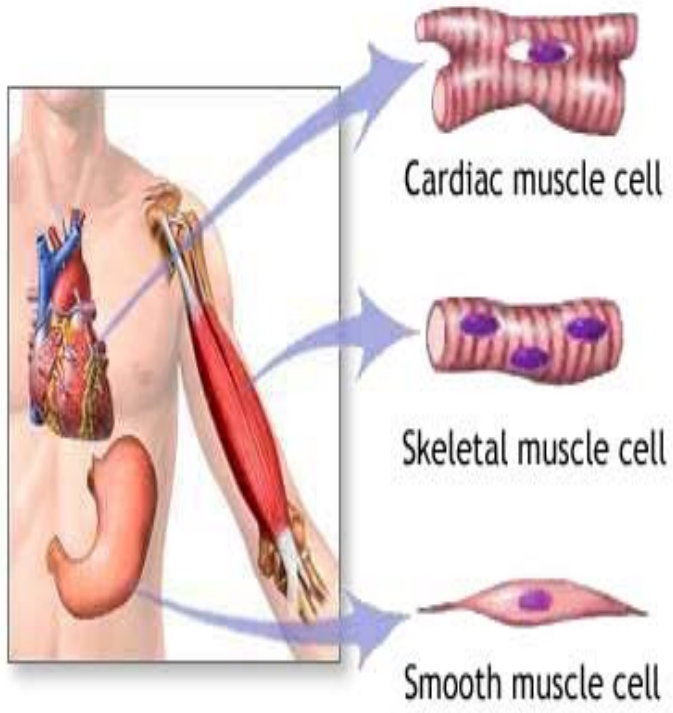
Muscular tissue

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

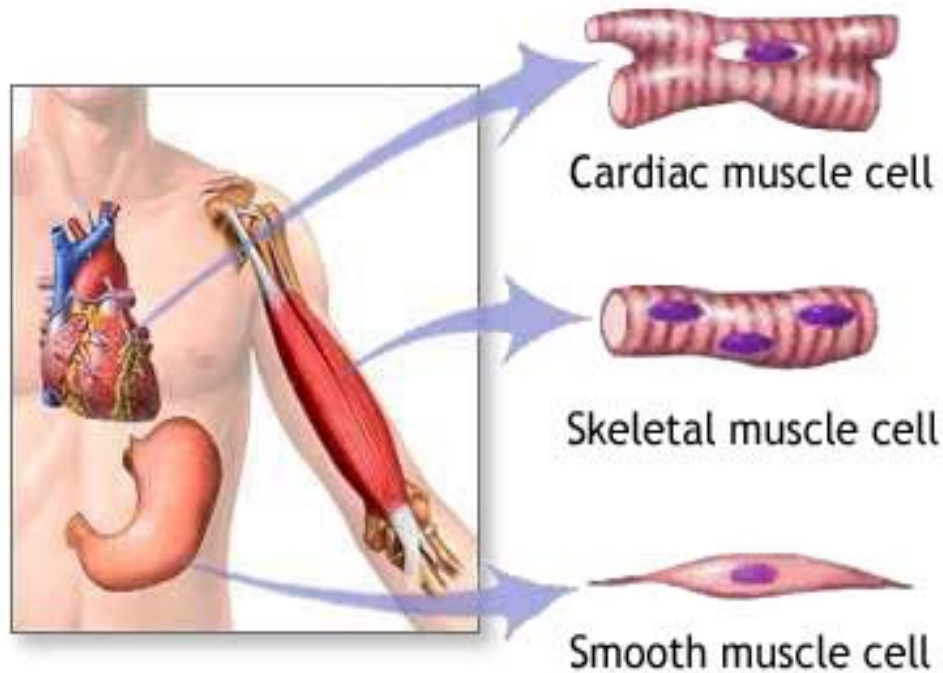
General features

- **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).**



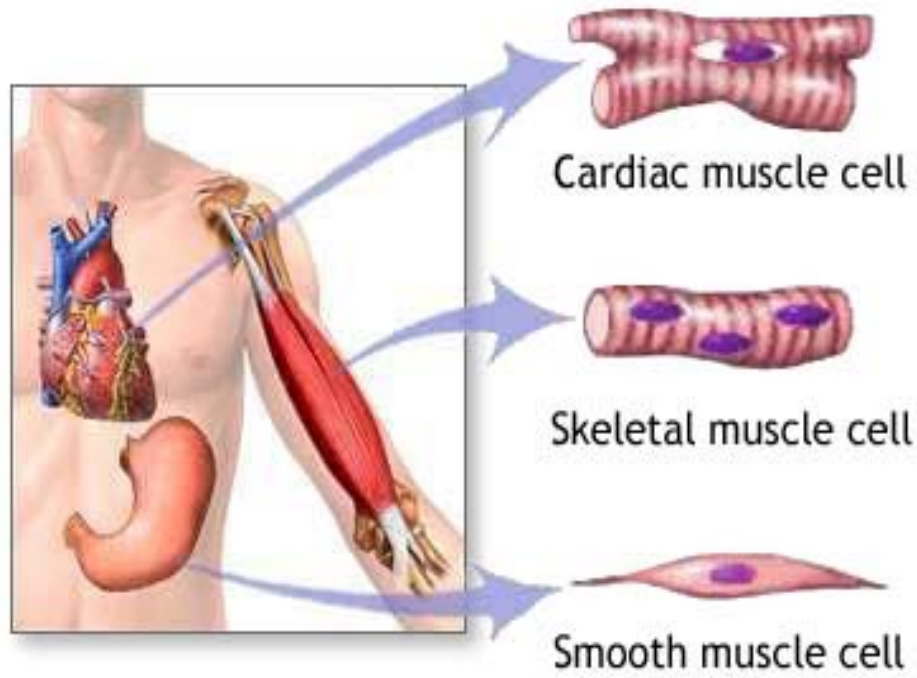
General features

- **There are <u>three types</u> of muscle tissue:**
- **Skeletal muscles**
- **Cardiac muscles**
- **Smooth muscles**



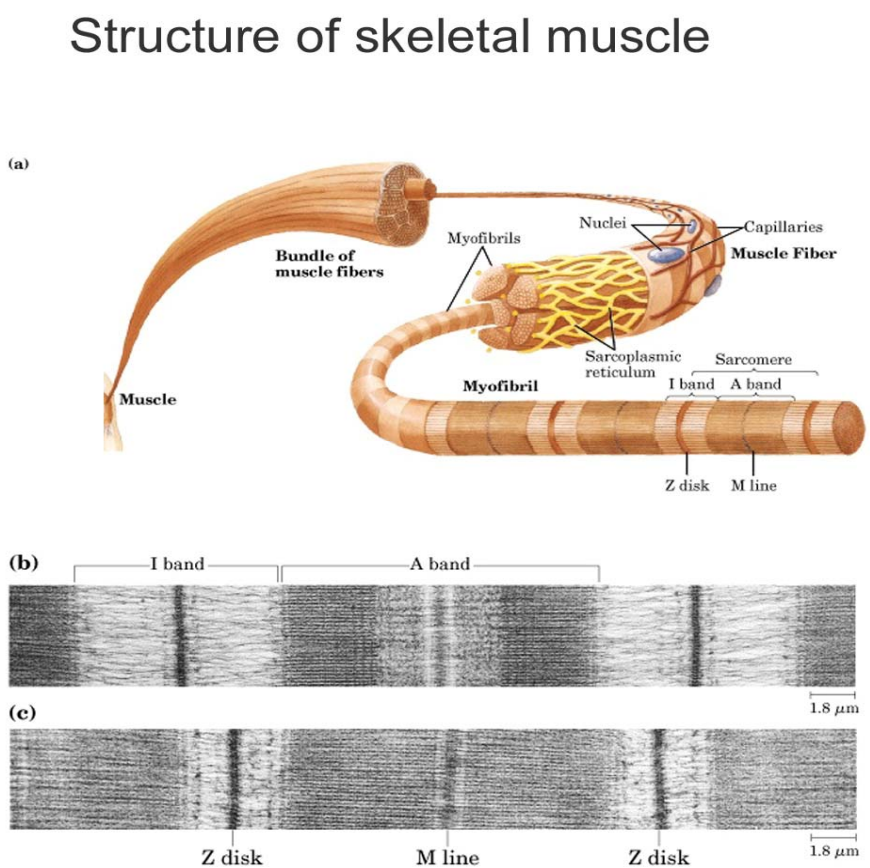
Skeletal muscle (Striated and voluntary myofibers)

