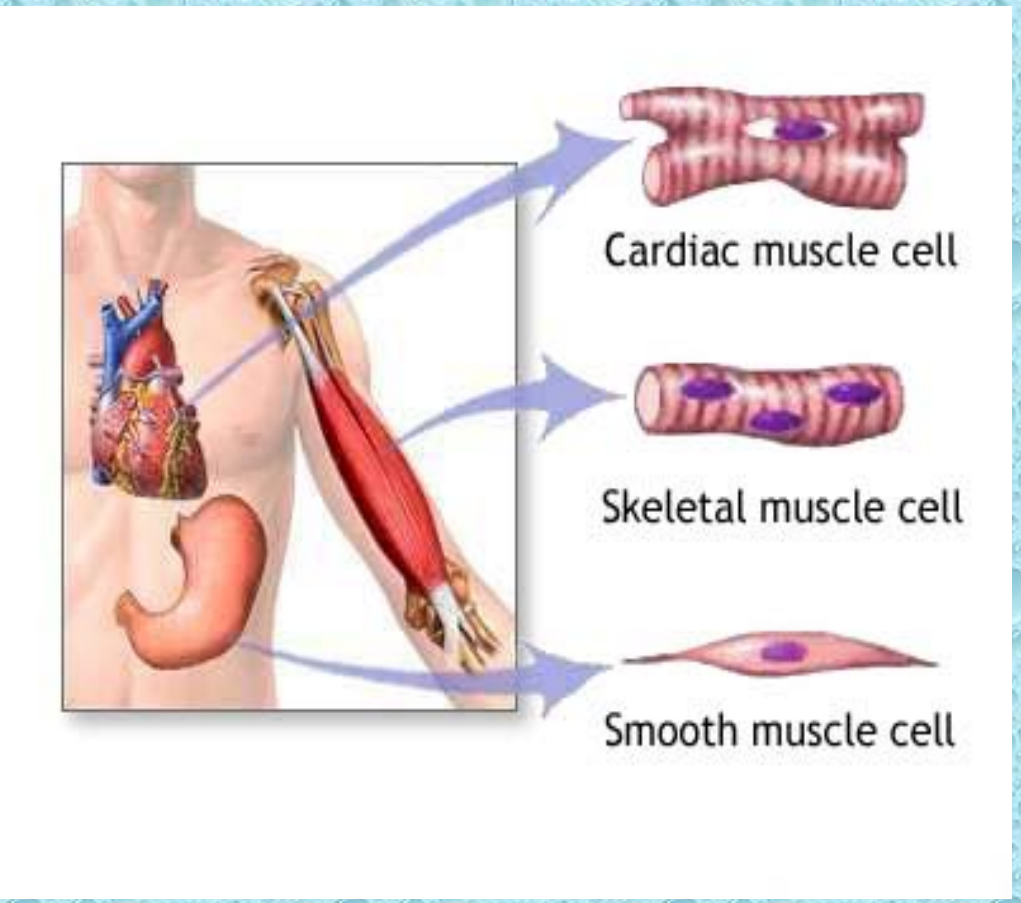
General features

- There are three types of muscle tissue:
- **Skeletal muscles**
- **Cardiac muscles**
- **Smooth muscles**



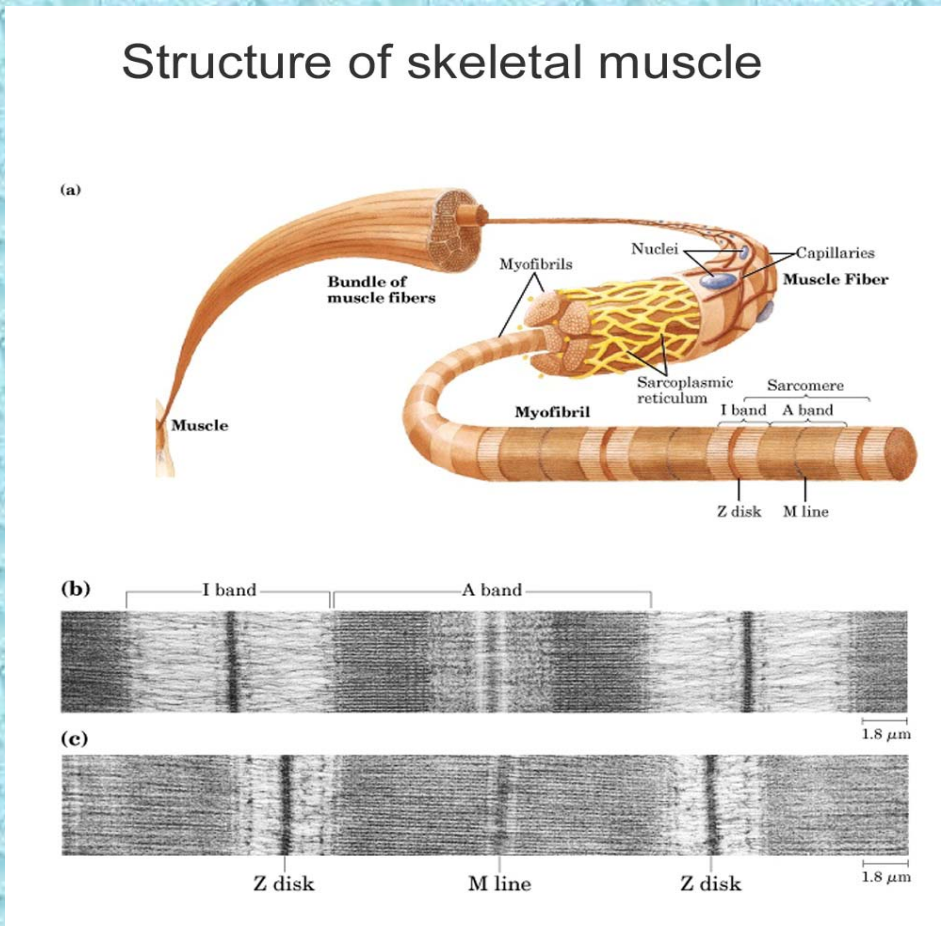
Skeletal muscle (Striated and voluntary myofibers)

- They are found in all skeletal muscles, tongue larynx, pharynx and eye.



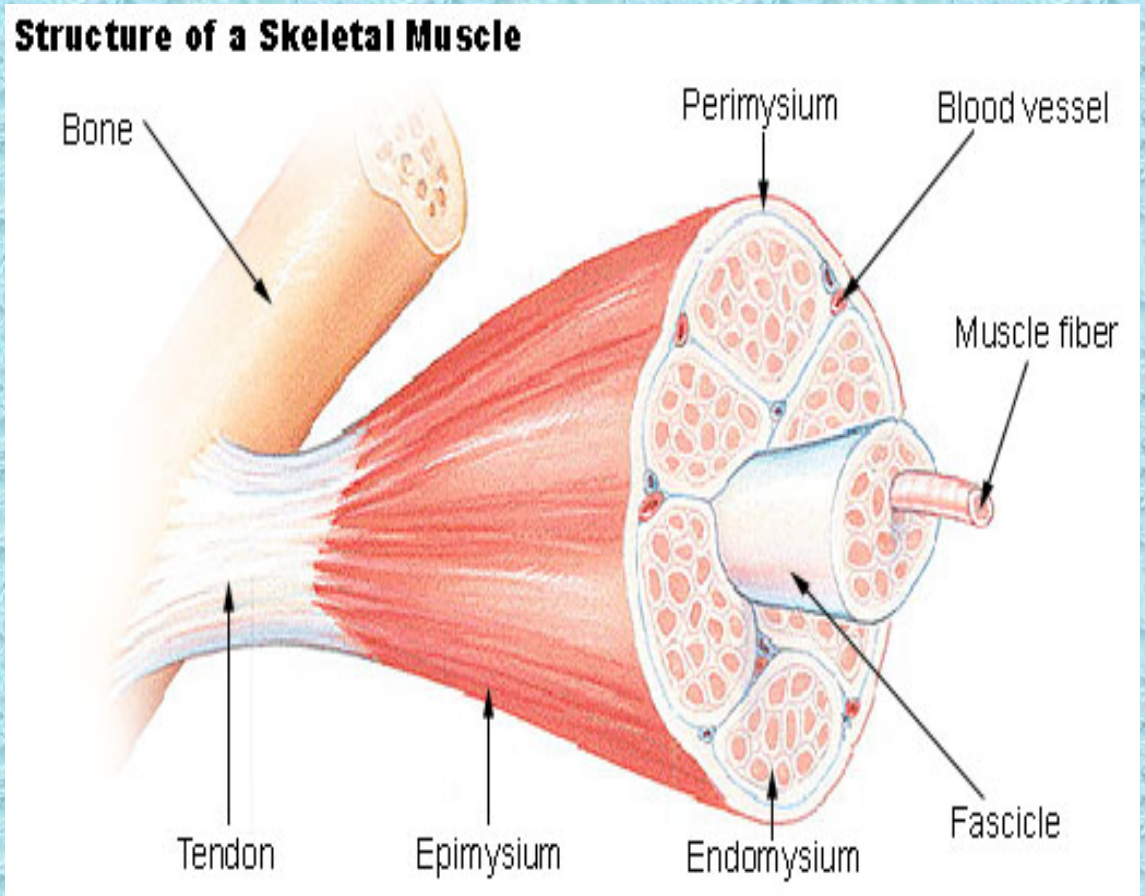
Skeletal muscle (Striated and voluntary myofibers)

- **Skeletal:** its contraction moves some parts of the skeleton.
- **Voluntary:** its contraction is under conscious control.
- **Striated:** its fiber shows alternating dark and light bands called cross-striation.



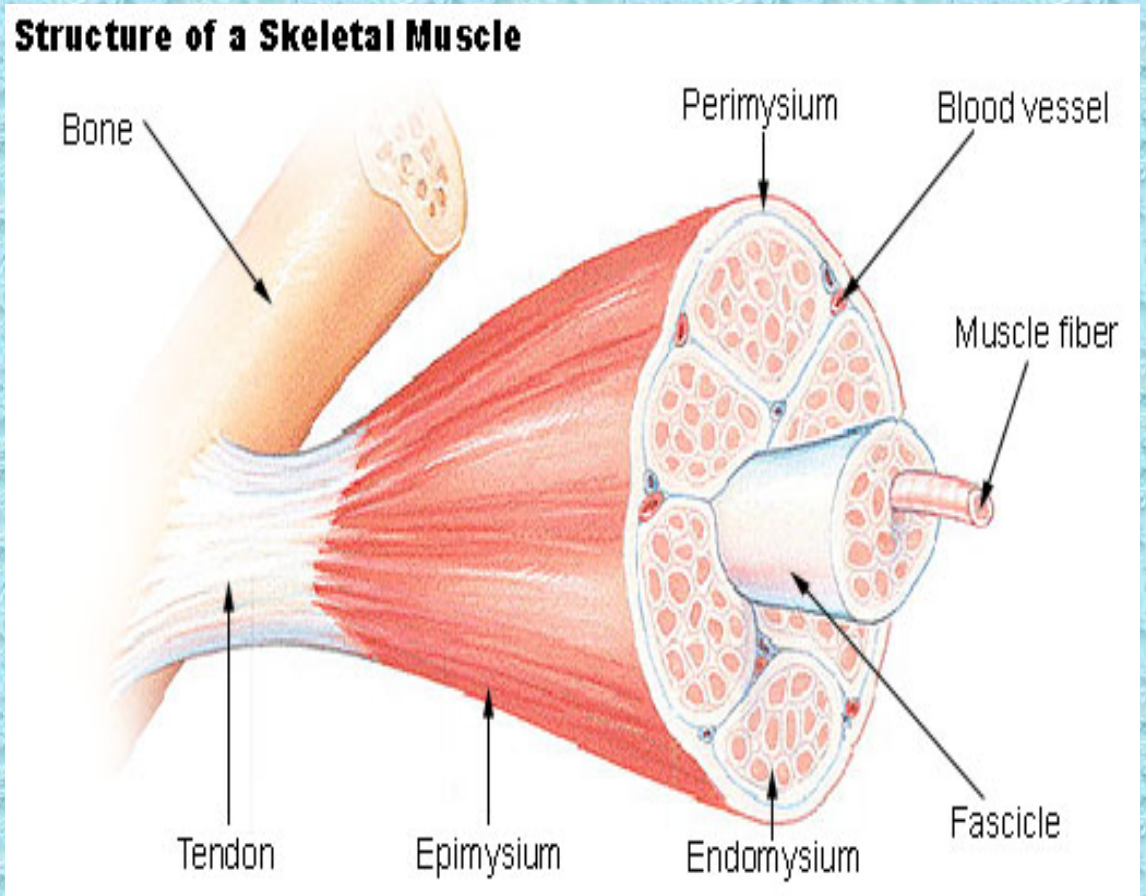
Skeletal muscle (Striated and voluntary myofibers)

- Composed of:
- Skeletal myofibers.
- Connective tissue.
- A sheath of dense connective tissue called epimysium encloses the entire muscle.



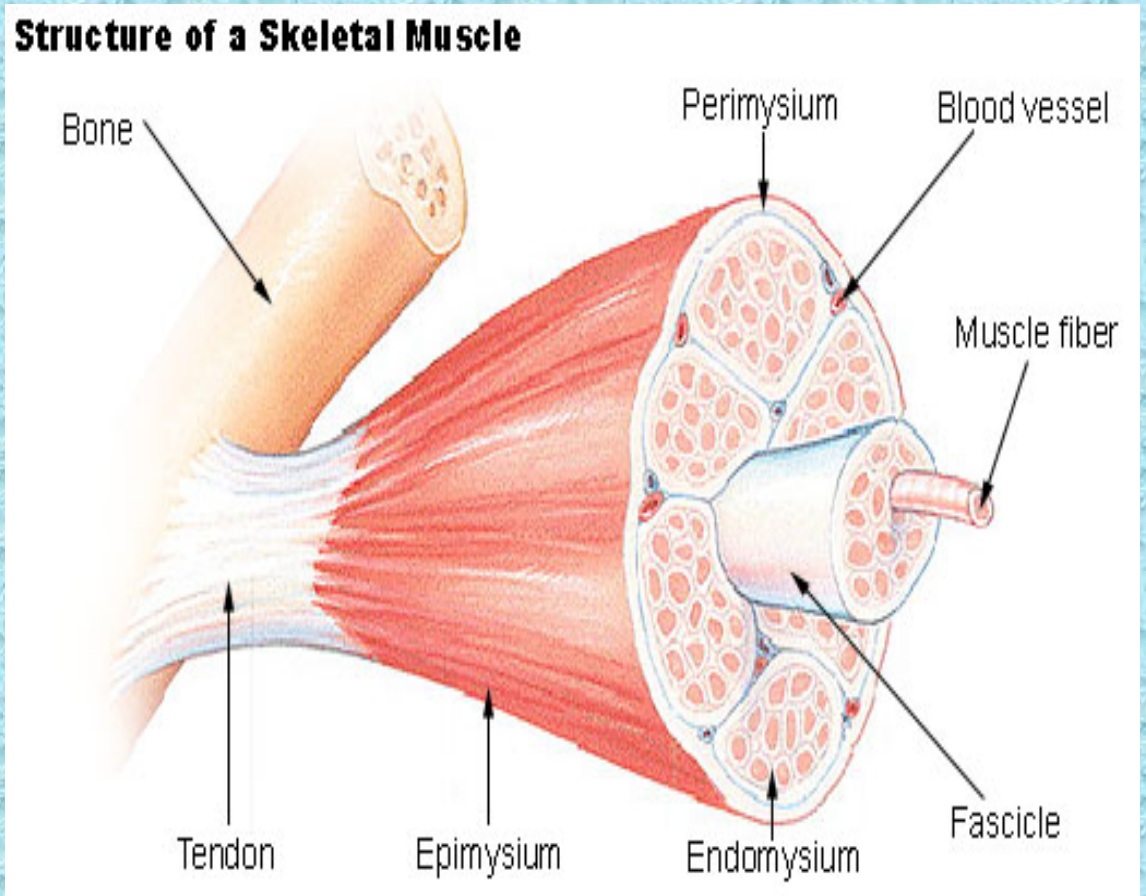
Skeletal muscle (Striated and voluntary myofibers)

- From the epimysium, thin collagenous septa extend inward to divide the muscle into a number of bundles or fascicles.
- These septa are called the perimysium.



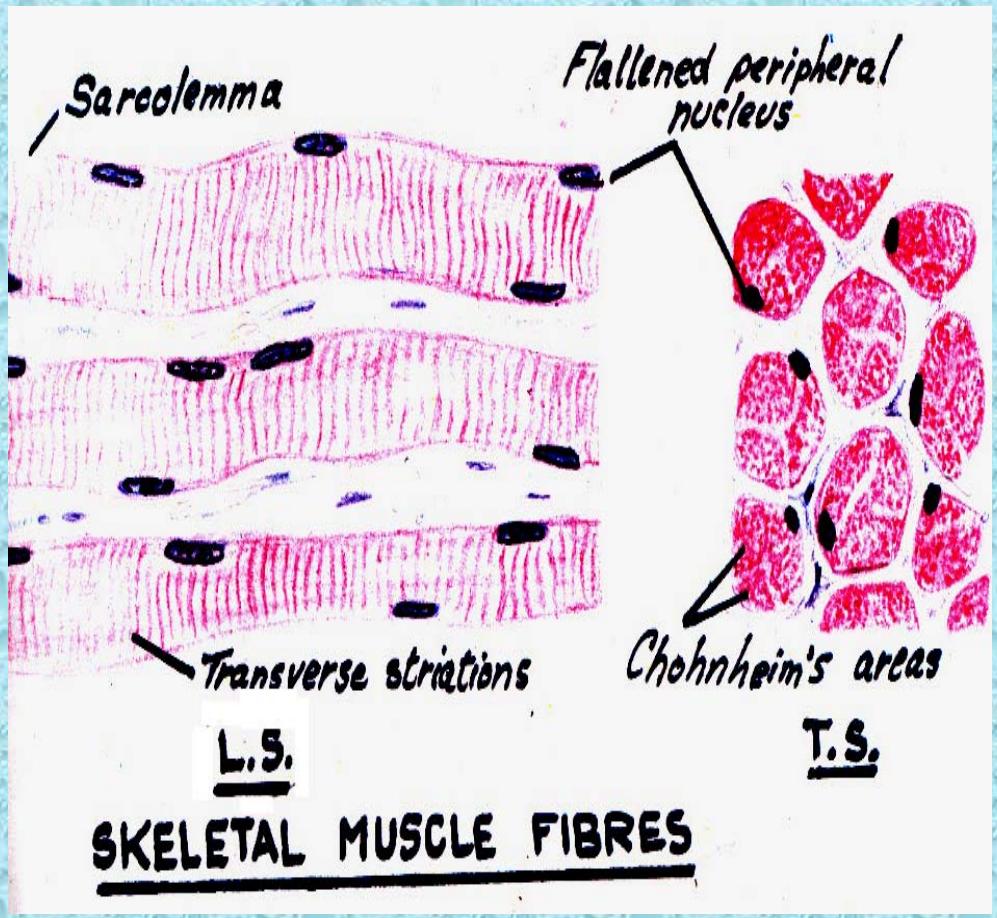
Skeletal muscle (Striated and voluntary myofibers)

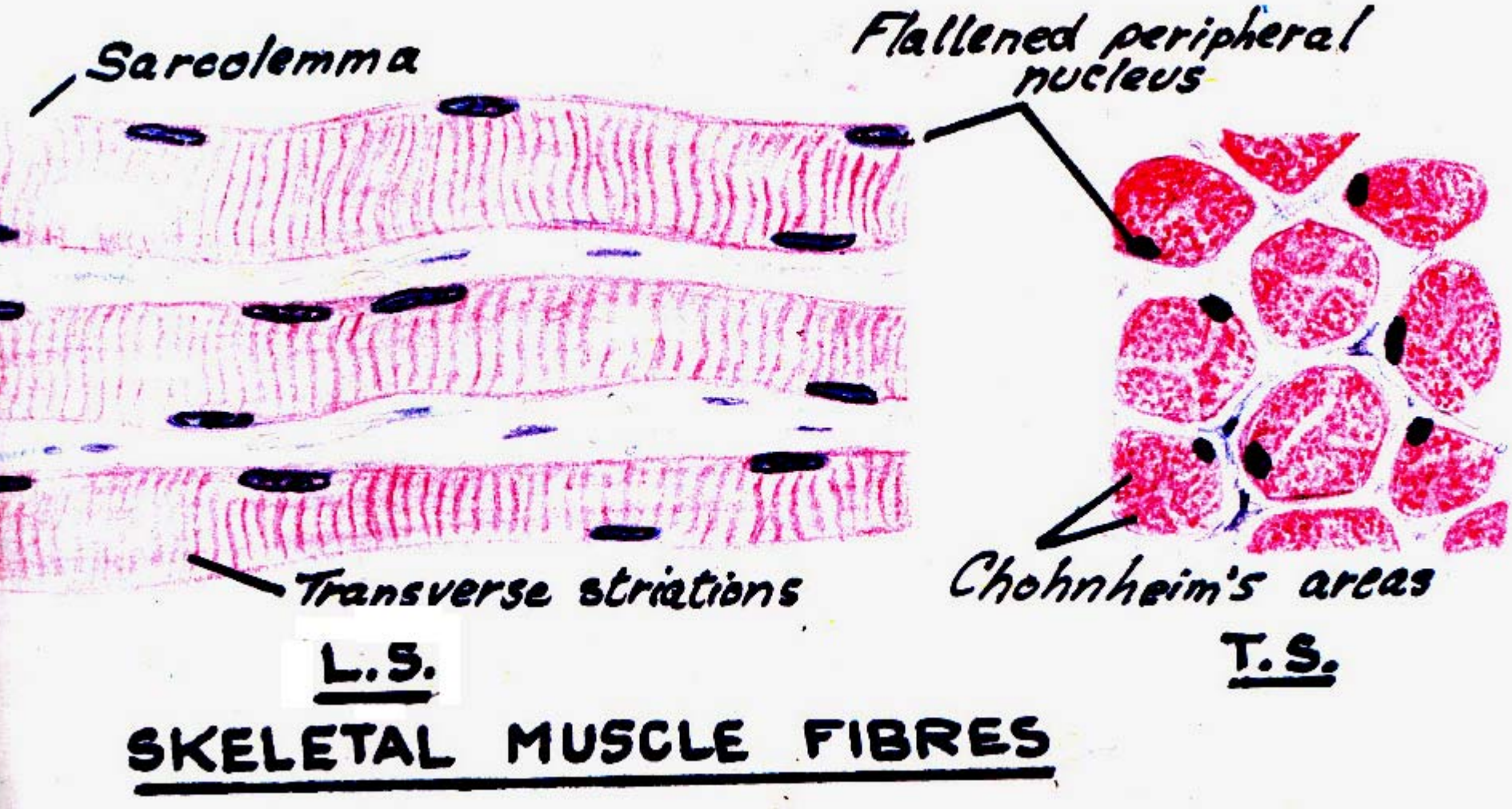
- The perimysium is continuous with the endomysium that is a delicate connective tissue layer surrounds each individual myofibers.



Structure of skeletal myofiber (LM)

- At the LM level, the skeletal myofibers are extremely long, multinucleated cylindrical cells.
- Their diameter range from 10-100 μm and their length about 1-4 mm.

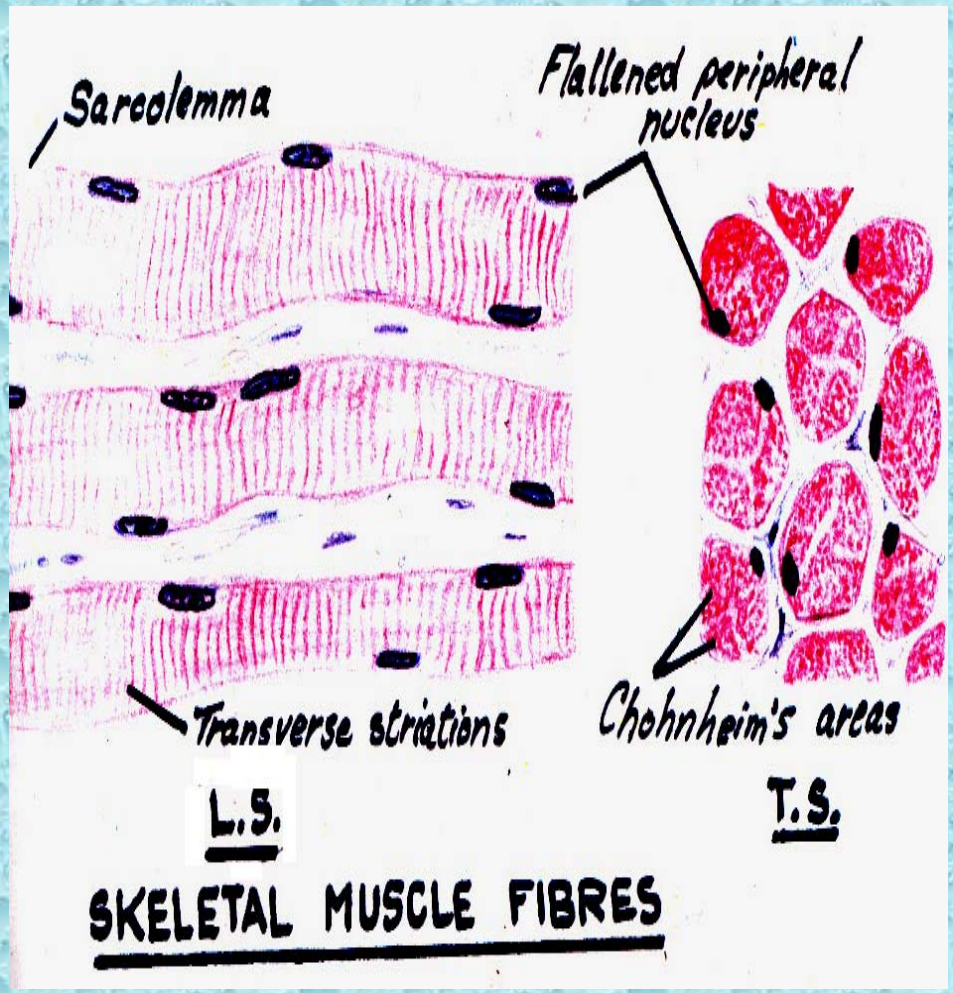




SKELETAL MUSCLE FIBRES

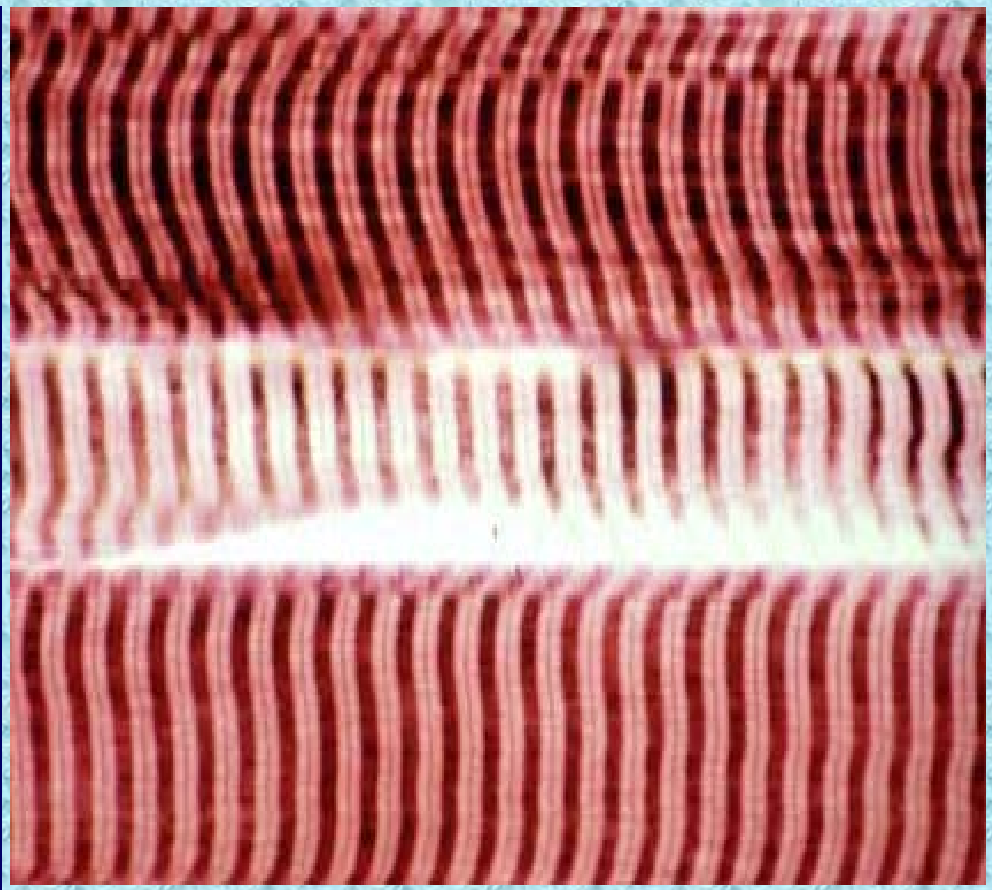
Structure of skeletal myofiber (LM)

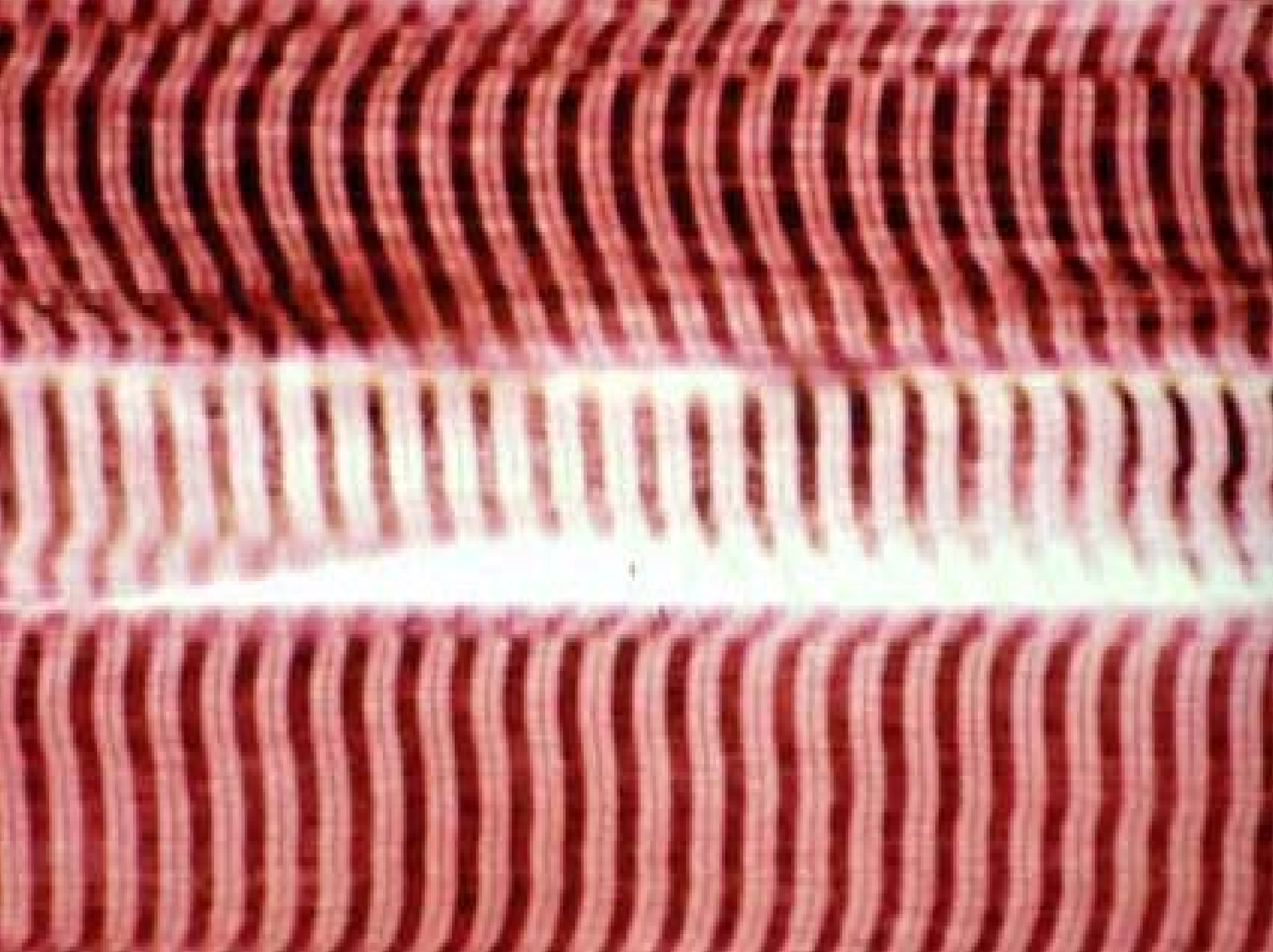
- The **nuclei are:**
- **oval**, elongated
- located just underneath the sarcolemma.



Structure of skeletal myofiber (LM)

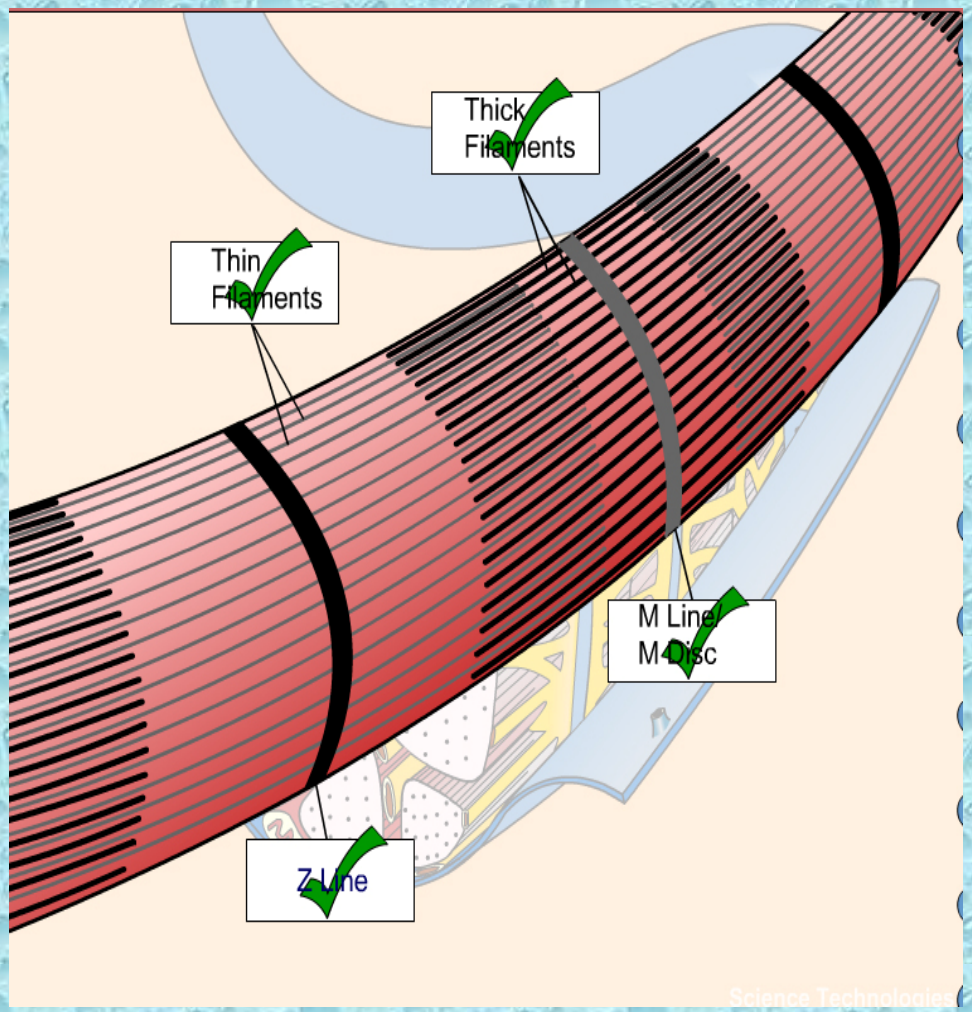
- Myofibrils show alternating dark and light transverse bands.
- The light-staining bands are called isotropic or I-band and the dark band is called anisotropic or A-band.
- The Light I bands are bisected by dark line called Z lines.





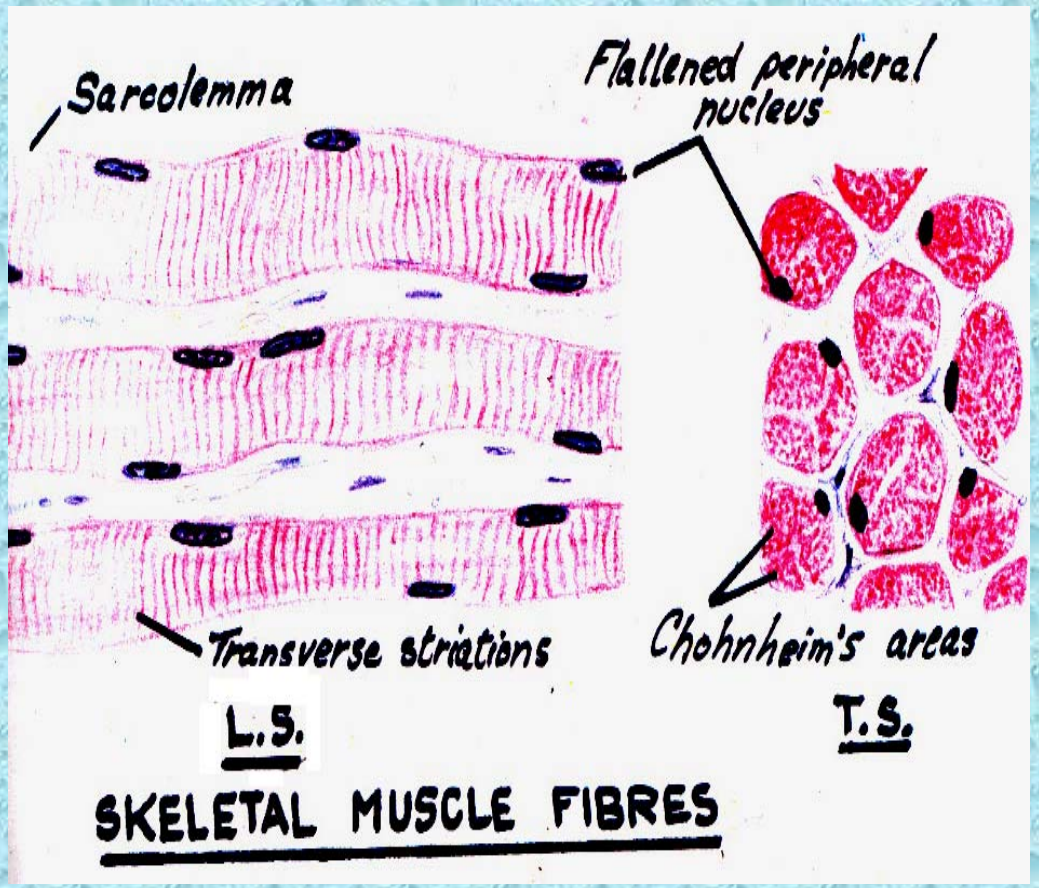
Structure of skeletal myofiber (LM)

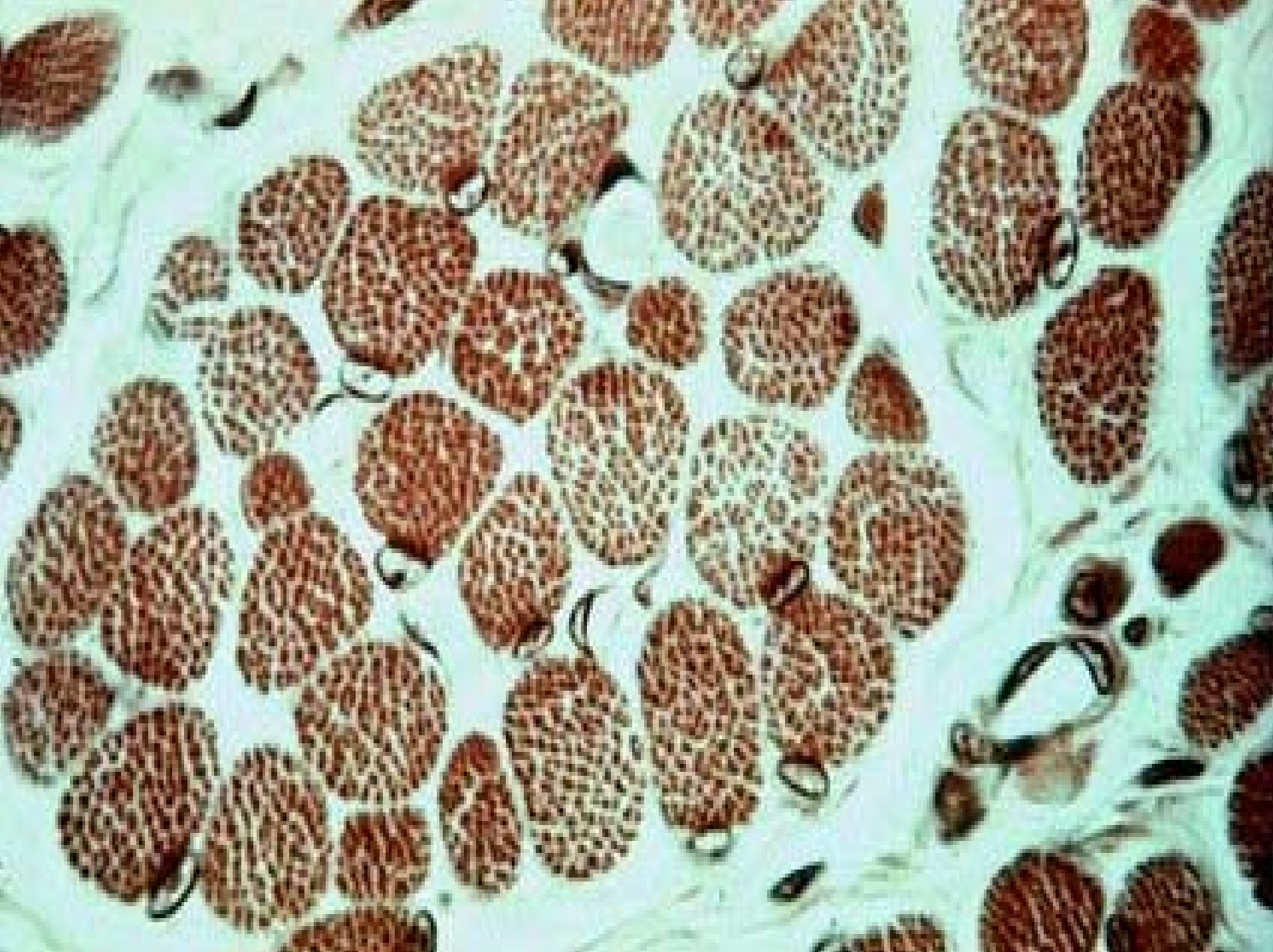
- The center of each dark A-band contains a paler region called **H-zones or H-band.**
- The distance between two successive Z lines is called sarcomere that is the contractile unit of the skeletal muscles.