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



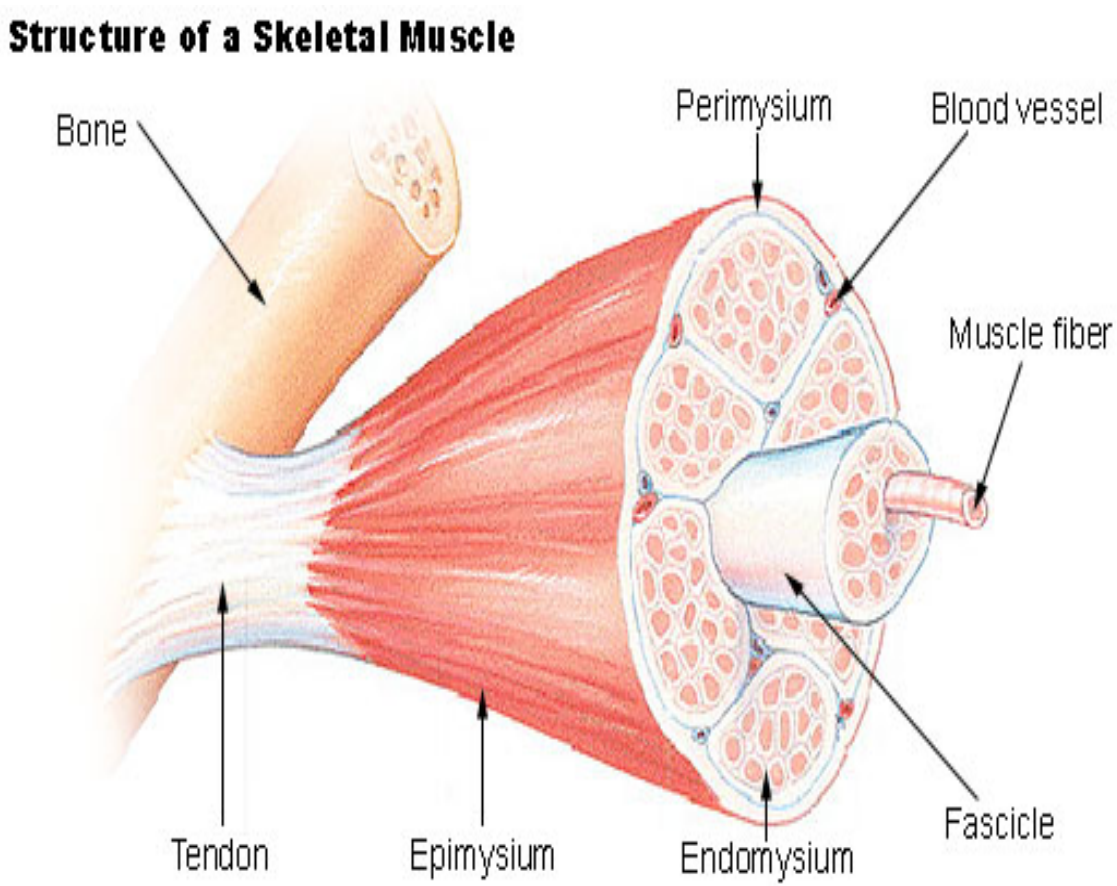
Skeletal muscle (Striated and voluntary myofibers)

- **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.**



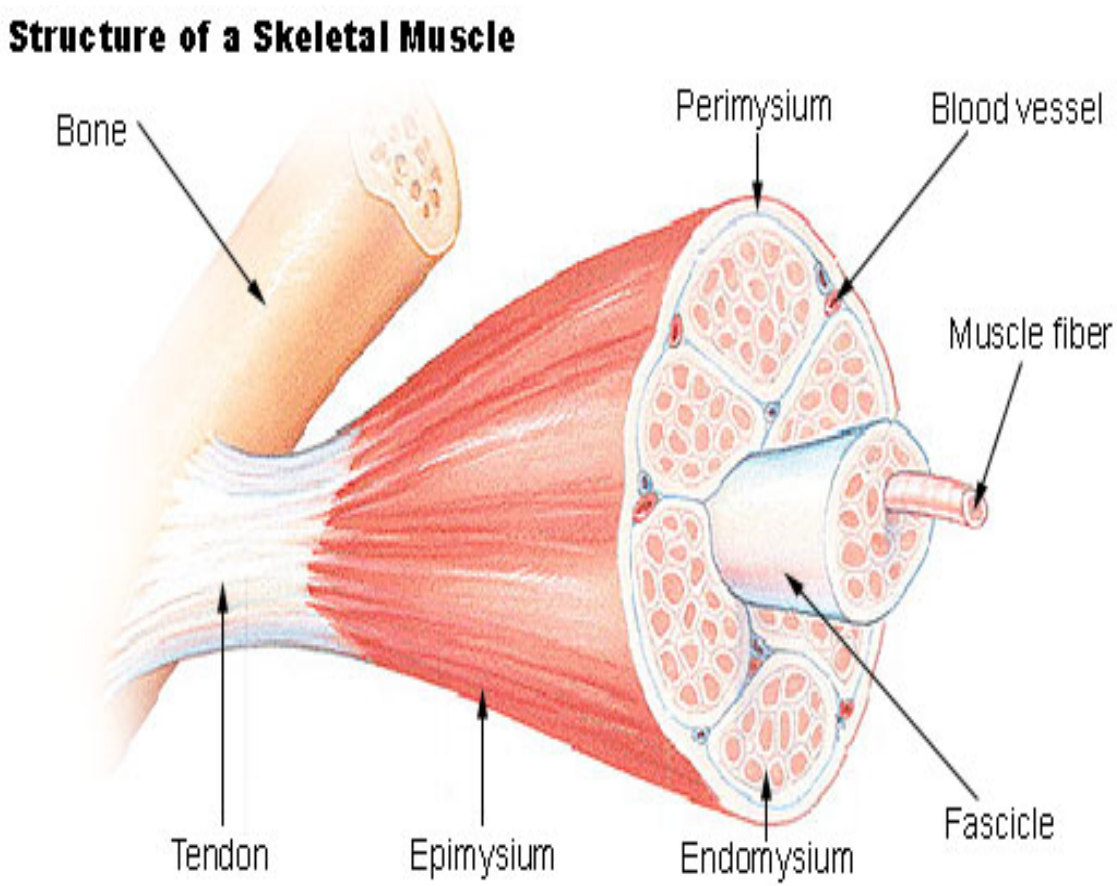
Skeletal muscle (Striated and voluntary myofibers)

- **Composed of:**
- **Skeletal myofibers.**
- **Connective tissue.**
- **A sheath of dense connective tissue called <u>epimysium</u> encloses the entire muscle.**



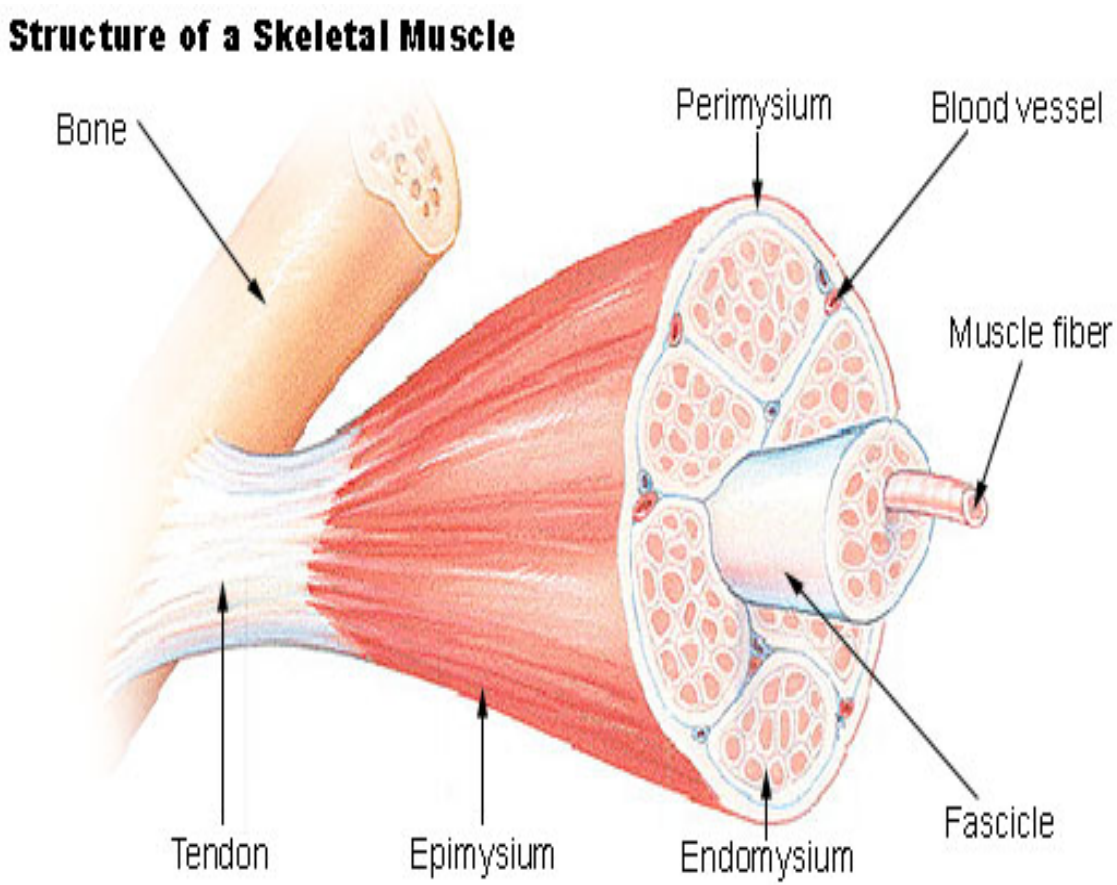
Skeletal muscle (Striated and voluntary myofibers)

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



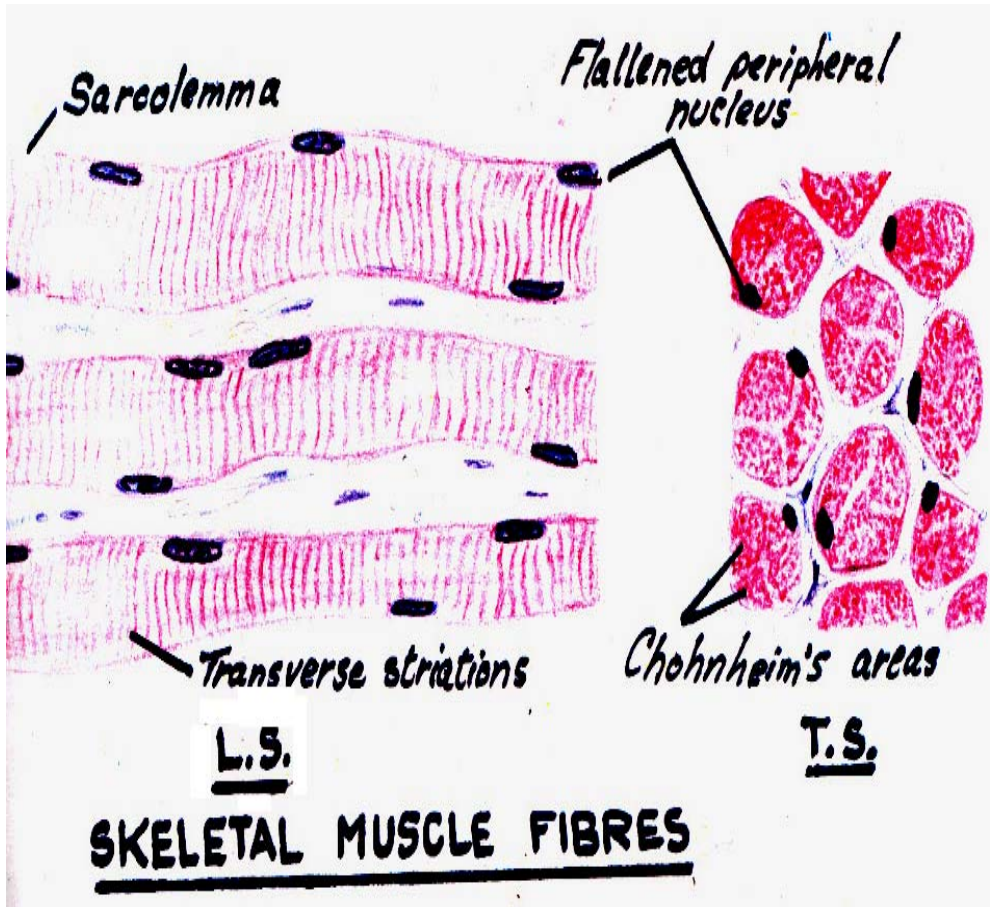
Skeletal muscle (Striated and voluntary myofibers)