Structure of skeletal myofiber (LM)

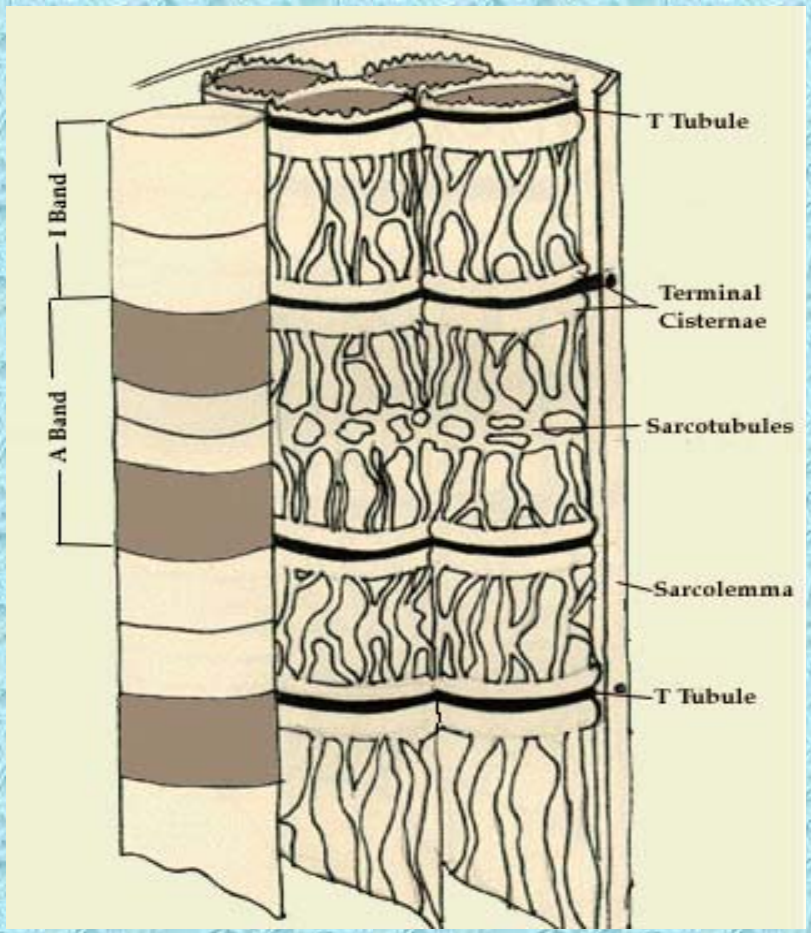
- In cross sections, the skeletal myofibers appear oval, spherical or polygonal with their nuclei are peripherally located.

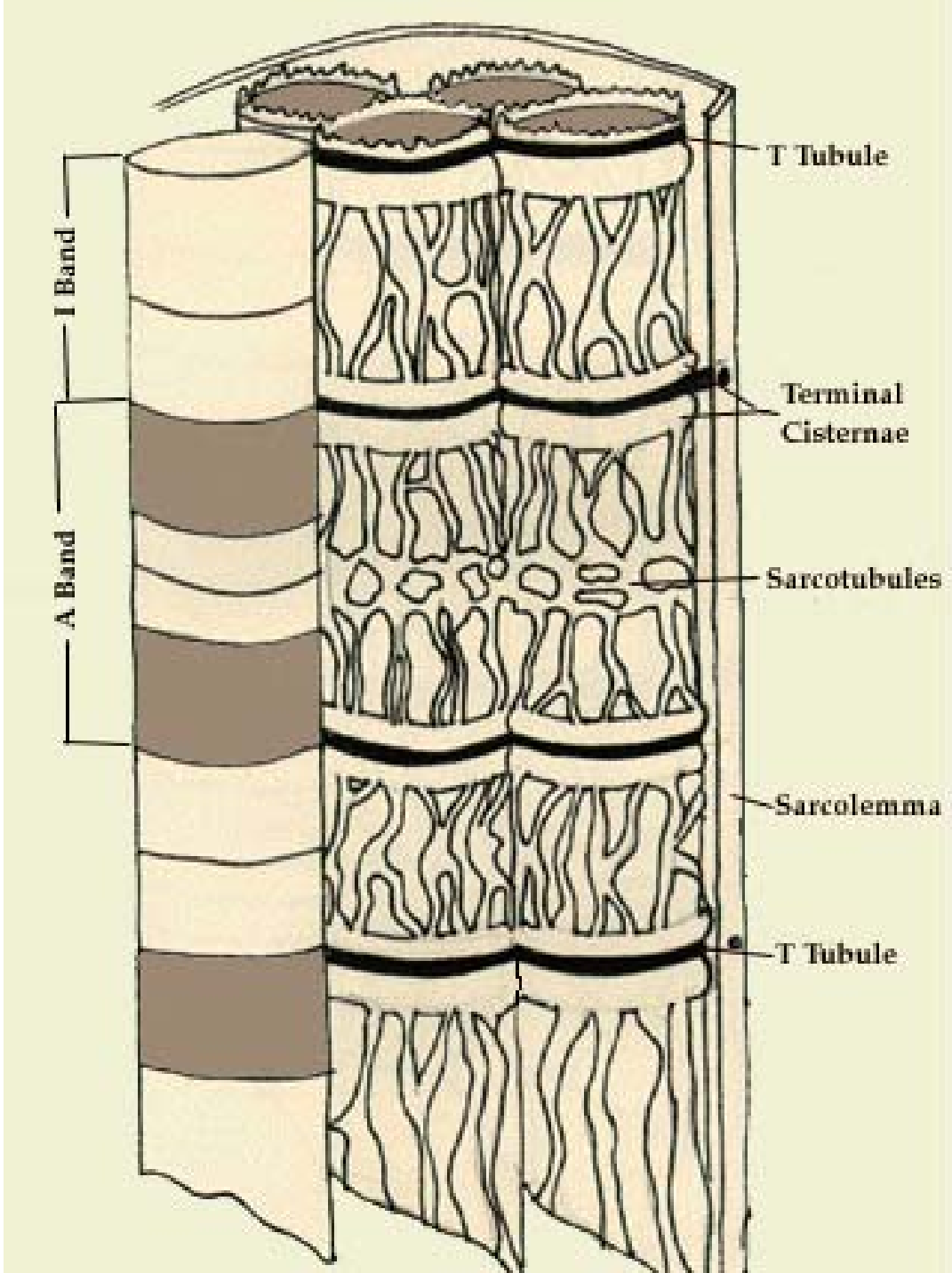




Structure of skeletal myofiber (EM)

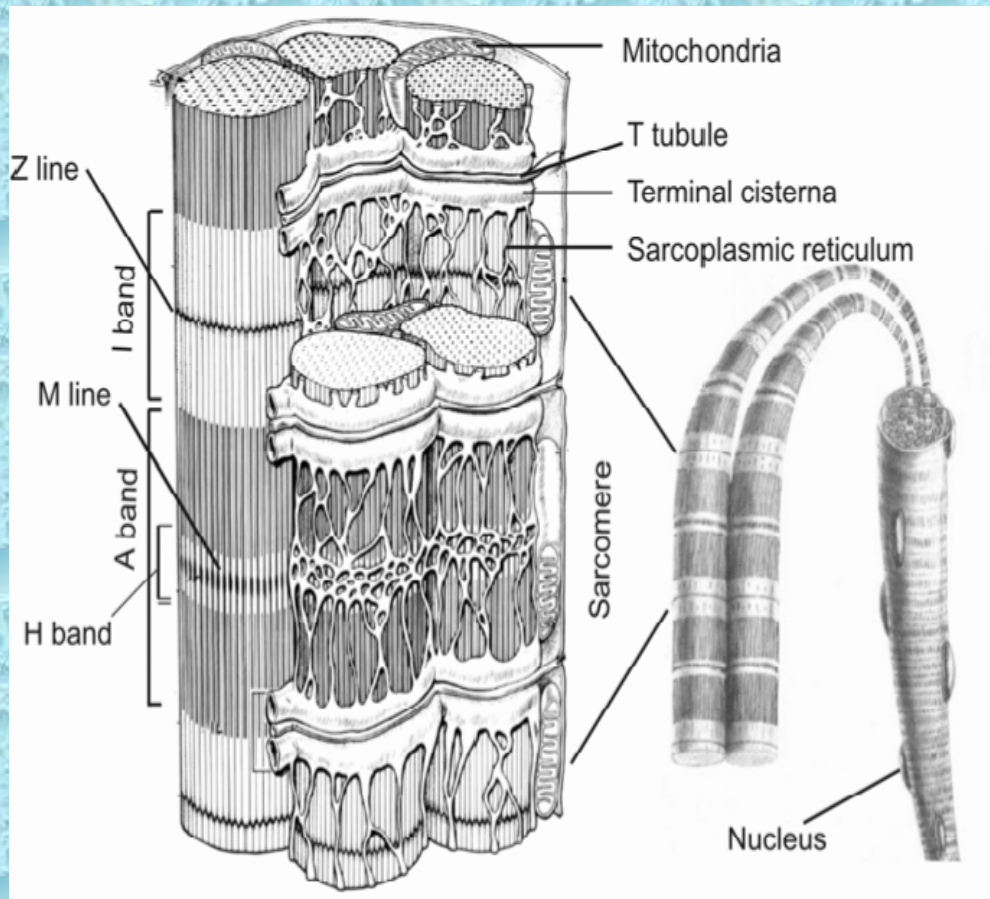
- **At the EM level,** the sarcoplasm is filled with **myofibrils** arranged parallel to the long axis of the cell.

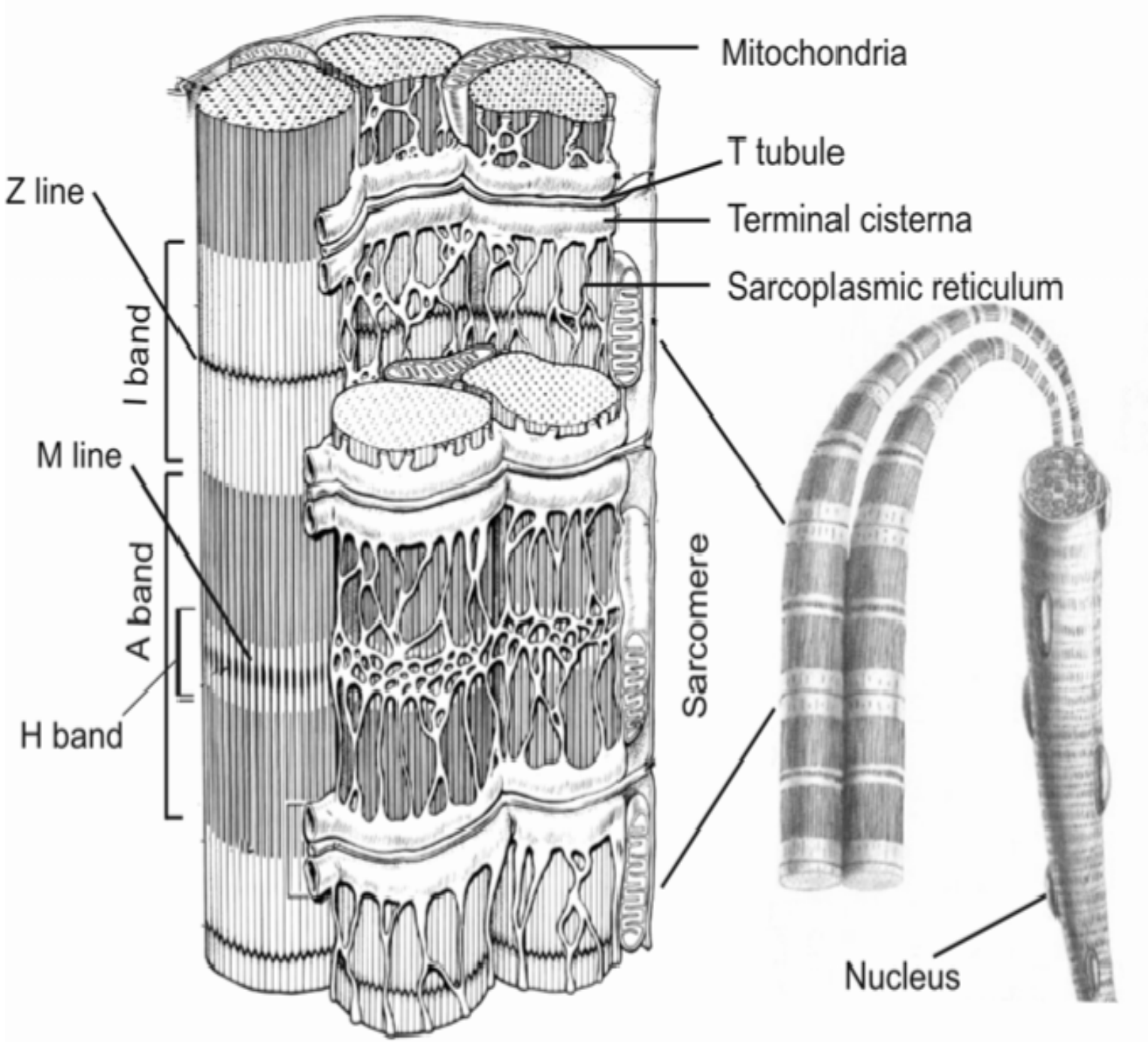


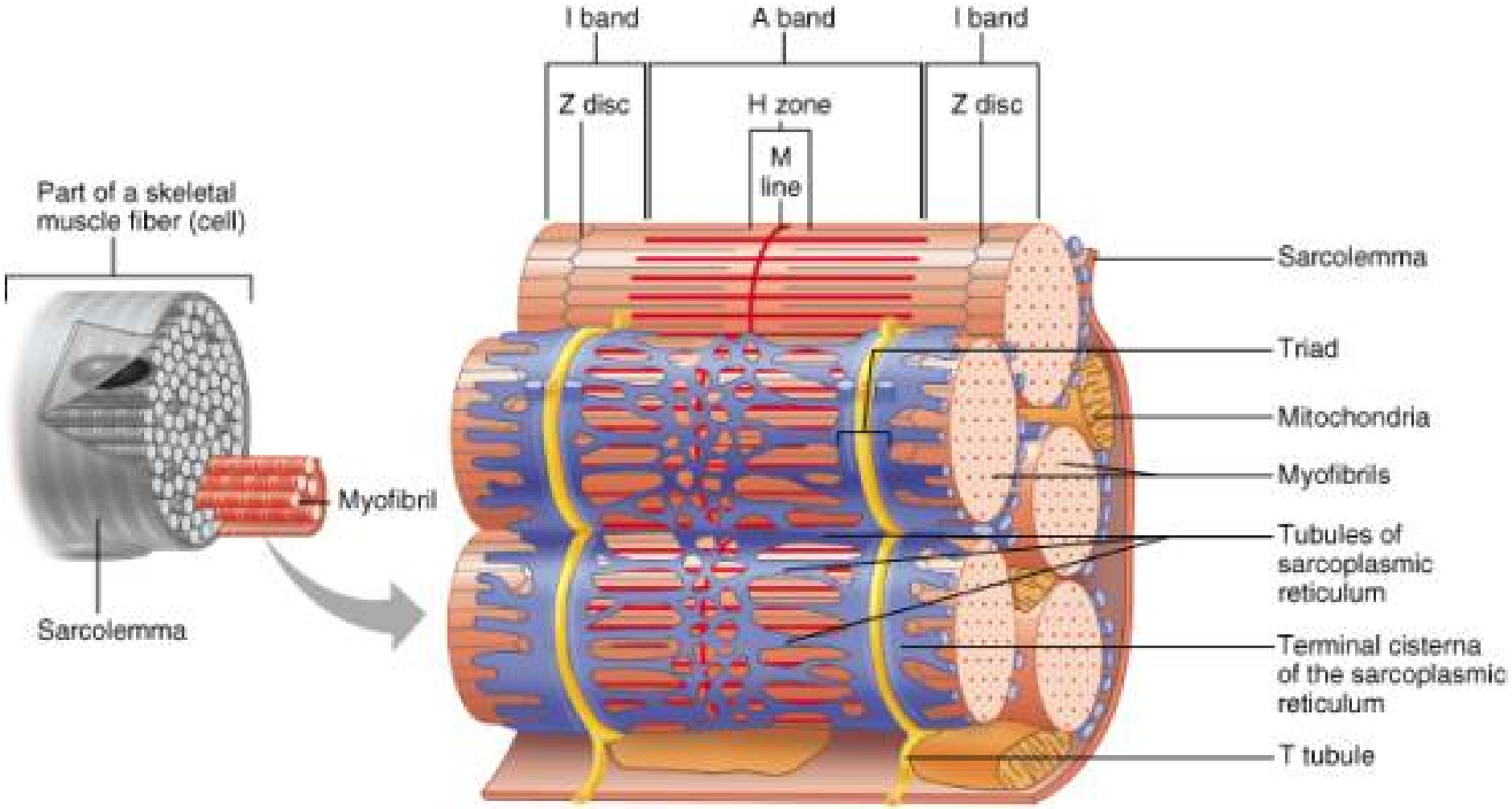

T Tubule
I Band
A Band
Terminal
Cisternae
Sarcotubules
Sarcolemma
T Tubule

Structure of skeletal myofiber (EM)

- Each myofibril has cross-striations.
- Arranged with their cross striations in register.
- With LM: regular cross-striations along the muscle fiber.

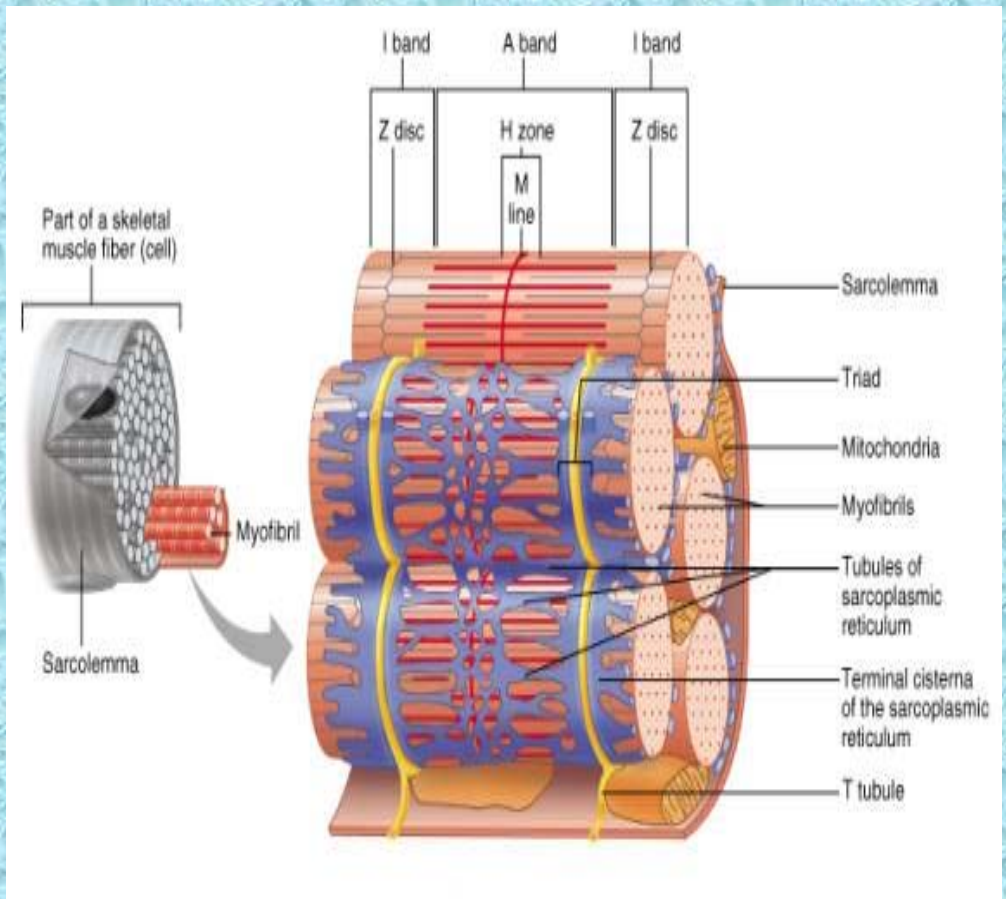


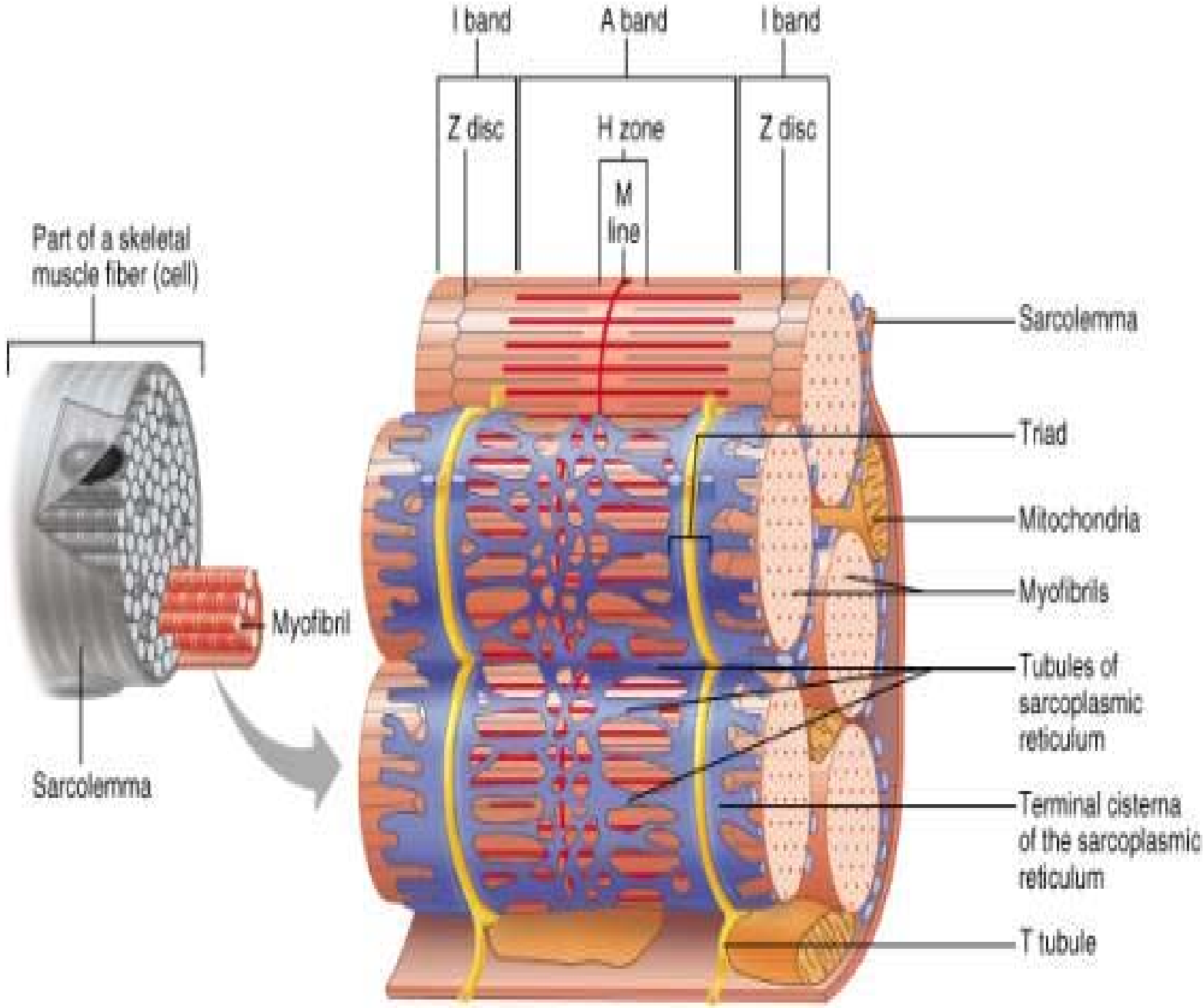

Mitochondria
T tubule
Terminal cisterna
Sarcoplasmic reticulum
Z line
I band
M line
A band
H band
Sarcomere
Nucleus



Structure of skeletal myofiber (EM)

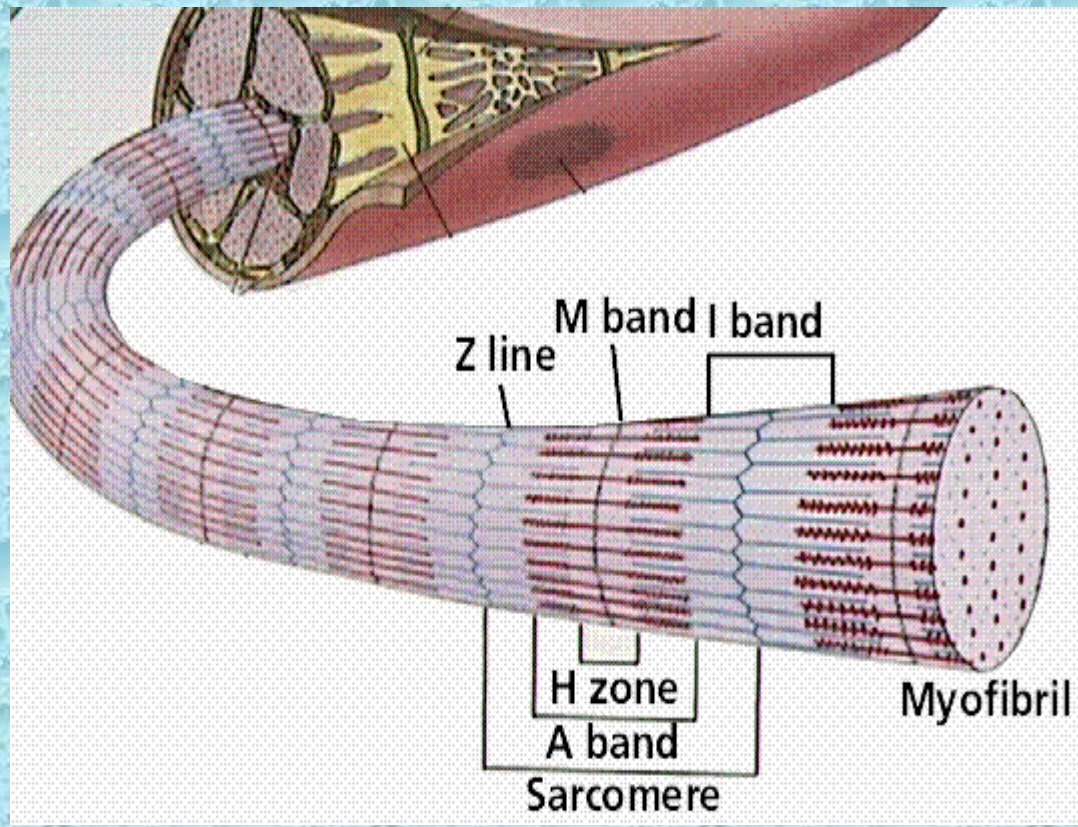
- The myofibrils are found to be composed of smaller units called the myofilaments that are of two types: myosin (thick) and actin (thin) filaments.




I band
A band
I band
Z disc
H zone
Z disc
M line
Part of a skeletal muscle fiber (cell)
Myofibril
Sarcolemma
Sarcolemma
Triad
Mitochondria
Myofibrils
Tubules of sarcoplasmic reticulum
Terminal cisterna of the sarcoplasmic reticulum
T tubule

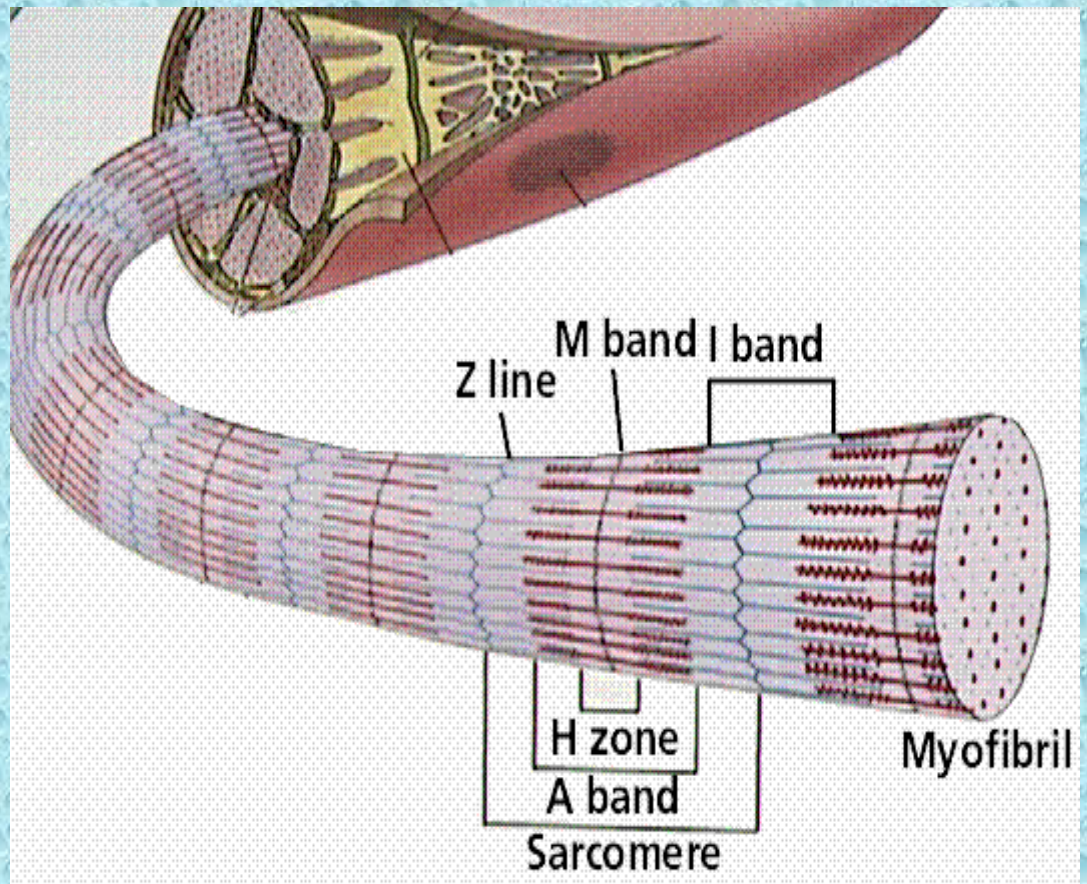
Structure of skeletal myofiber (EM)

- The thick filaments are composed mainly of protein myosin and are arranged parallel to each other in the A-band.



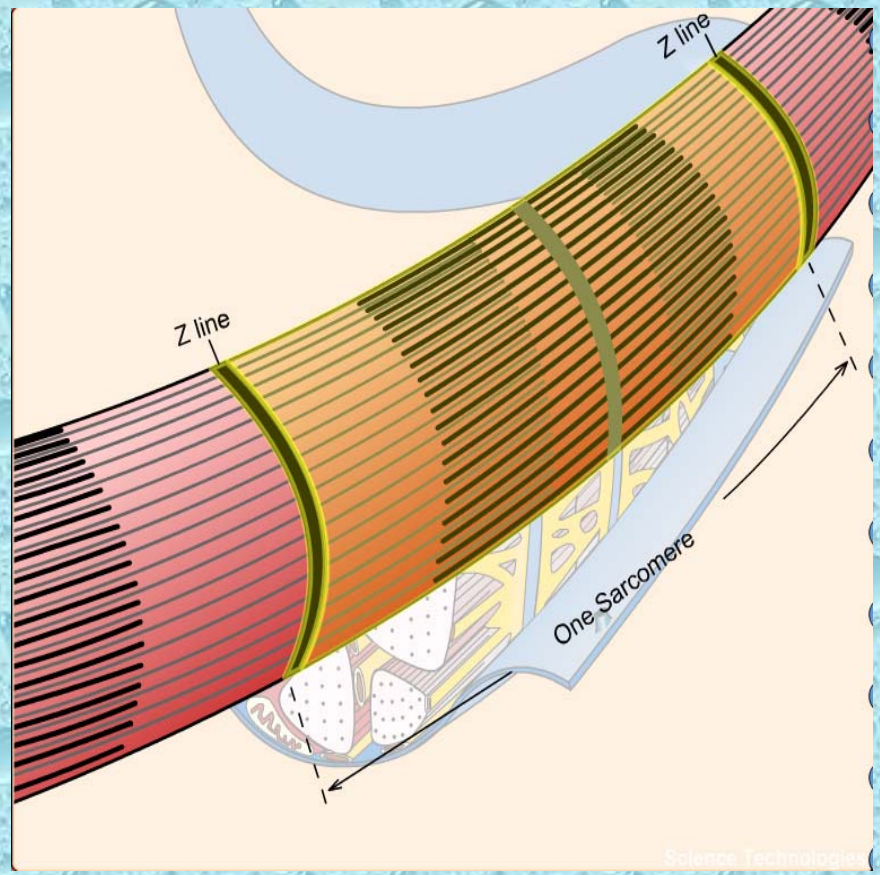
Structure of skeletal myofiber (EM)

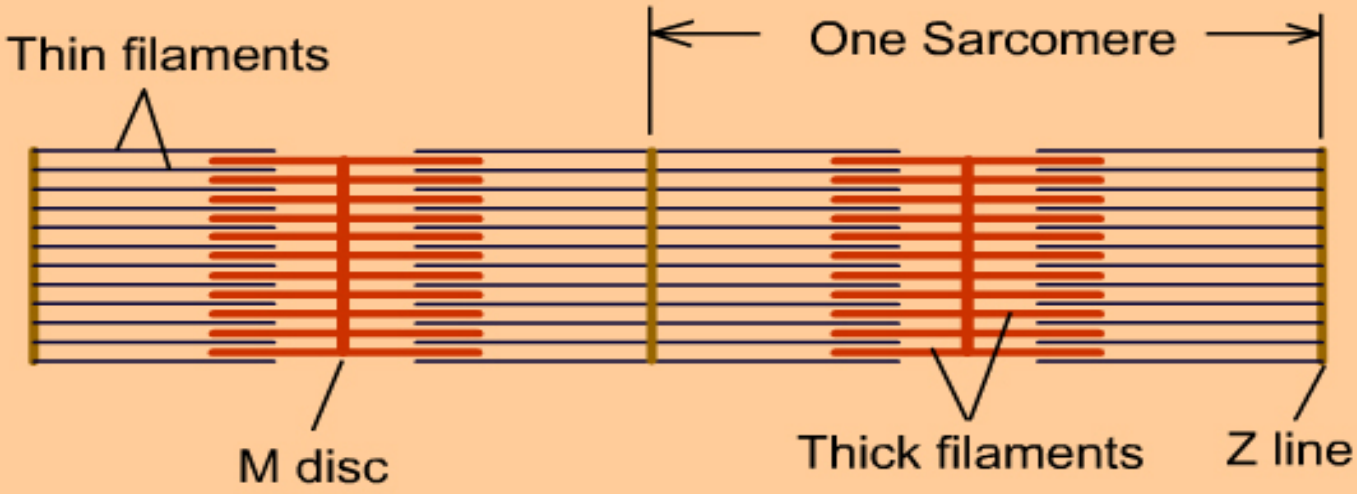
- They are maintained in parallel by their attachment to a disc-like zone called the M-band that is located in the center of H-band.



Structure of skeletal myofiber (EM)

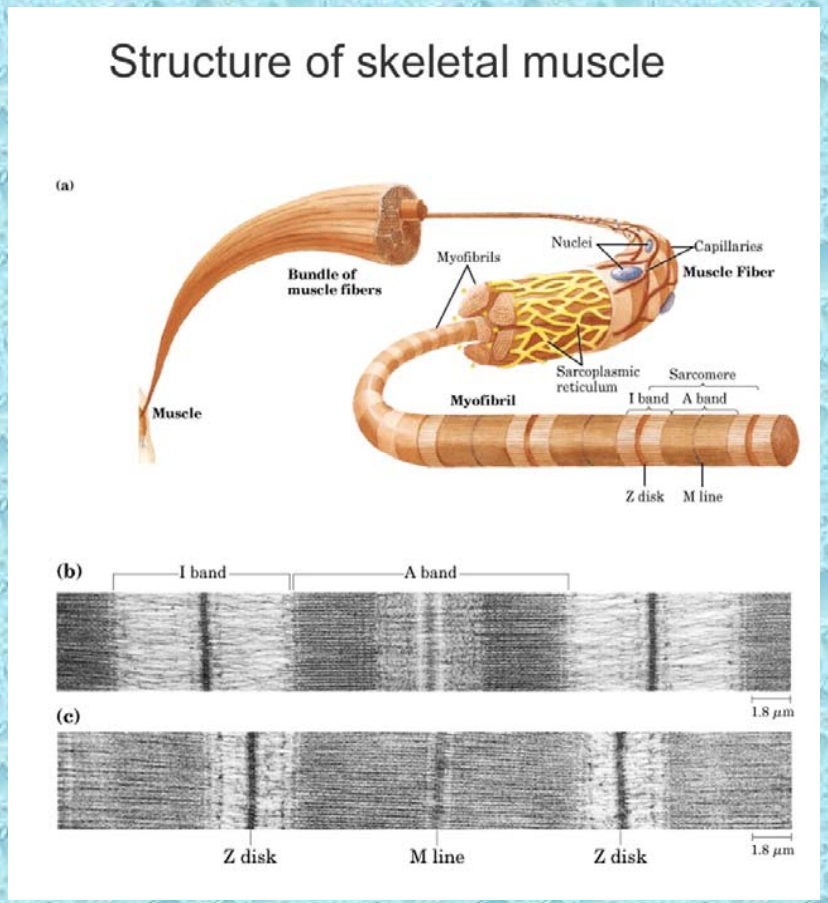
- The thin filaments are composed mainly of protein actin that is associated with two other proteins, tropomyosin and troponin.
- They are attached to both sides of the Z-lines to form the I-band.





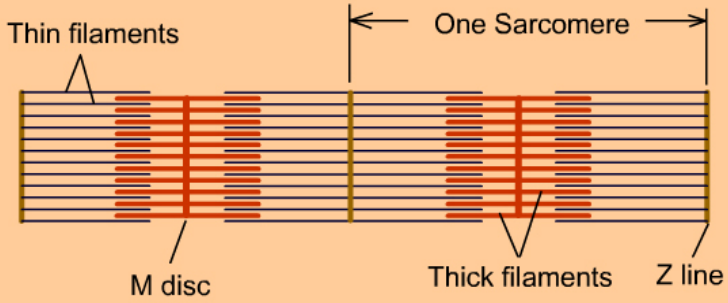
Structure of skeletal myofiber (EM)

- The A-bands are electron-dense and appear dark because they contain two types of filaments.

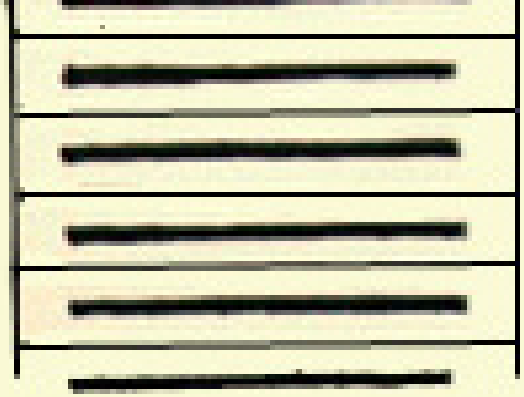


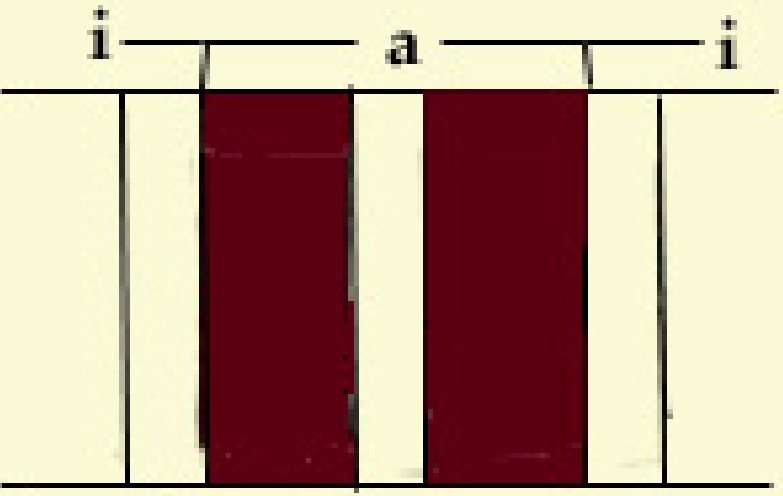
Structure of skeletal myofiber (EM)

- The H-bands and I are of low electron density and appear light because the thin and thick filaments do not overlap one another.