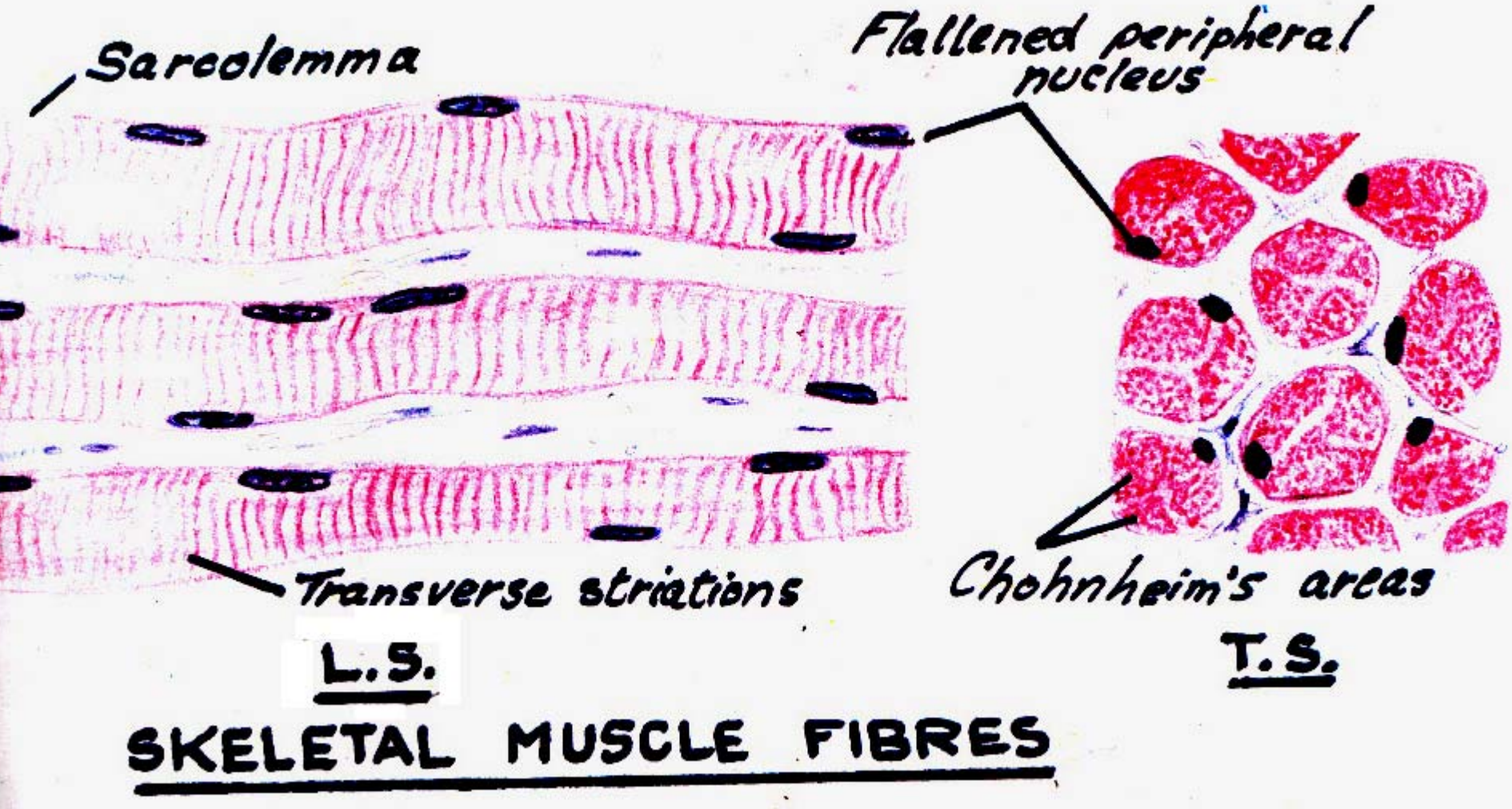
- **The perimysium is continuous with the endomysium that is a delicate connective tissue layer surrounds each individual myofibers.**



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.**

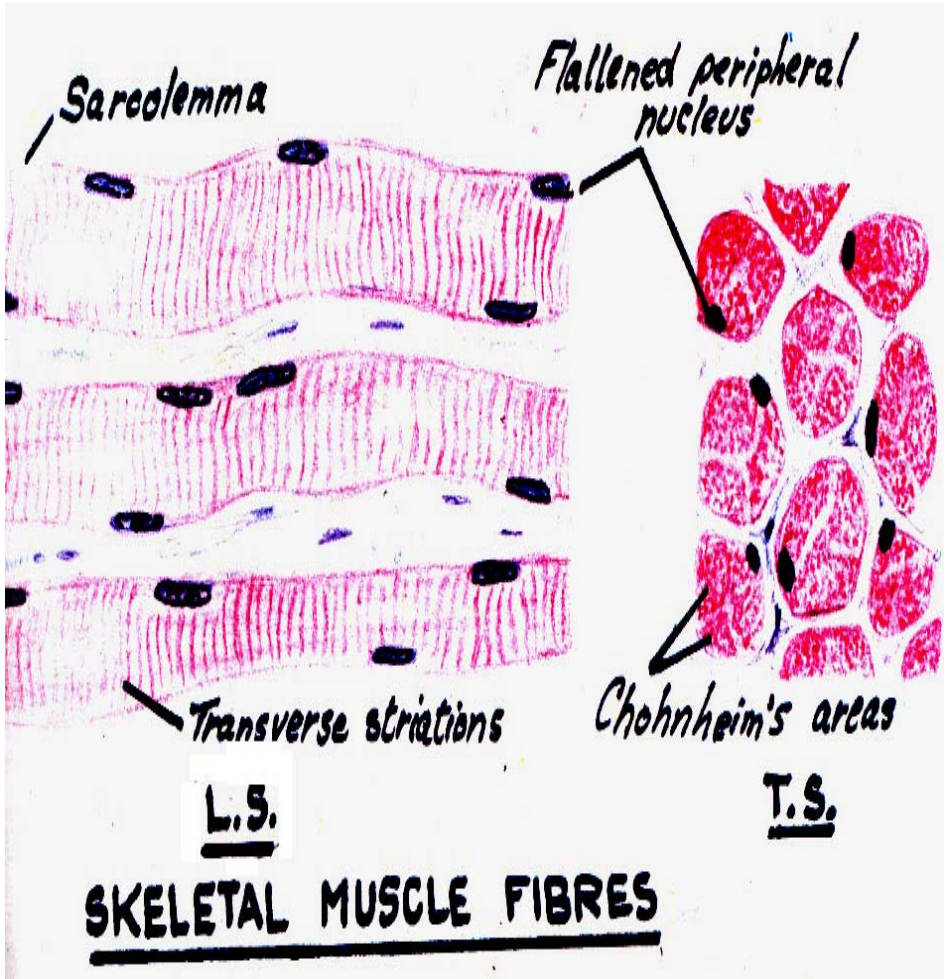




SKELETAL MUSCLE FIBRES

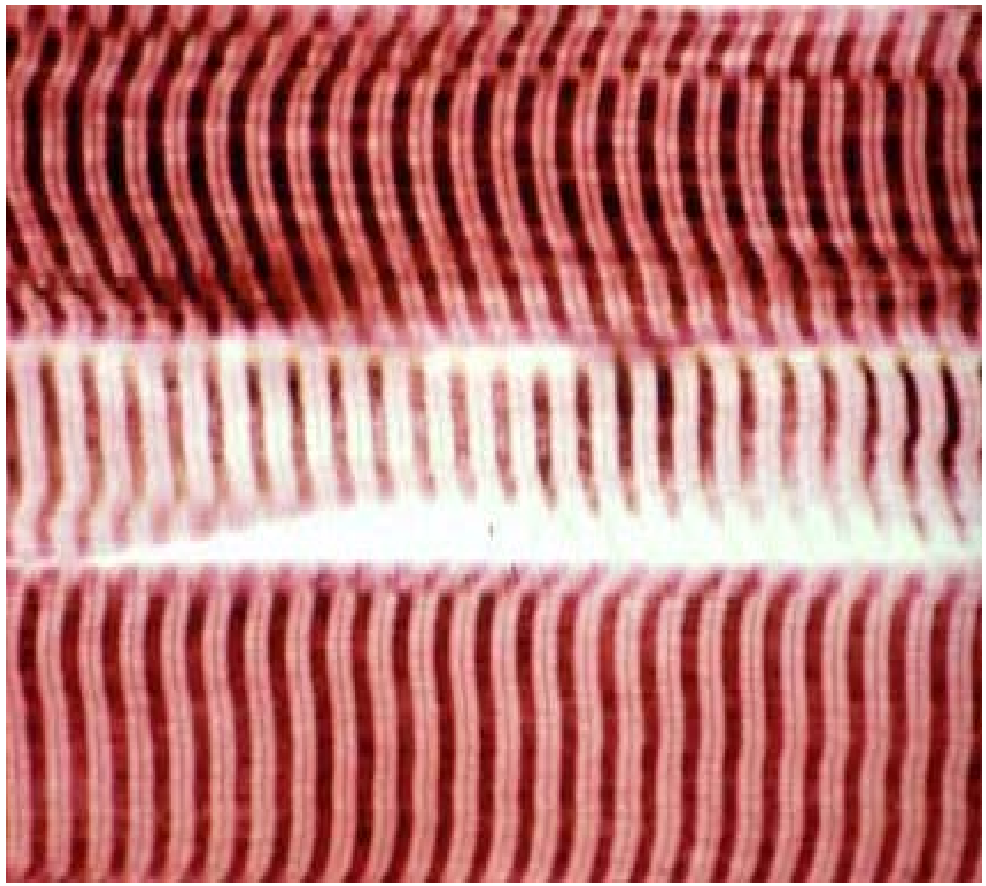
Structure of skeletal myofiber (LM)