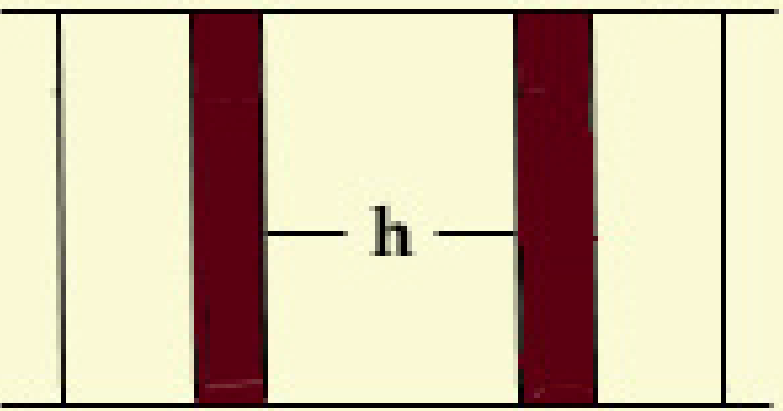
Contracted





Rest
Length

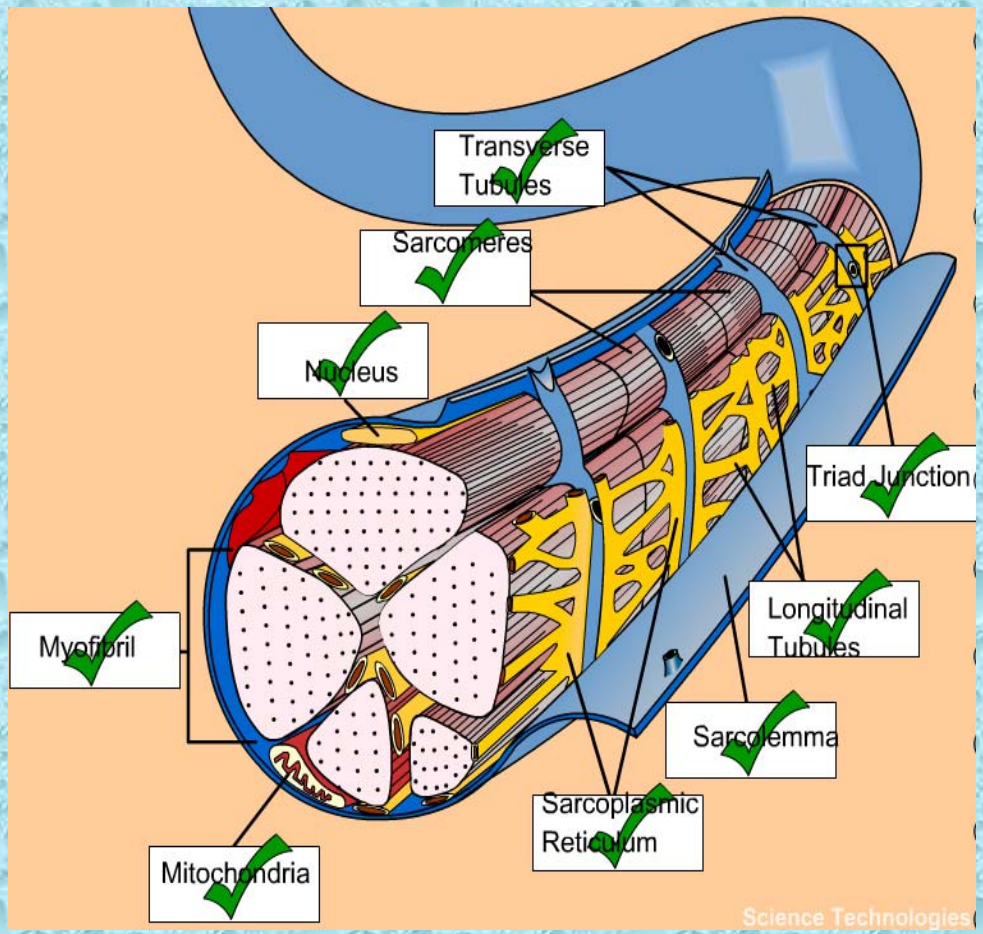
z z

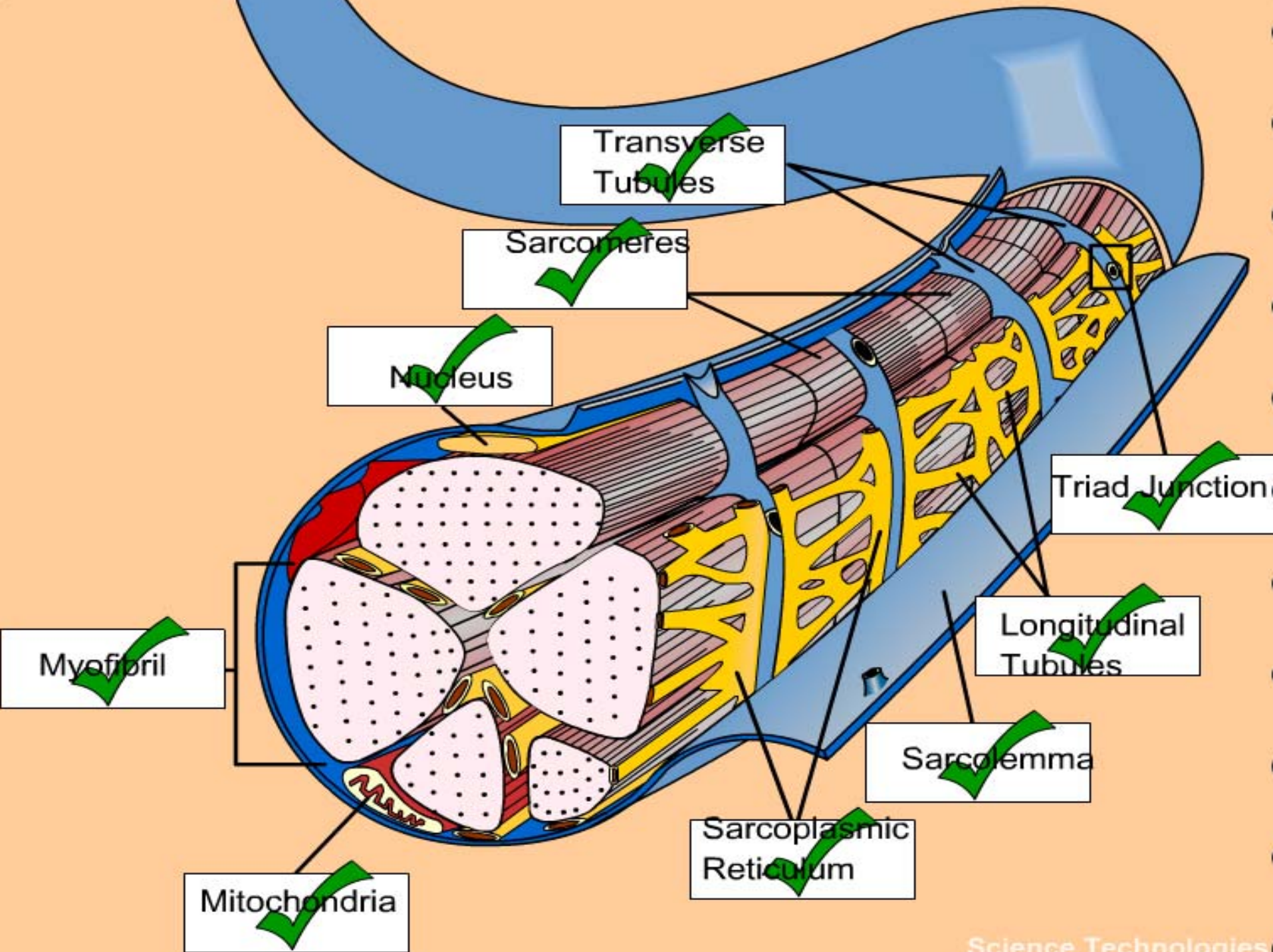


Stretched

Structure of skeletal myofiber (EM)

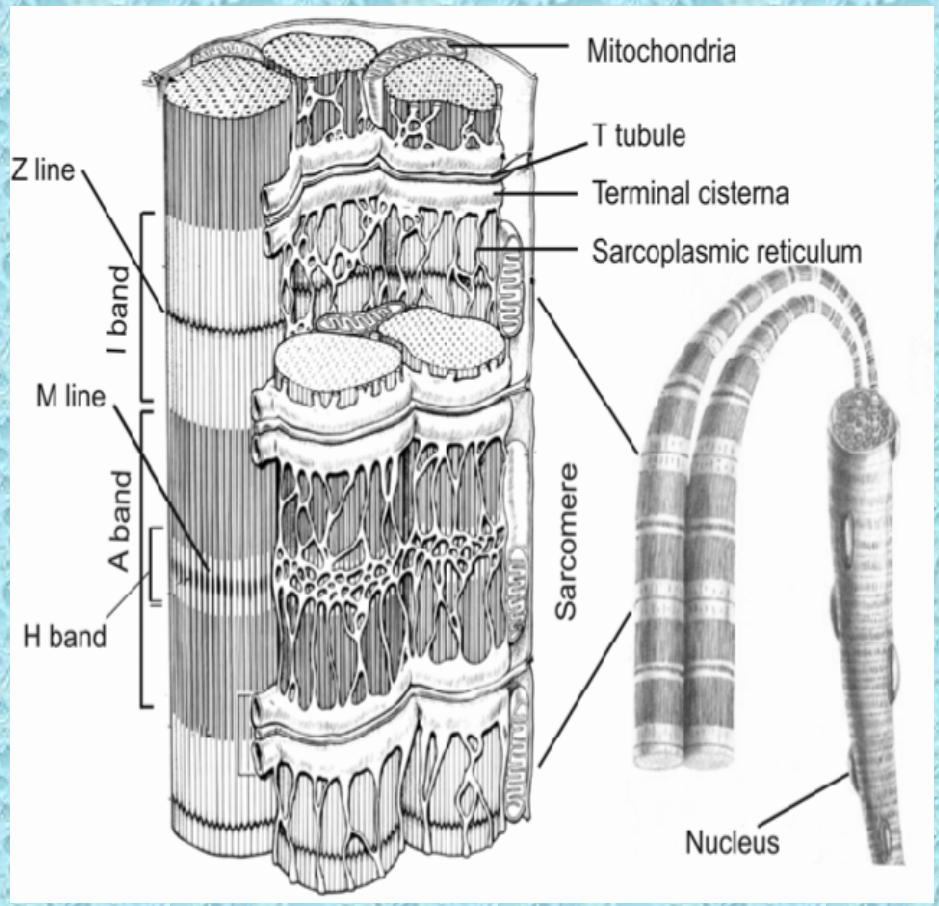
- The sarcolemma gives rise to tubular extensions (T-tubules) that extend transversely in the sarcoplasm to surround each myofibril at the region of A-I junctions.

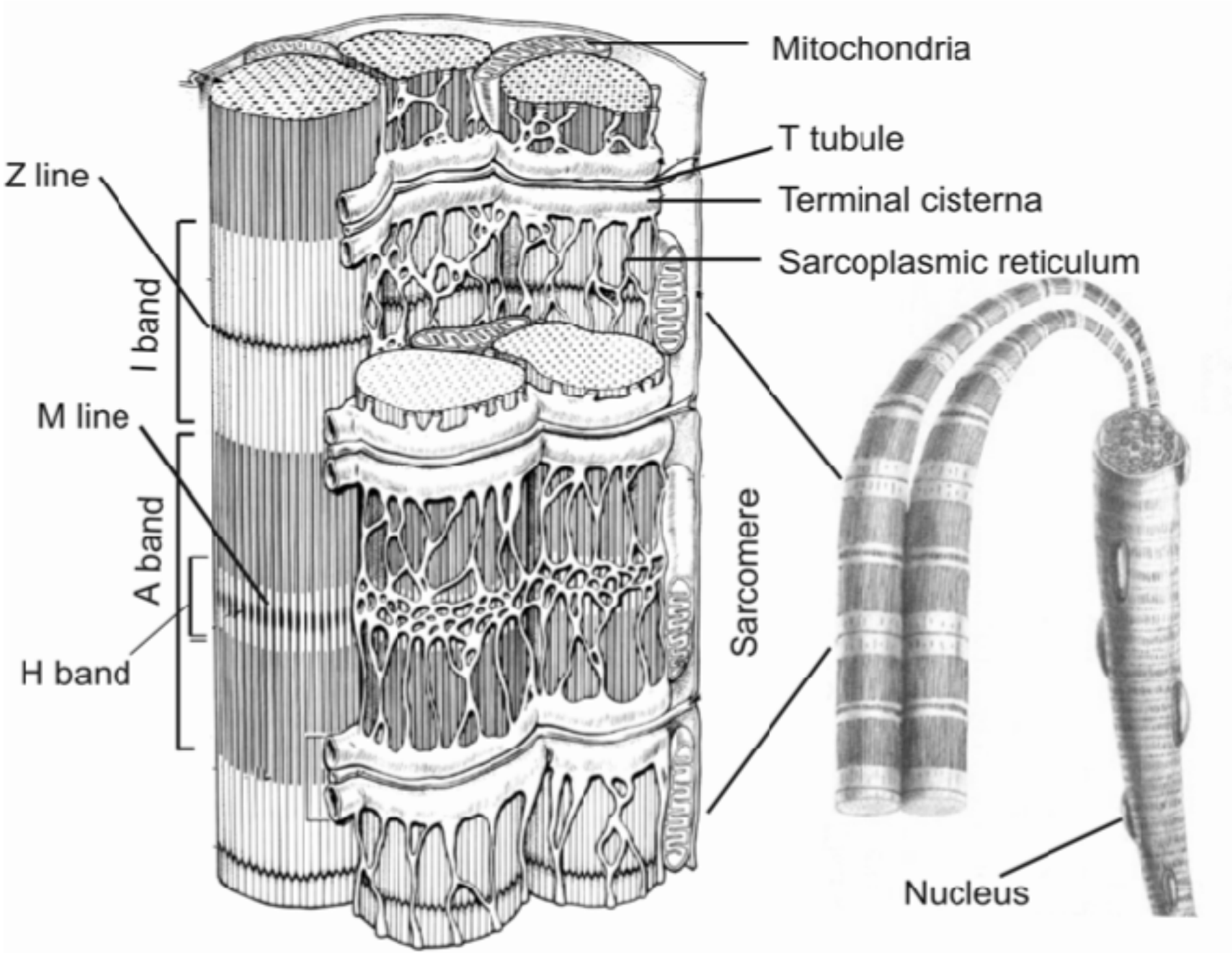



Transverse Tubules
Sarcomeres
Nucleus
Triad Junction
Longitudinal Tubules
Myofibril
Sarcolemma
Sarcoplasmic Reticulum
Mitochondria

Structure of skeletal myofiber (EM)

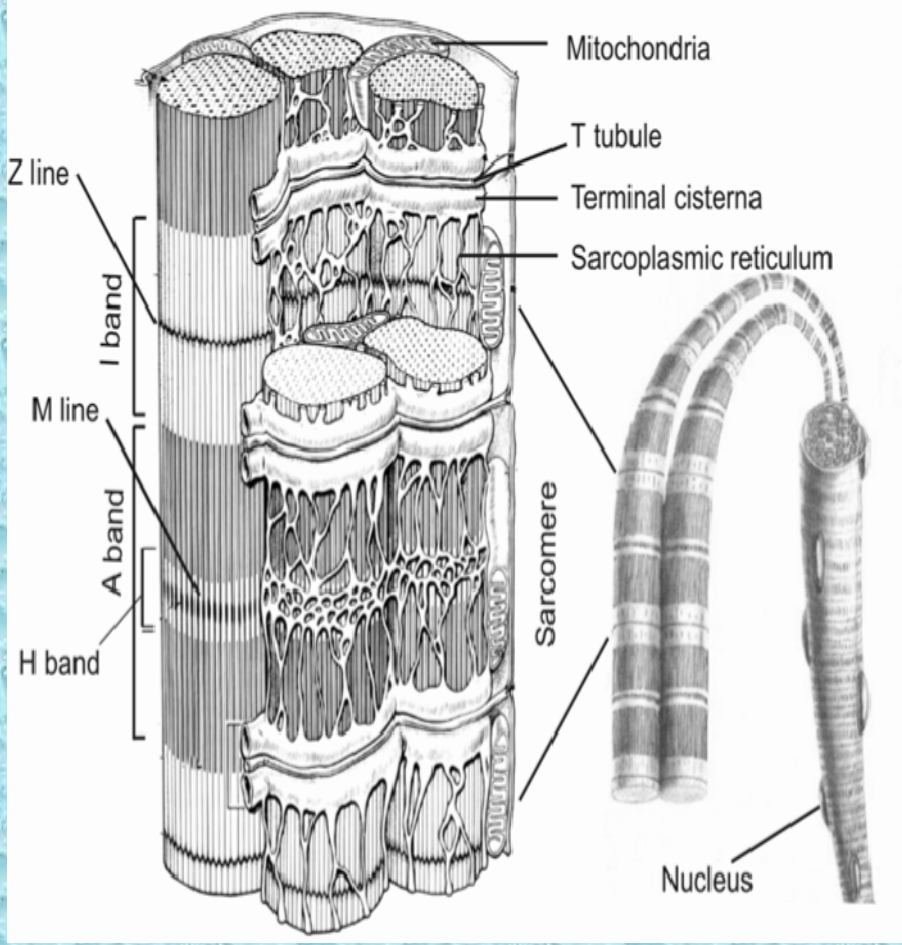
- Each tubule is associated with two dilated cisternae of the sarcoplasmic reticulum to form a structure called triad.




Mitochondria
T tubule
Terminal cisterna
Sarcoplasmic reticulum
Z line
I band
M line
A band
H band
Sarcomere
Nucleus

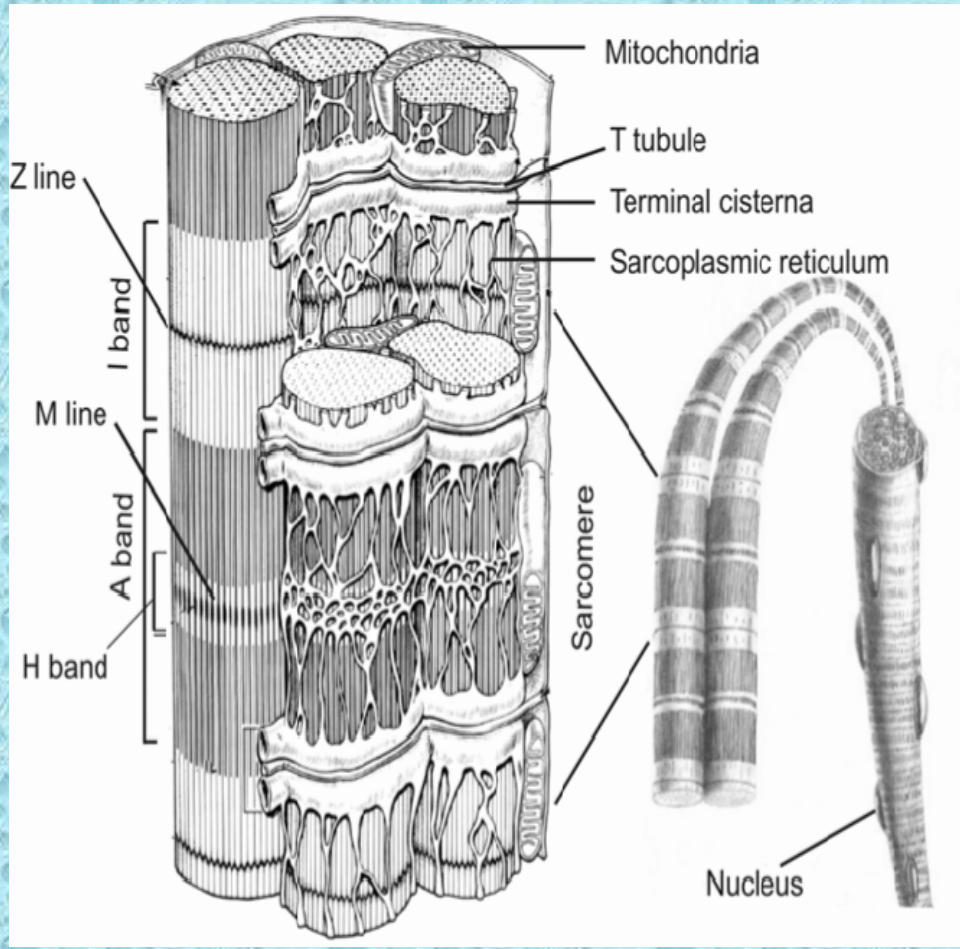
Structure of skeletal myofiber (EM)

- The T-tubules transmit nerve impulses from the outer sarcolemma to the sER cisternae leading to release of Ca^{++} ions that are necessary for myofibers contraction.



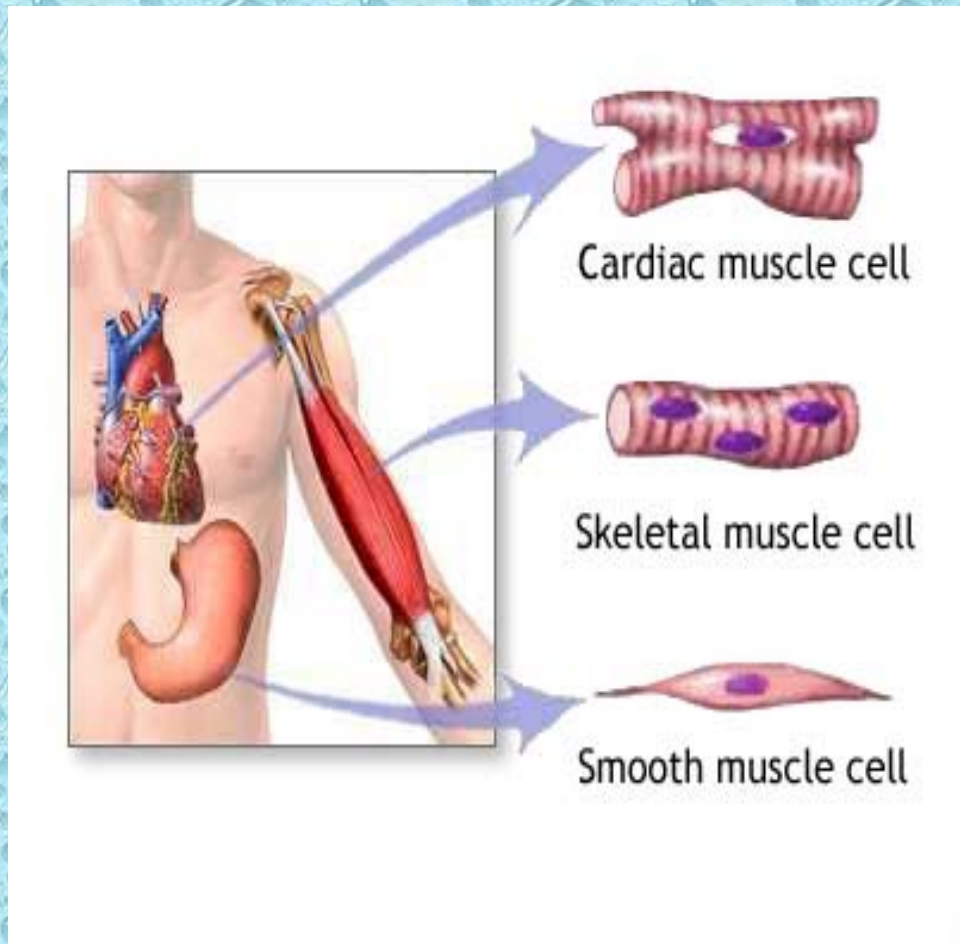
Structure of skeletal myofiber (EM)

- Other cytoplasmic organelles include small inactive Golgi, dense glycogen and well-developed sER.



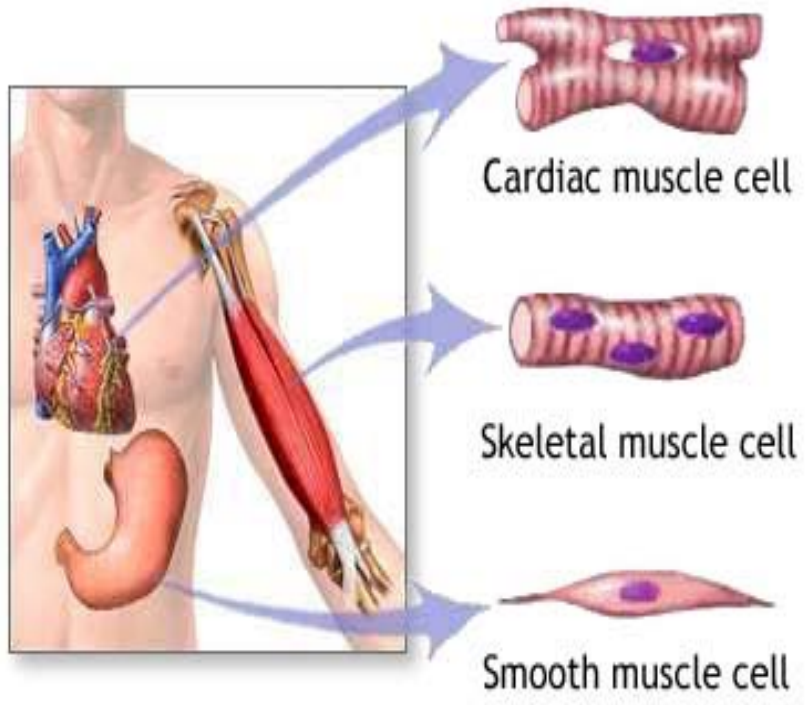
Cardiac muscle (Striated and involuntary)

- It is called cardiac because it constitutes most of the heart although some cardiac muscle can also be found in the wall of pulmonary vein and vena cava.



Cardiac muscle (Striated and involuntary)

- Cardiac myofibers are striated, however, the striation is less distinct than that of the skeletal myofibers due to: irregular branching shape of the fiber, the less myofibrils content and the abundance of non-contractile sarcoplasm.

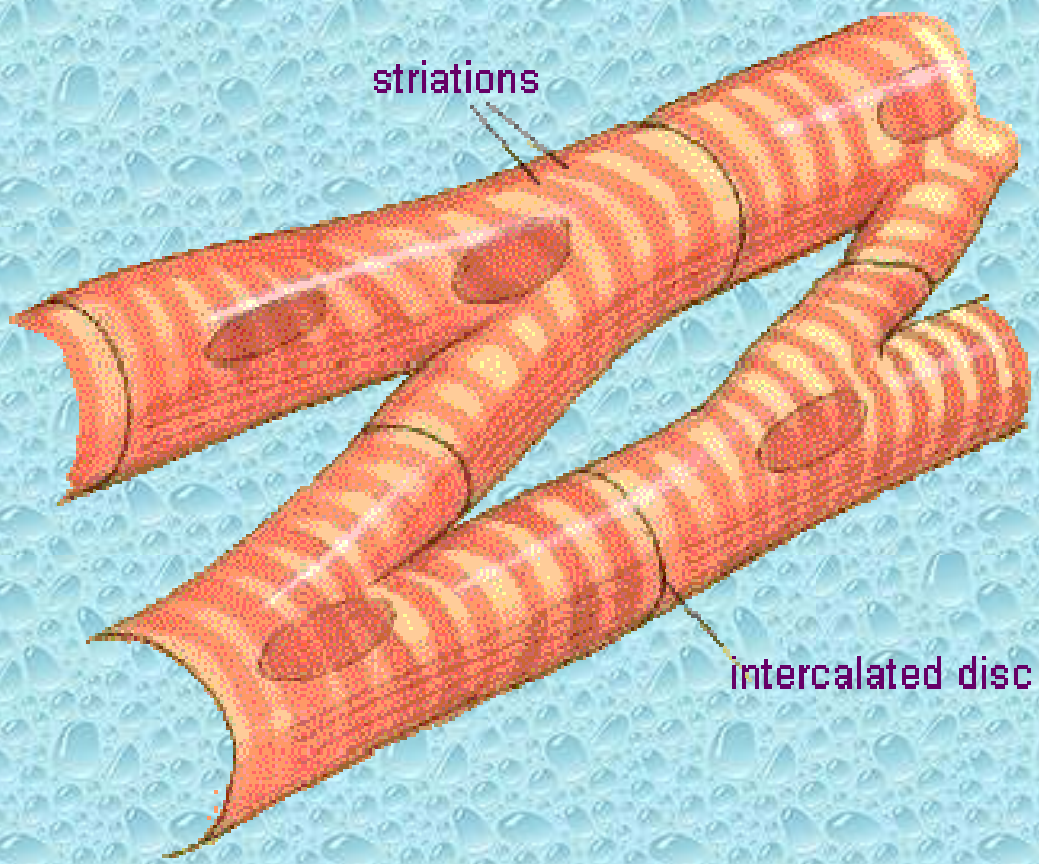


Cardiac muscle (Striated and involuntary)

- They are involuntary, they contract spontaneously without any nerve supply.
- The rate this inherent rhythm can be modulated by autonomic and hormonal stimuli.

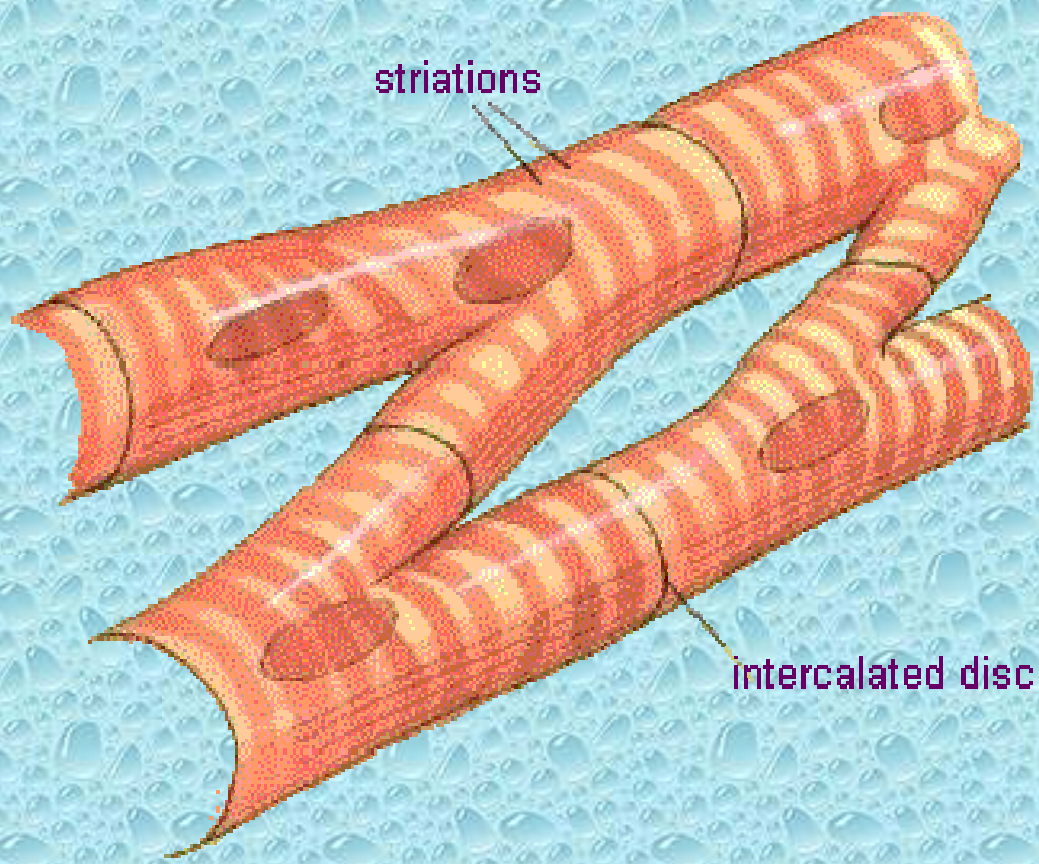
Structure of cardiac muscle (LM)

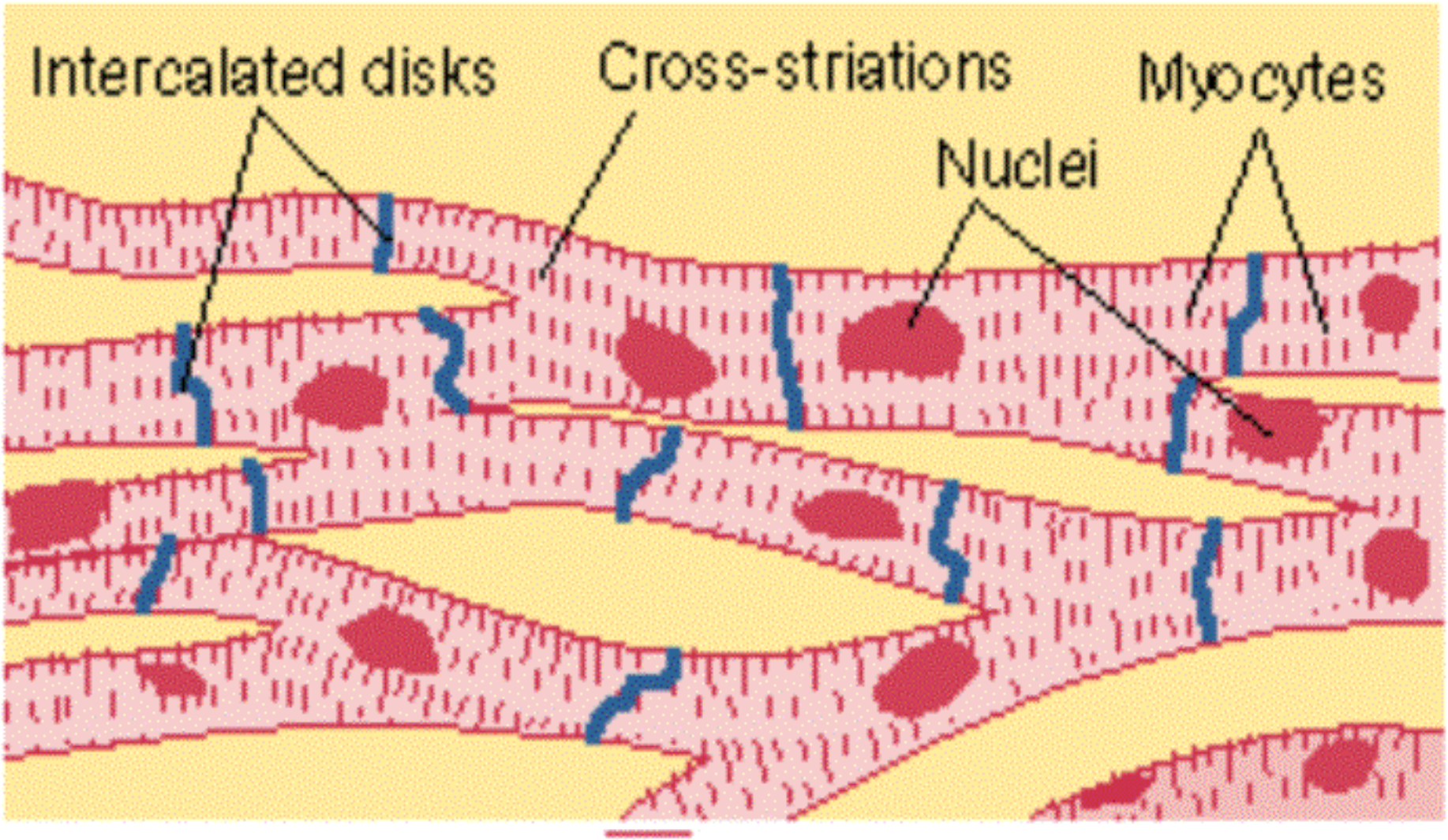
- At the LM level, the cardiac myofibers are long (50-100 μm) cylindrical cells that are branched and anastomosed forming a network.



Structure of cardiac muscle (LM)

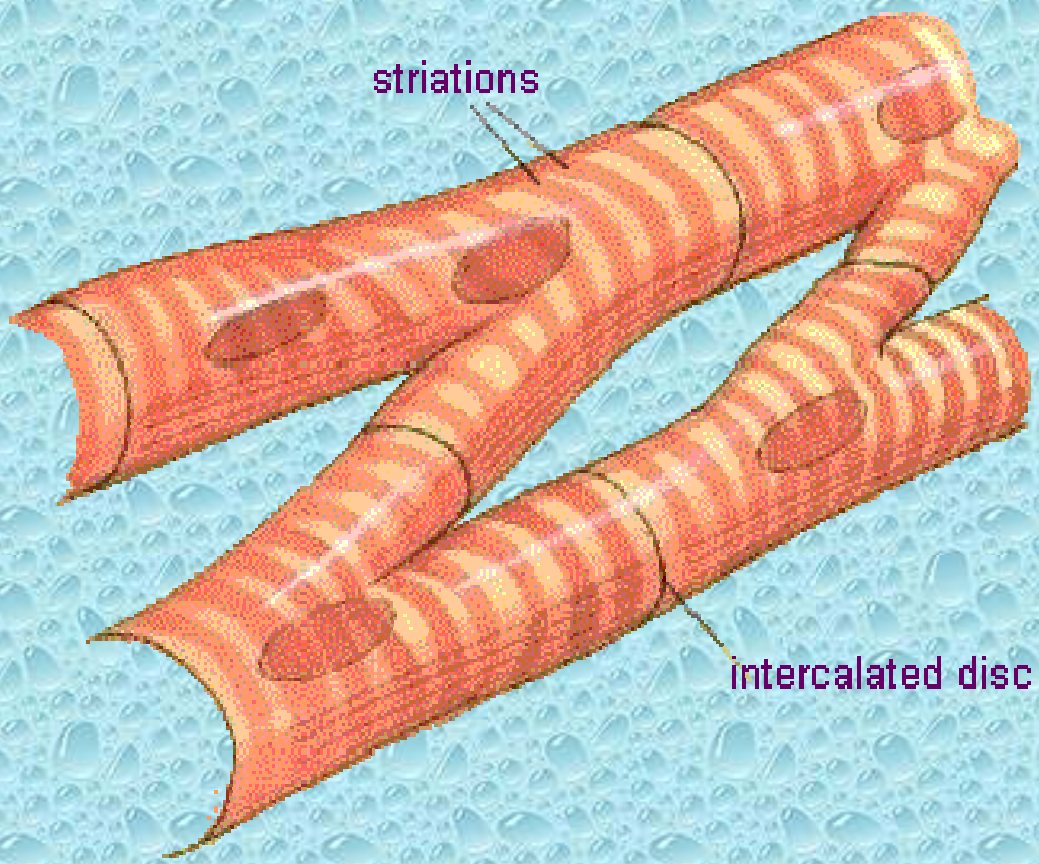
- They are traversed at intervals by dark-staining structures called intercalated discs that extend across the fiber in a stepwise manner.




Intercalated disks
Cross-striations
Myocytes
Nuclei

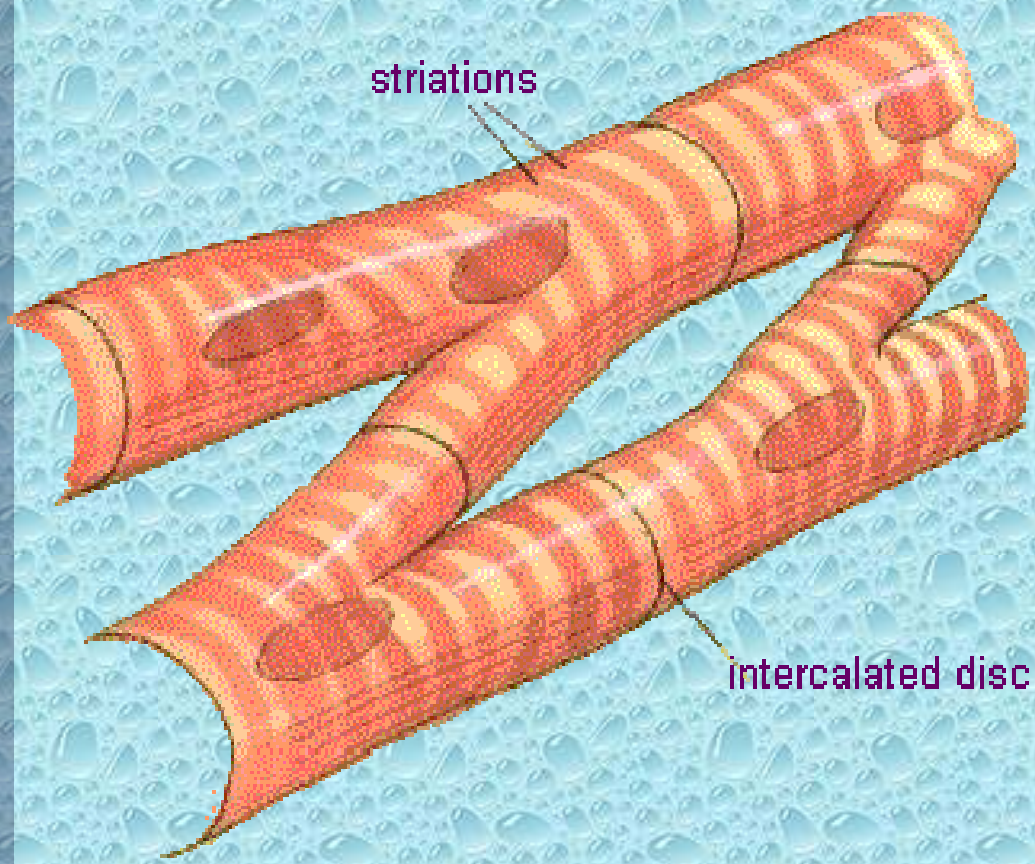
Structure of cardiac muscle (LM)

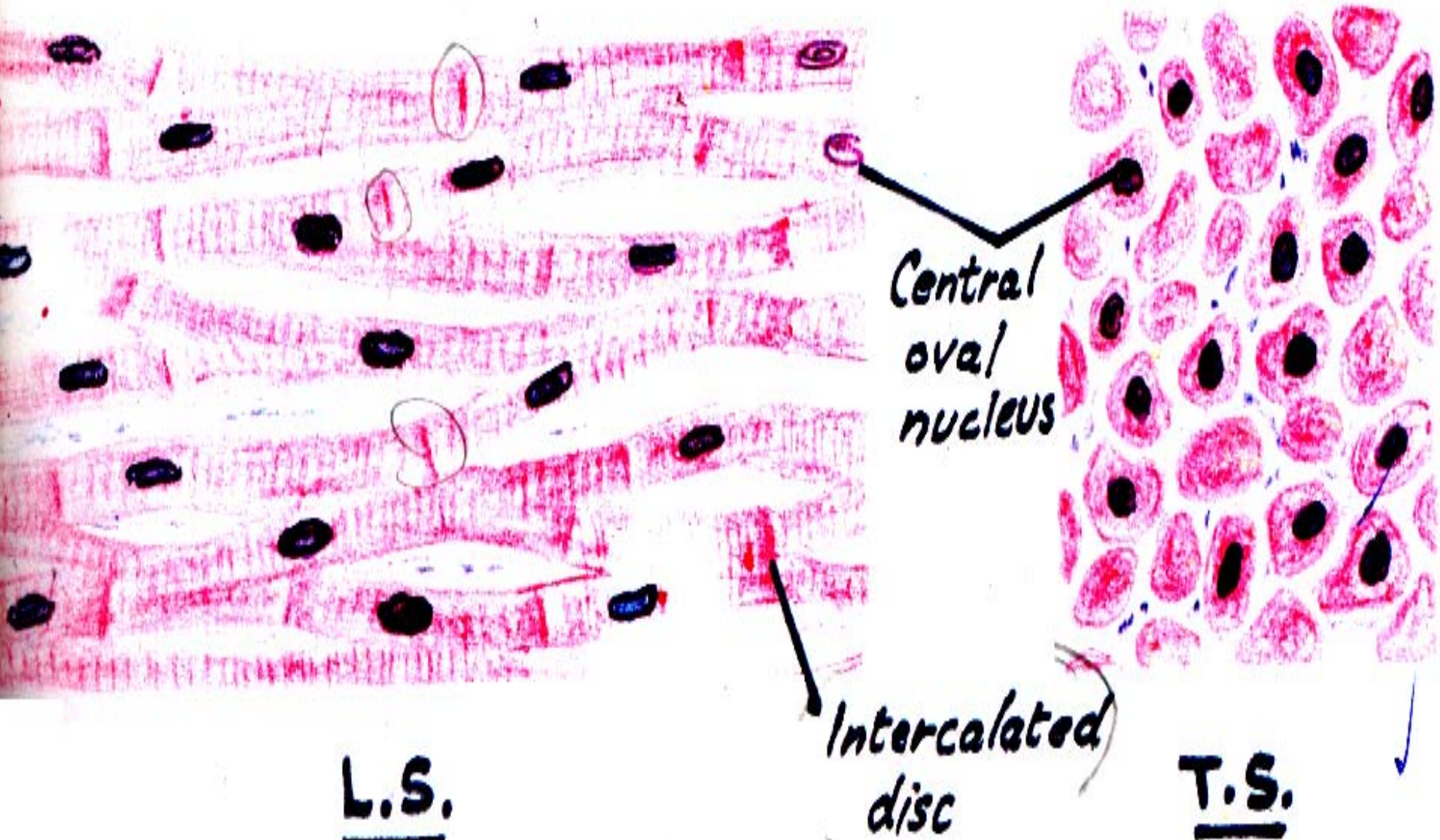
- Most of the cells have one nucleus and at most two nuclei.
- The nuclei are oval and centrally located within the cell.