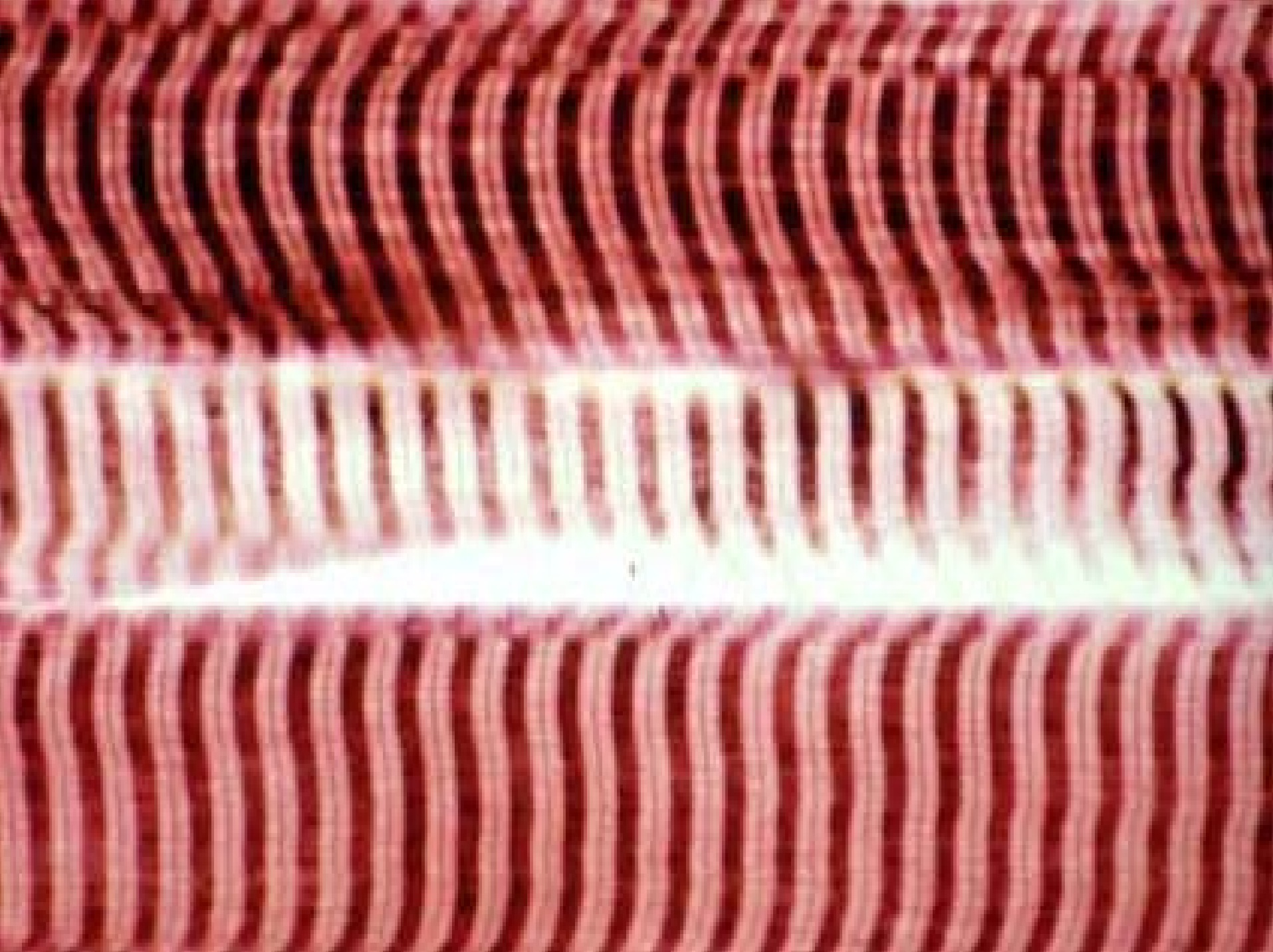
- **The nuclei are:**
- **oval, elongated**
- **located just underneath the sarcolemma.**



Structure of skeletal myofiber (LM)

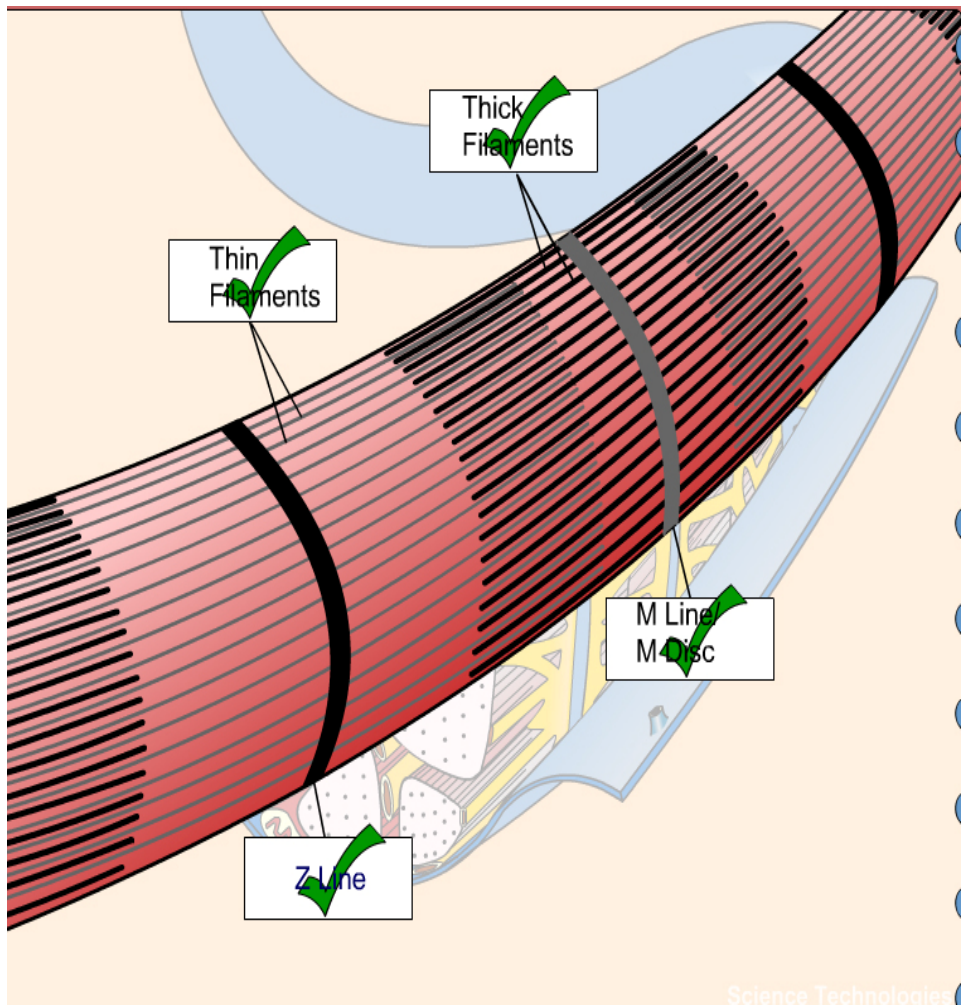
- **Myofibrils show alternating dark and light transverse bands.**
- **The light-staining bands are called isotropic or I-band and the dark band is called anisotropic or A-band.**
- **The Light I bands are bisected by dark line called Z lines.**





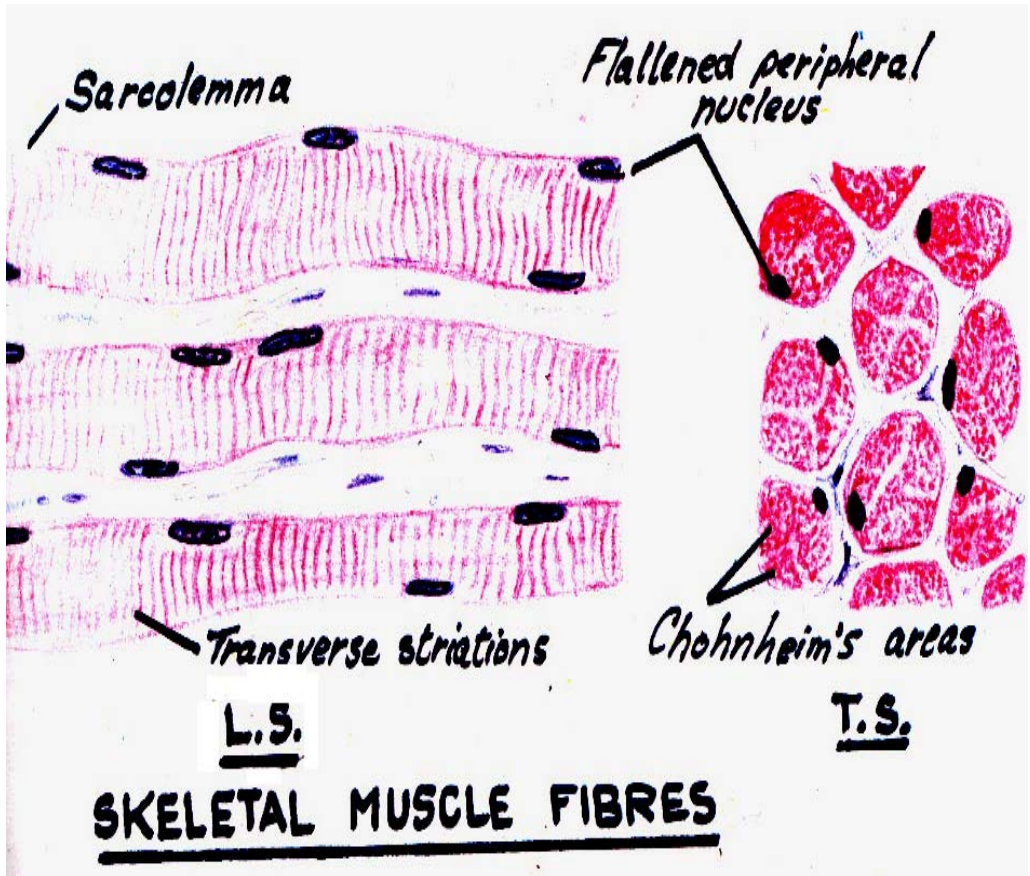
Structure of skeletal myofiber (LM)

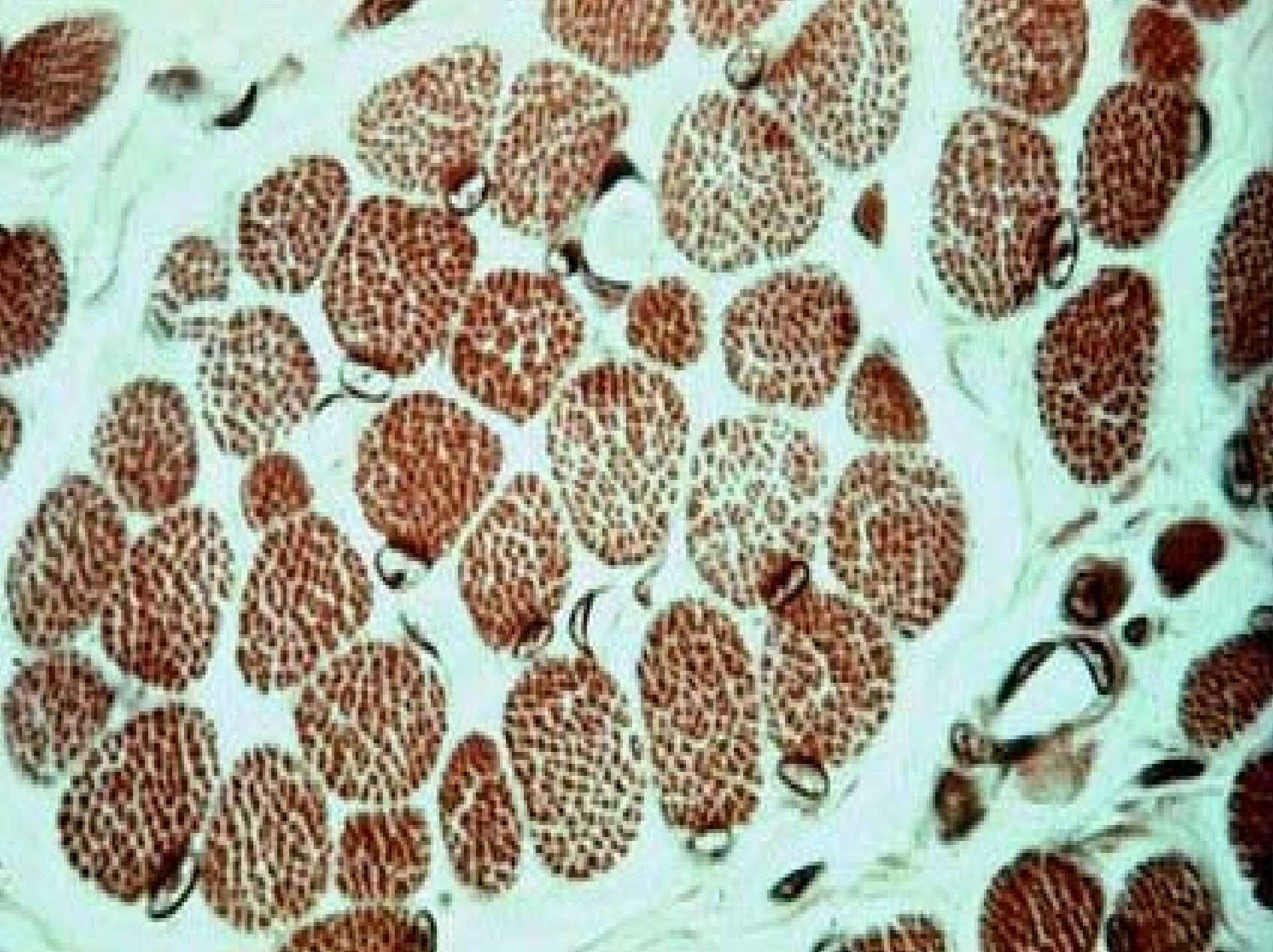
- **The center of each dark A-band contains a paler region called H-zones or H-band.**
- **The distance between two successive Z lines is called <u>sarcomere</u> that is the contractile unit of the skeletal muscles.**



Structure of skeletal myofiber (LM)

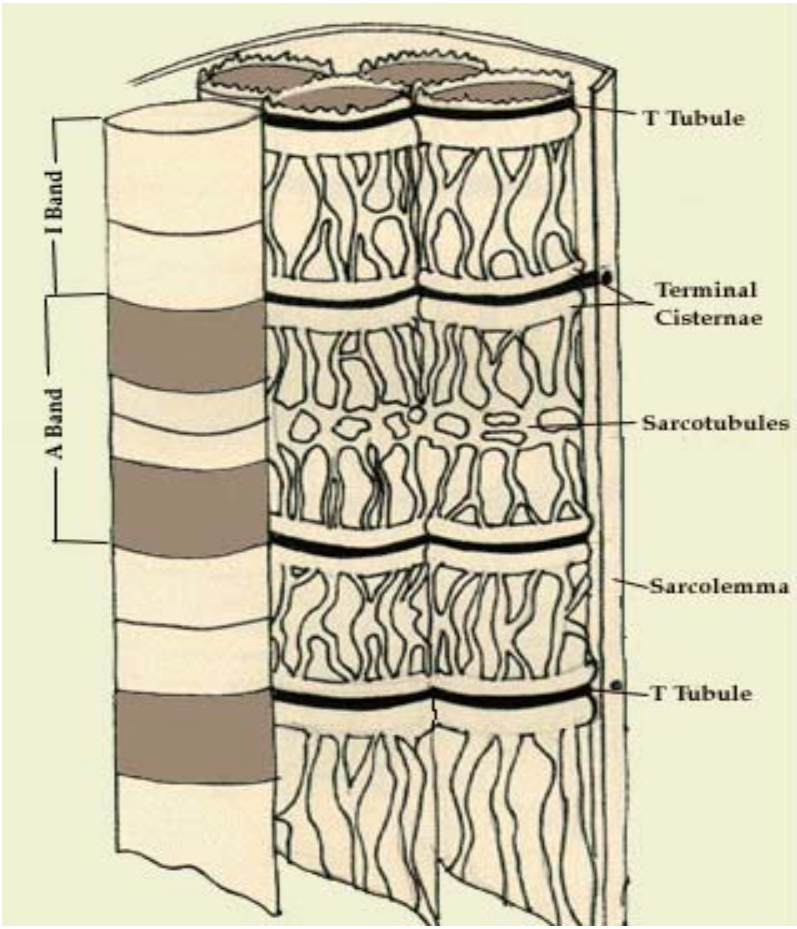
- **In cross sections, the skeletal myofibers appear oval, spherical or polygonal with their nuclei are peripherally located.**