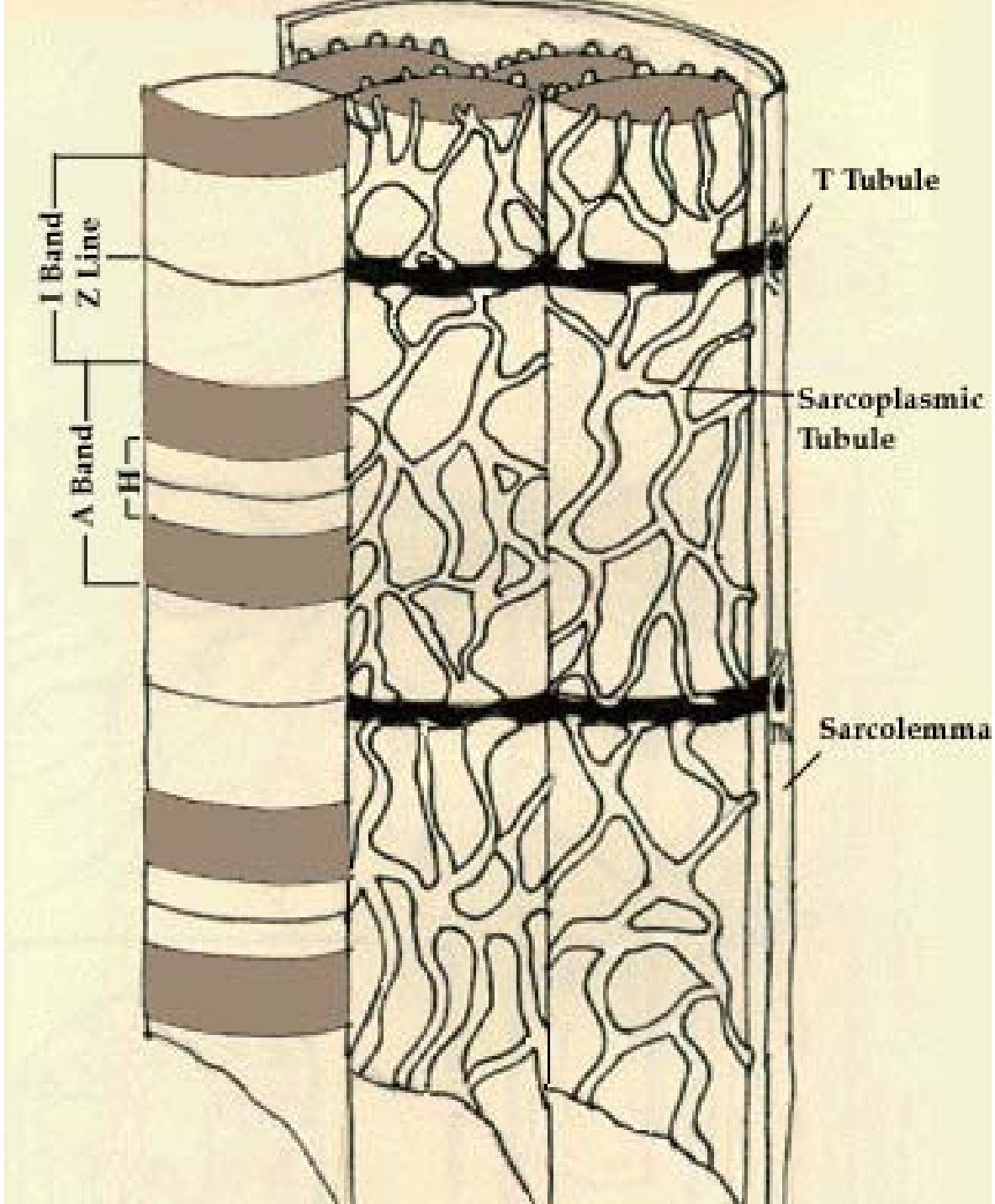
Structure of cardiac muscle (LM)

- Like the skeletal muscles, the cytoplasm is **acidophilic** and **striated** consisting of an alternated dark and light bands.



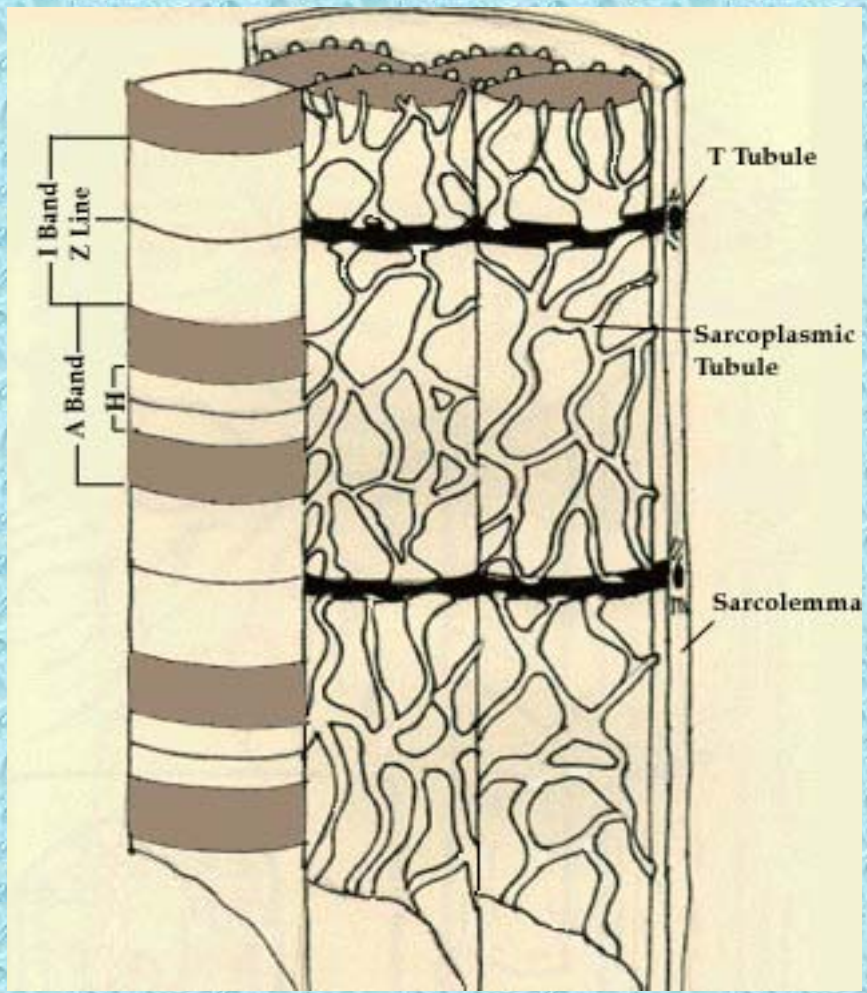


CARDIAC MUSCLE FIBRES


I Band
Z Line
A Band
H
T Tubule
Sarcoplasmic Tubule
Sarcolemma

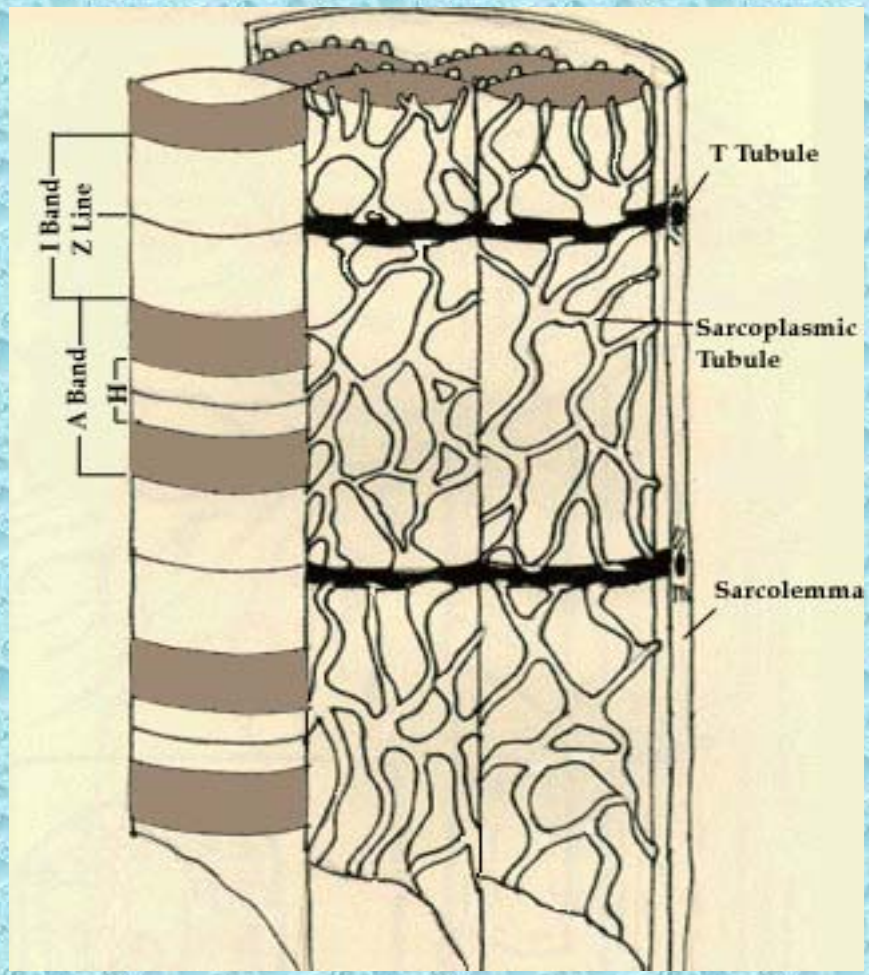
Structure of cardiac muscle (EM)

- 2) The T tubules are wider than those of the skeletal myofibers and penetrate the cardiac myocytes at the level of Z-lines and not at the A-I junctions.



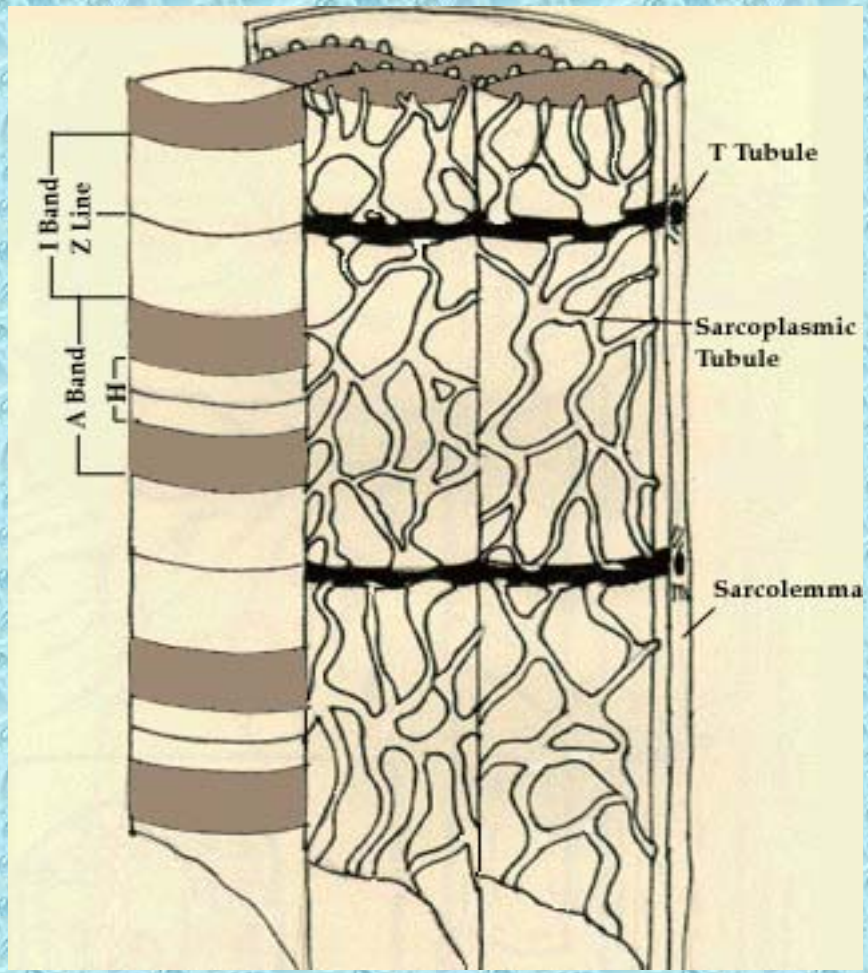
Structure of cardiac muscle (EM)

- 3) Each tubule is associated with single cisternae of sarcoplasmic reticulum forming a structure called diad.



Structure of cardiac muscle (EM)

- 4) Mitochondria are numerous with closely packed cristae rich in oxidative enzymes.
- 5) The sarcoplasm contains larger amount of glycogen.



Structure of cardiac muscle (EM)

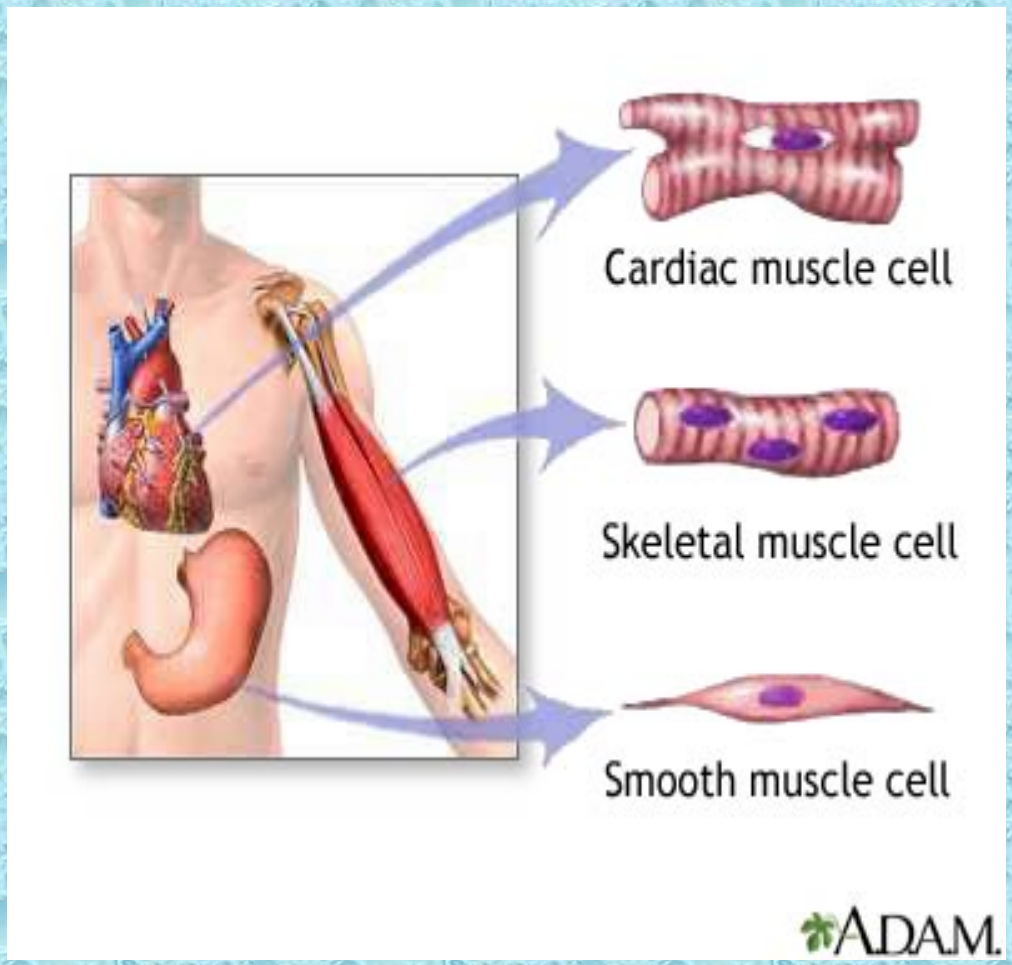
- 7) The cardiac myofibers are formed of several cells connected end-to-end by intercalated discs.
- Each intercalated disc crosses a cardiac fiber at the Z-line level in a stepwise manner.

Smooth muscle (Visceral muscle)

- Smooth muscles are found in the walls of hollow viscera and blood vessels.