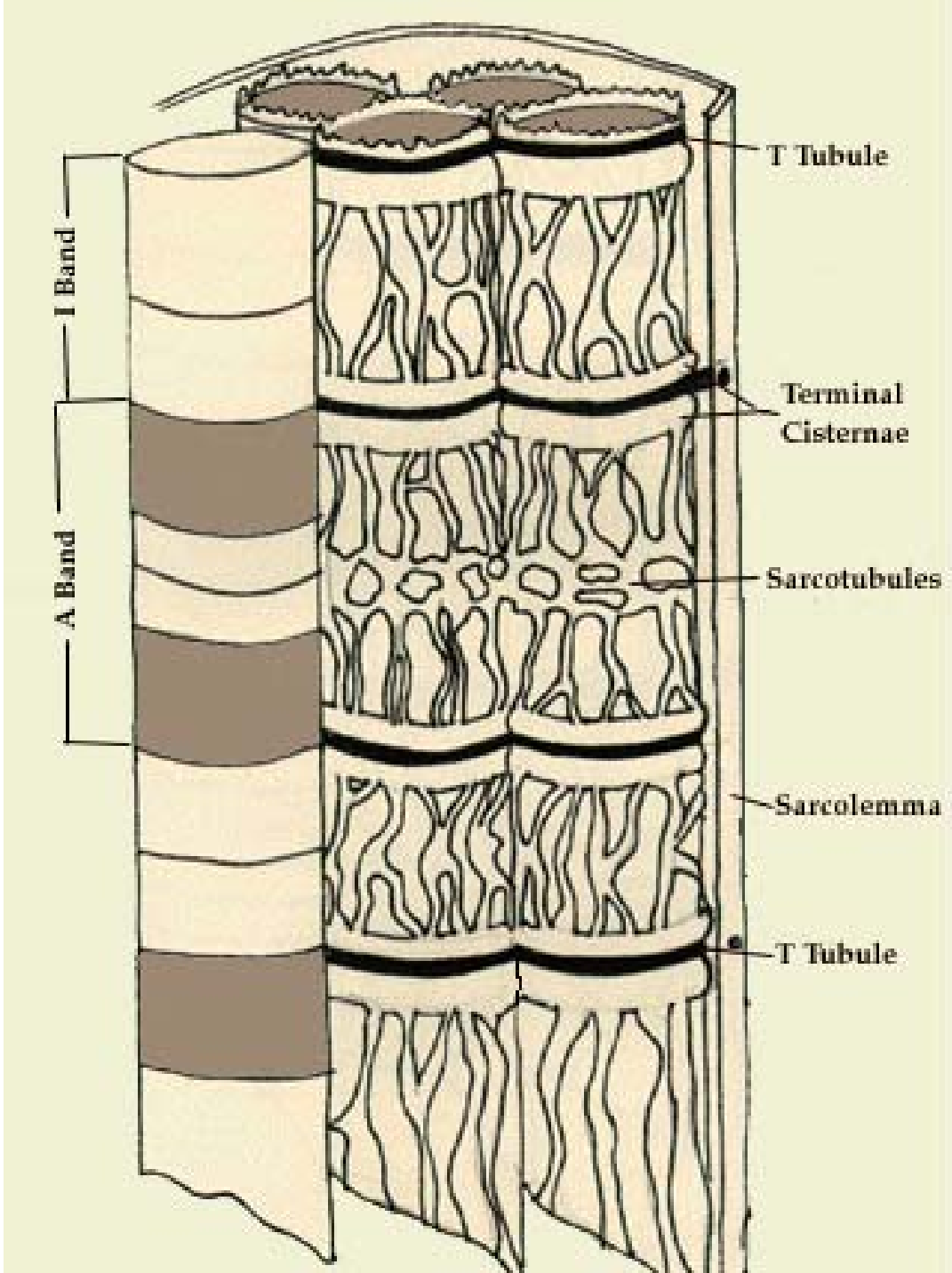




Structure of skeletal myofiber (EM)

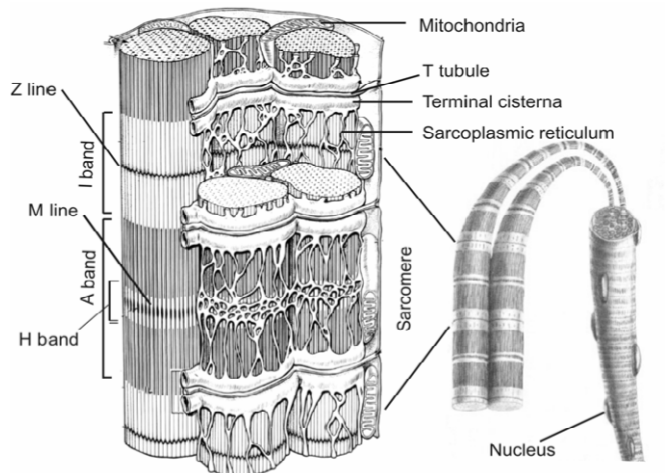
- **<u>At the EM level,</u> the sarcoplasm is filled with <u>myofibrils</u> arranged parallel to the long axis of the cell.**