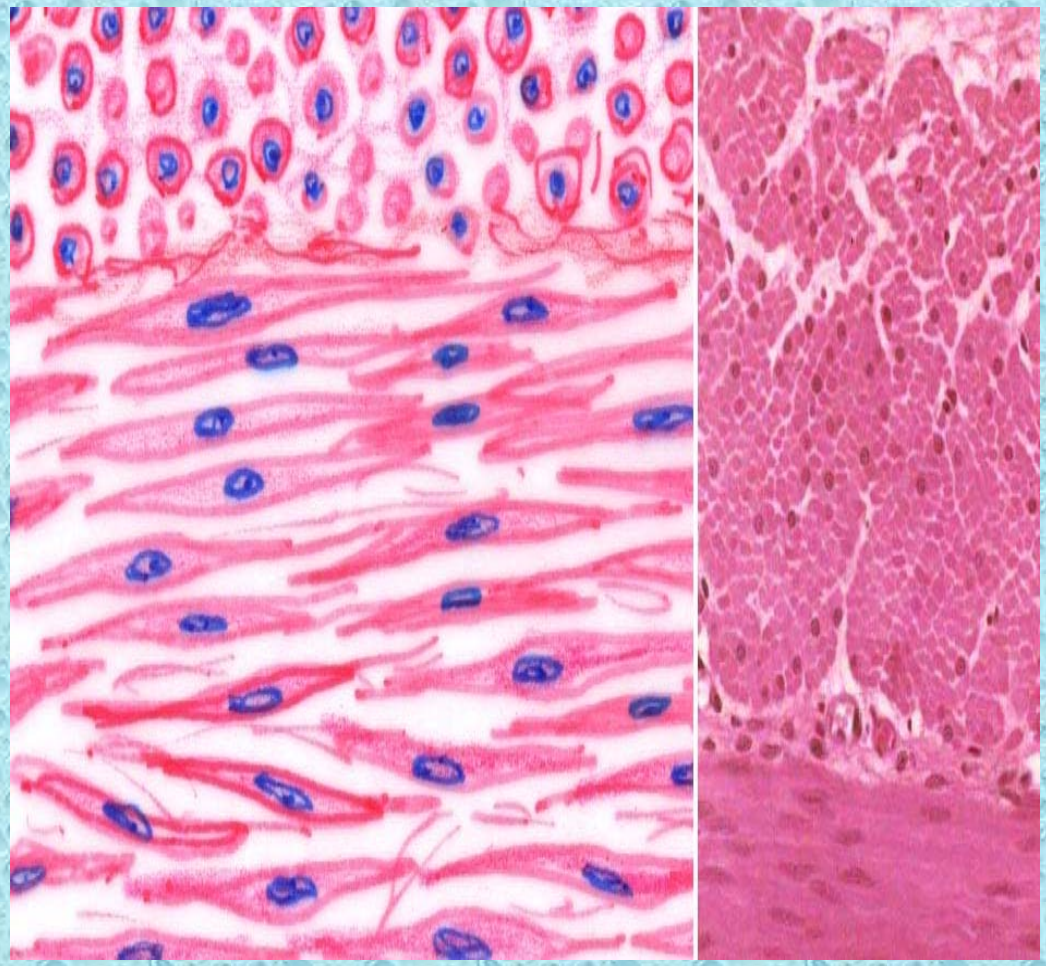
Smooth muscle (Visceral muscle)

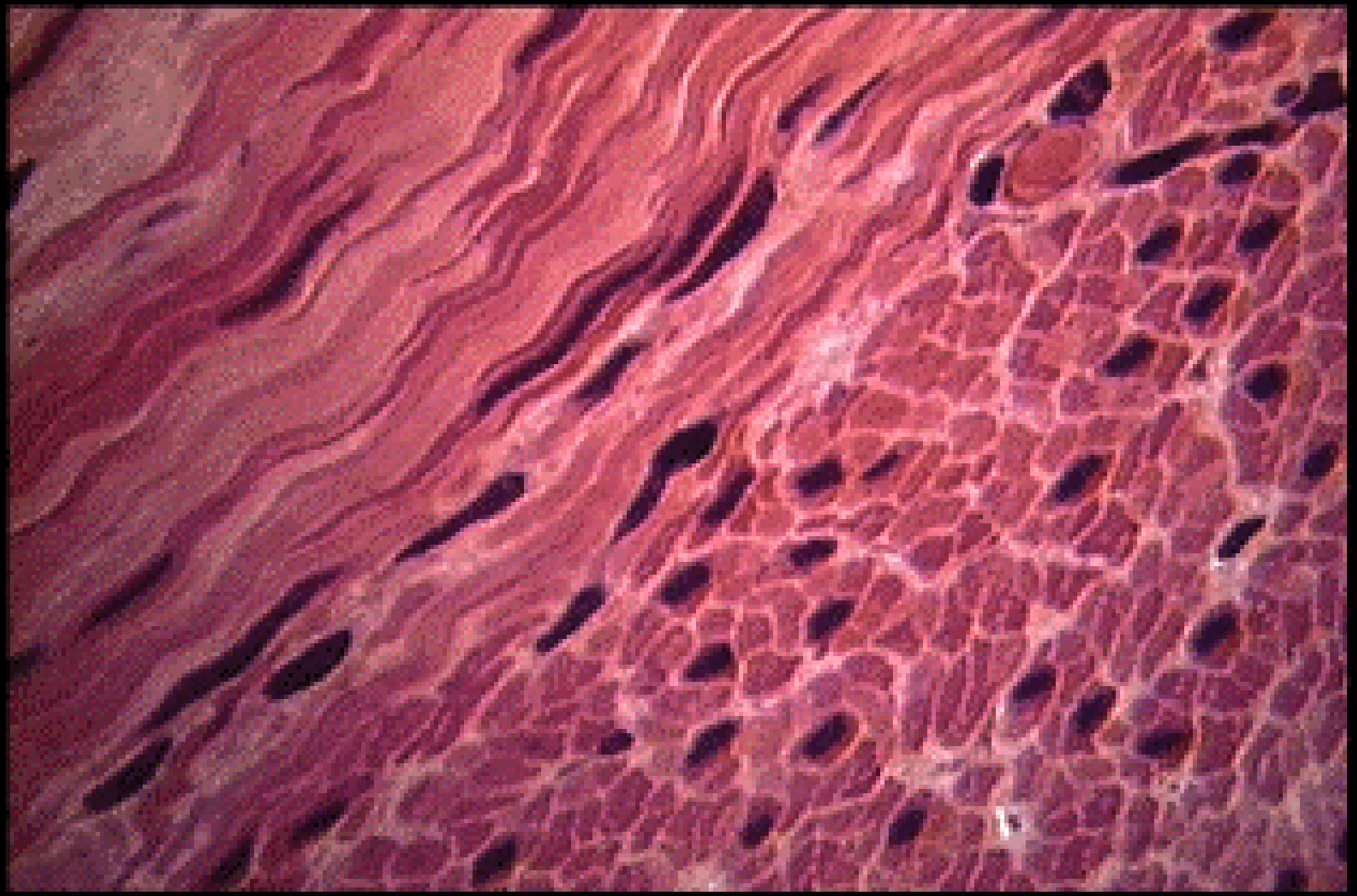
- **Smooth:** it has no cross striations.
- **Involuntary:** its contraction can not be elicited at will.
- **Visceral:** found in visceral organs.

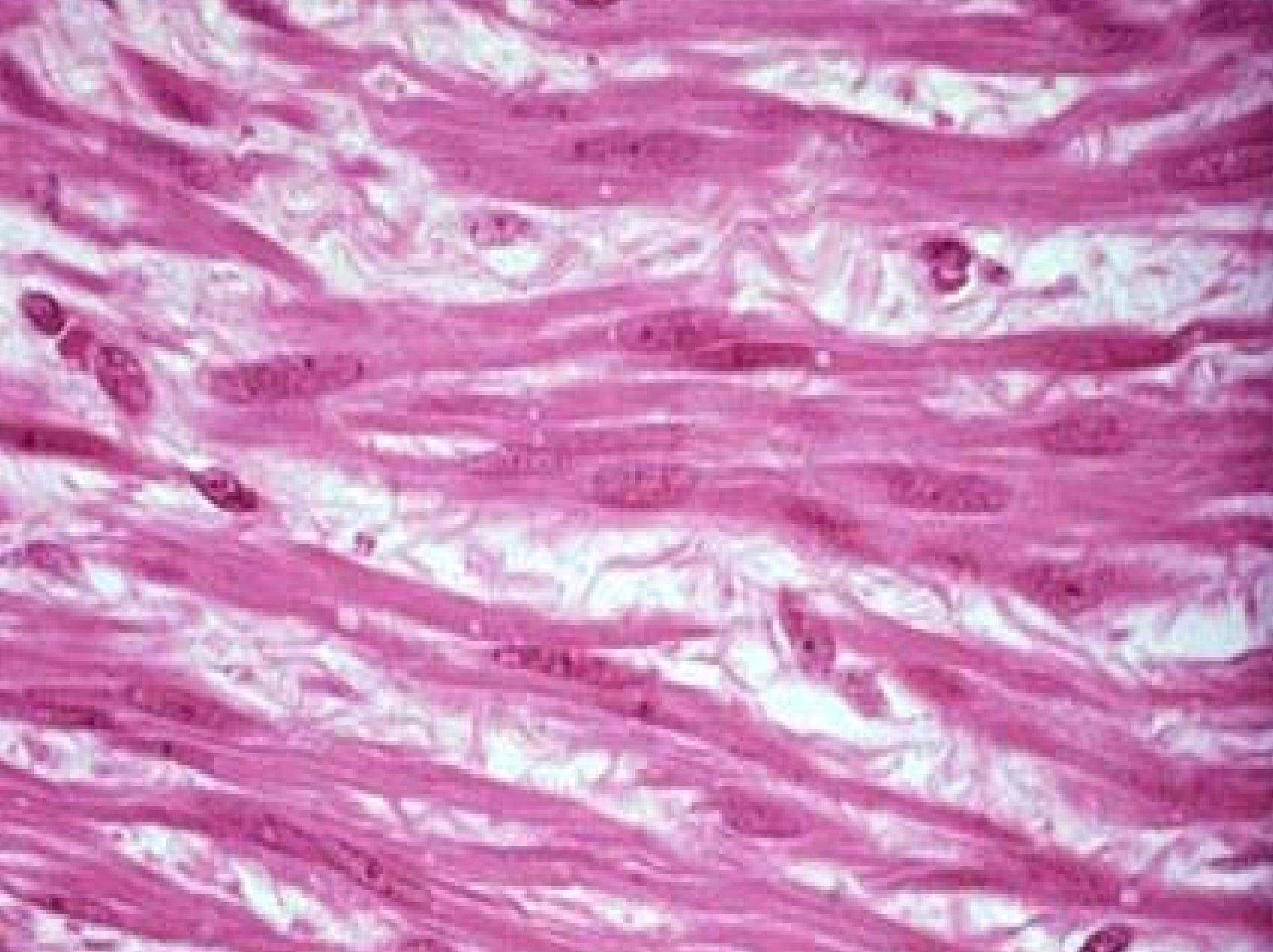


Structure of smooth myofibers (LM)

- **At the LM level:**
- **Elongated.**
- **Spindle-shaped with pointed ends.**
- **It has a diameter of 3-10 μm with length ranges between 30-500 μm.**

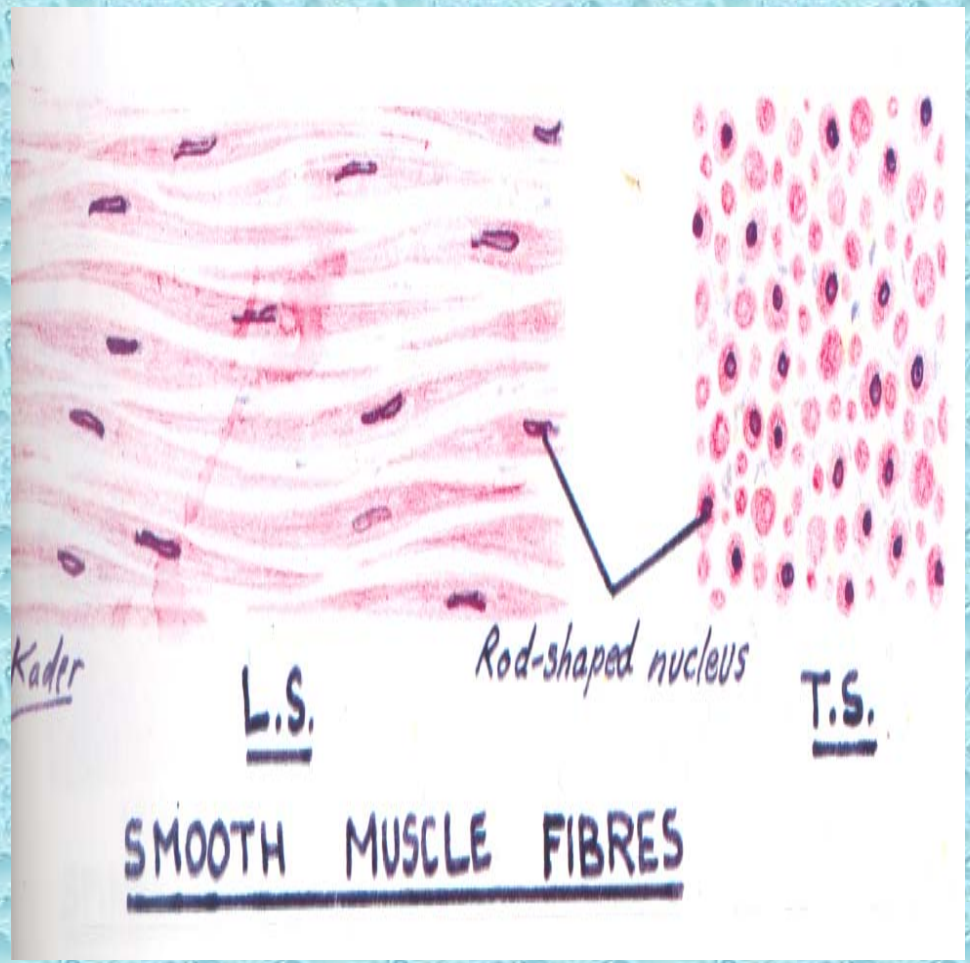


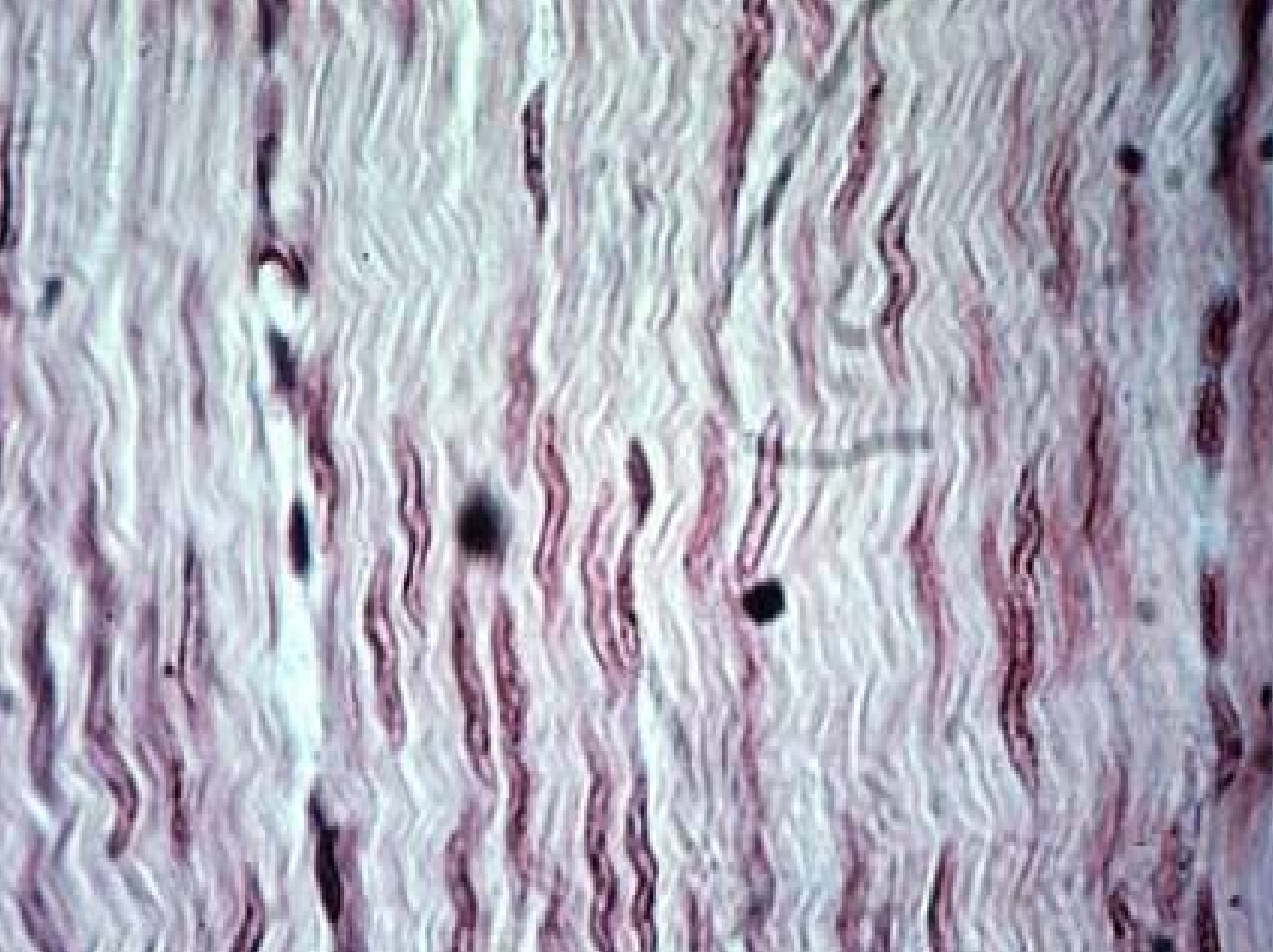




Structure of smooth myofibers (LM)

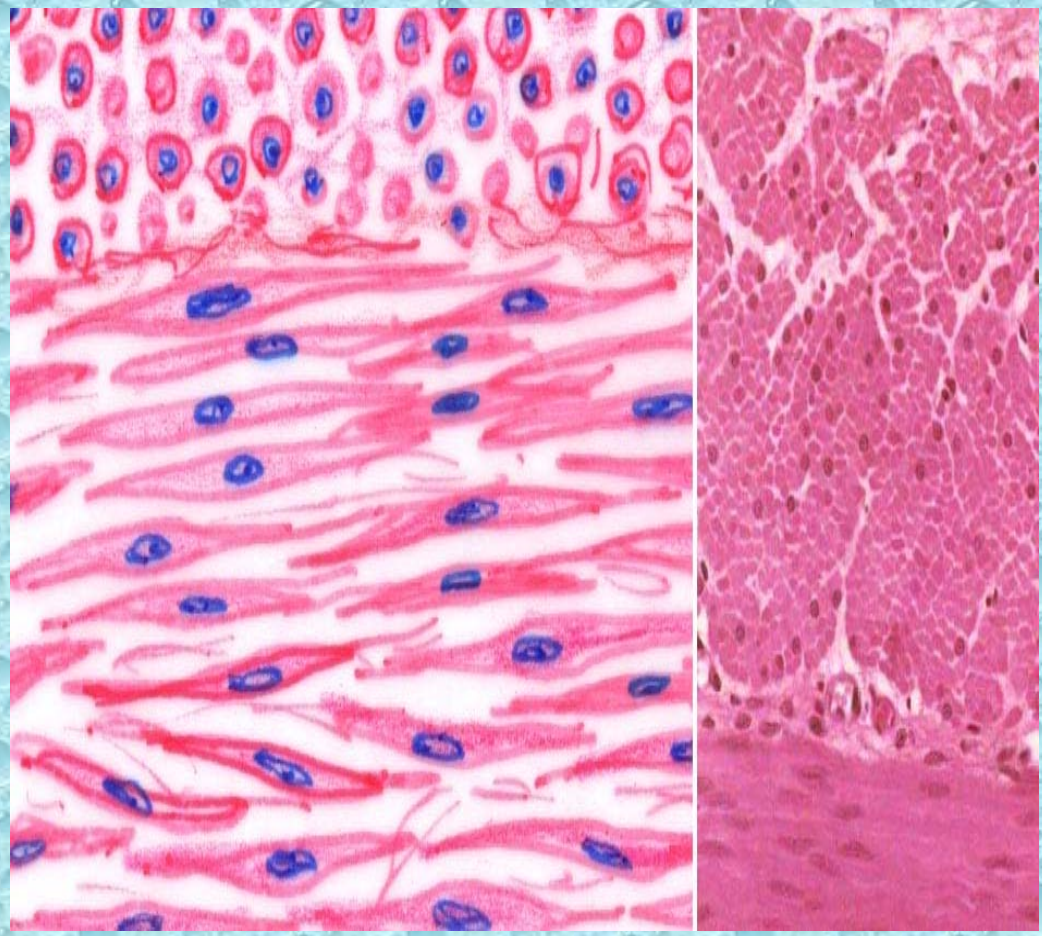
- The cytoplasm is acidophilic and contains only one nucleus.
- The nucleus is elongated and centrally located in the cytoplasm at the widest part of the cell. During contraction, the nuclei may appear spiral in shape.





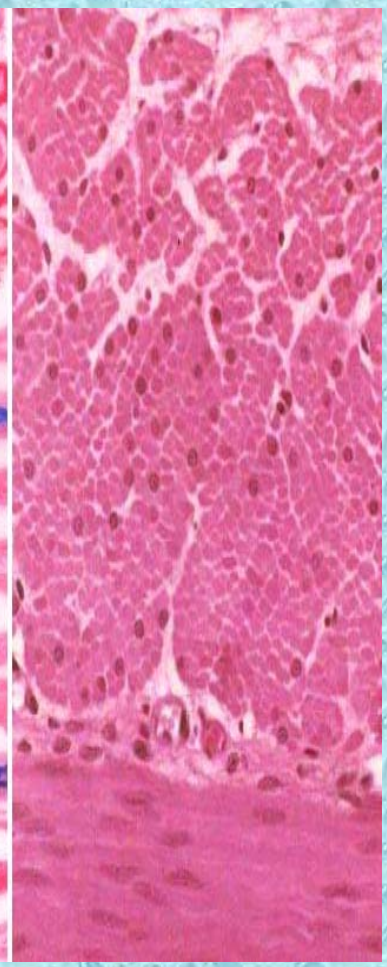
Structure of smooth myofibers (LM)

- In cross sections, the spindle shaped cells is sectioned at different levels along their length.
- The cells appear spherical or oval with a differing diameter.



Structure of smooth myofibers (LM)

- Nuclei are only included when the fiber cut through their widest portion and is located centrally.



Structure of smooth myofibers (EM)

- **The cytoplasm is filled with parallel thin (actin) and thick (myosin) filaments.**
- **The filaments do not have the arrangement seen in the sarcomeres.**