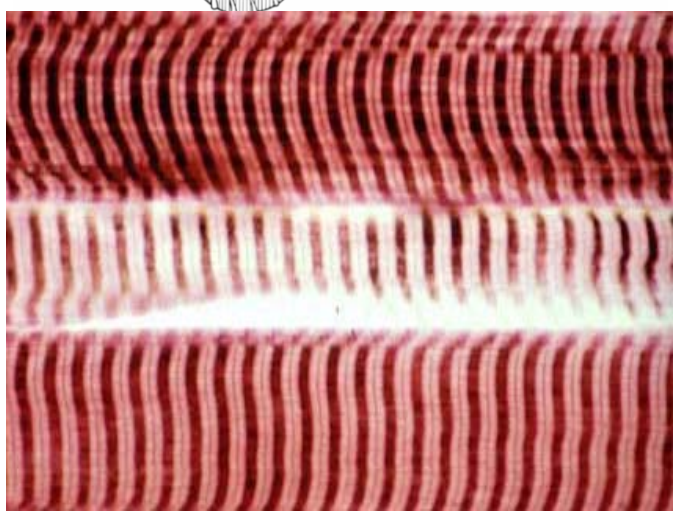


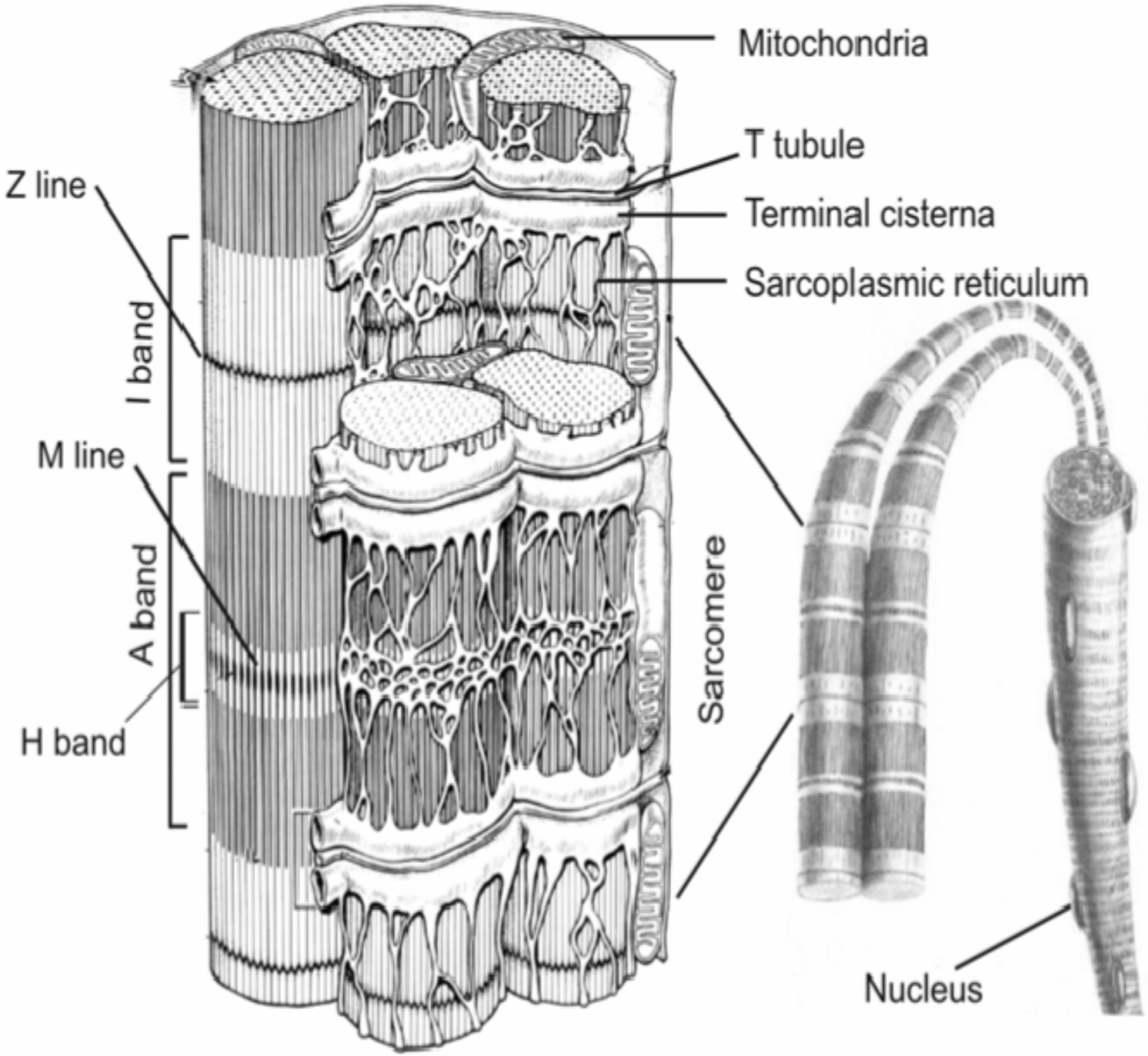

T Tubule
I Band
A Band
Terminal
Cisternae
Sarcotubules
Sarcolemma
T Tubule

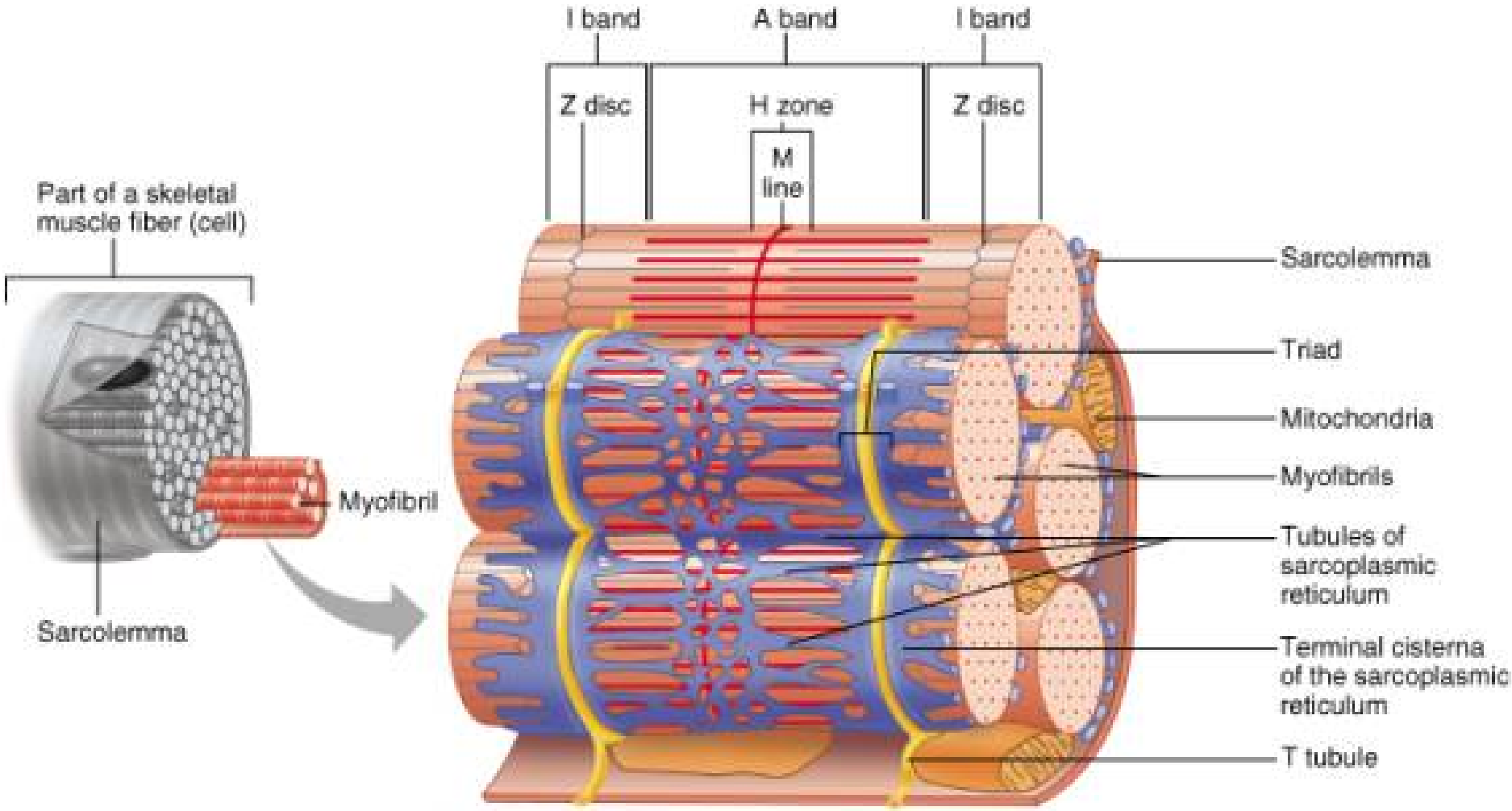
Structure of skeletal myofiber (EM)

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



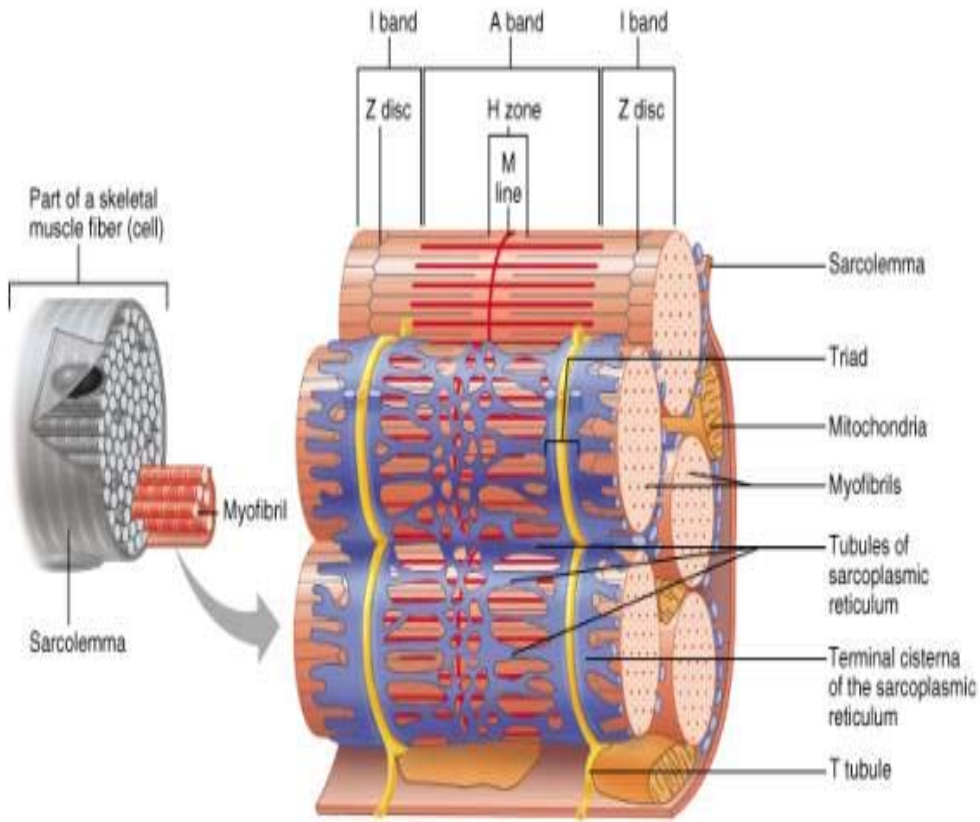


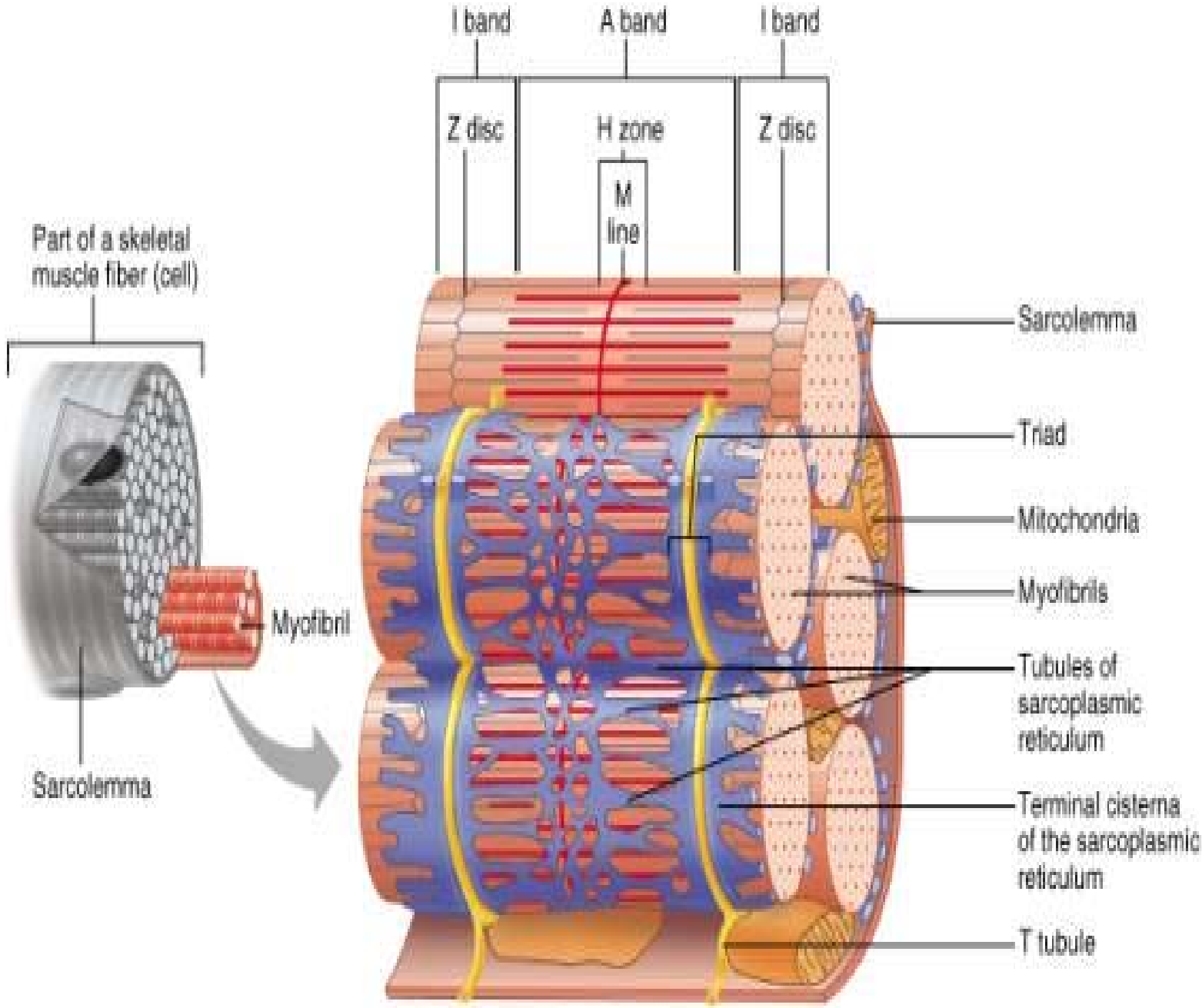

Mitochondria
T tubule
Terminal cisterna
Sarcoplasmic reticulum
Z line
I band
M line
A band
H band
Sarcomere
Nucleus



Structure of skeletal myofiber (EM)

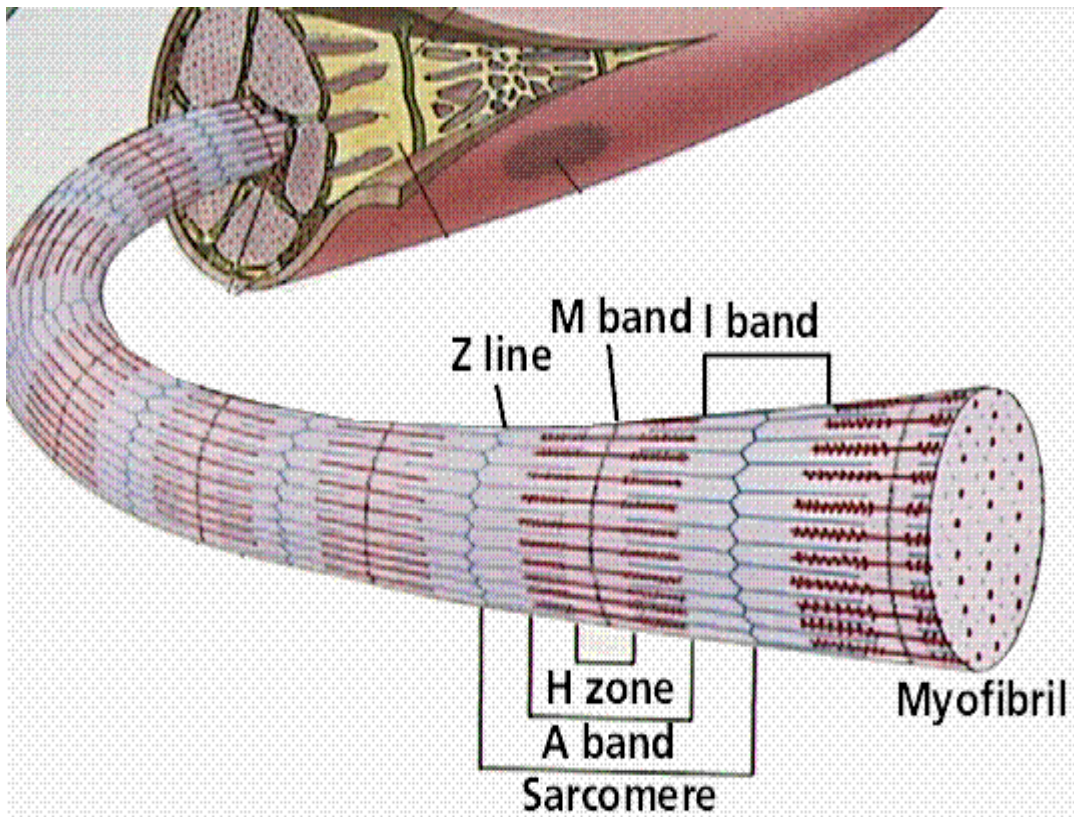
- **The myofibrils are found to be composed of smaller units called the myofilaments that are of two types: myosin (thick) and actin (thin) filaments.**




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

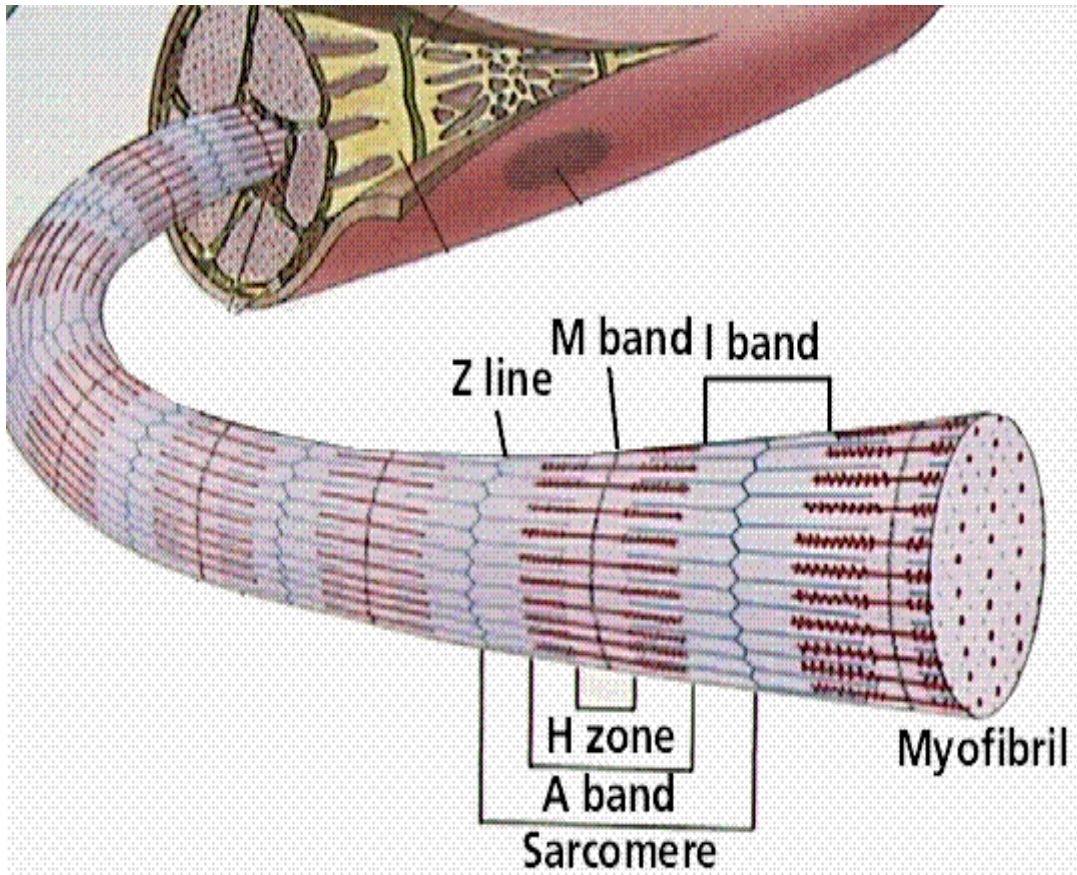
Structure of skeletal myofiber (EM)

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



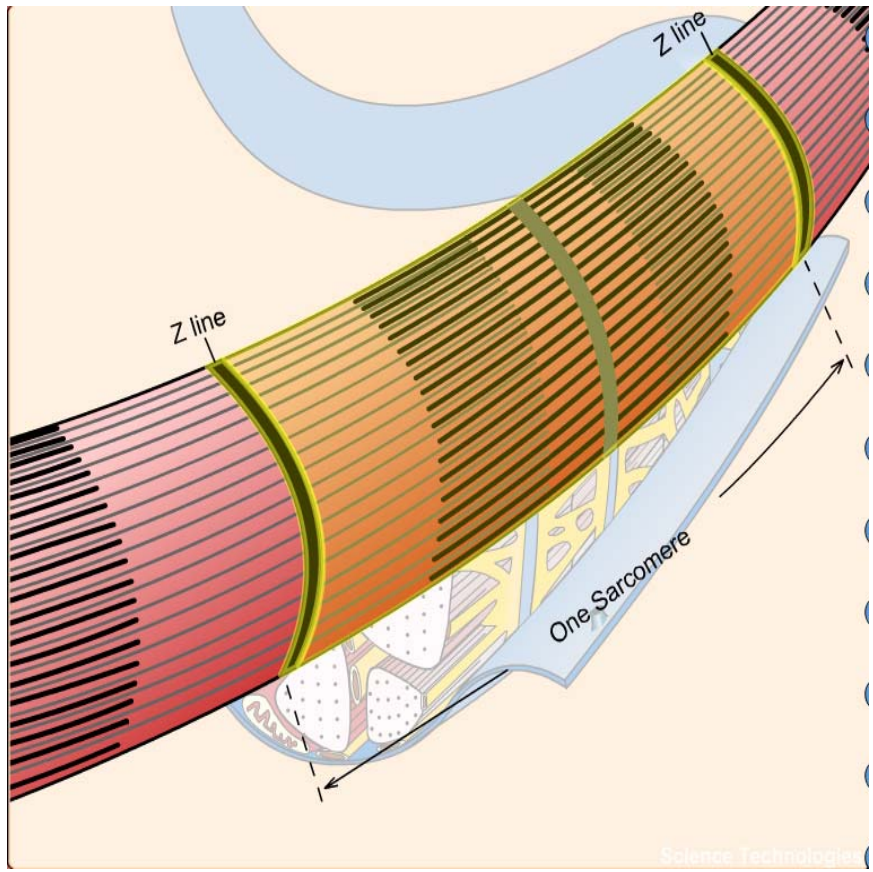
Structure of skeletal myofiber (EM)

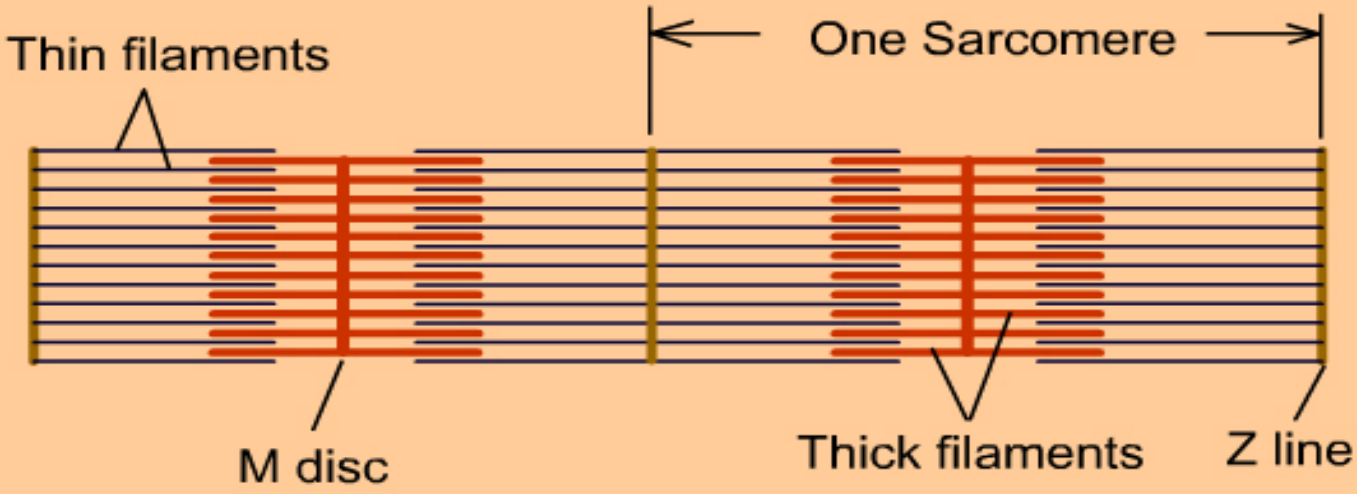
- **They are maintained in parallel by their attachment to a disc-like zone called the M-band that is located in the center of H-band.**



Structure of skeletal myofiber (EM)

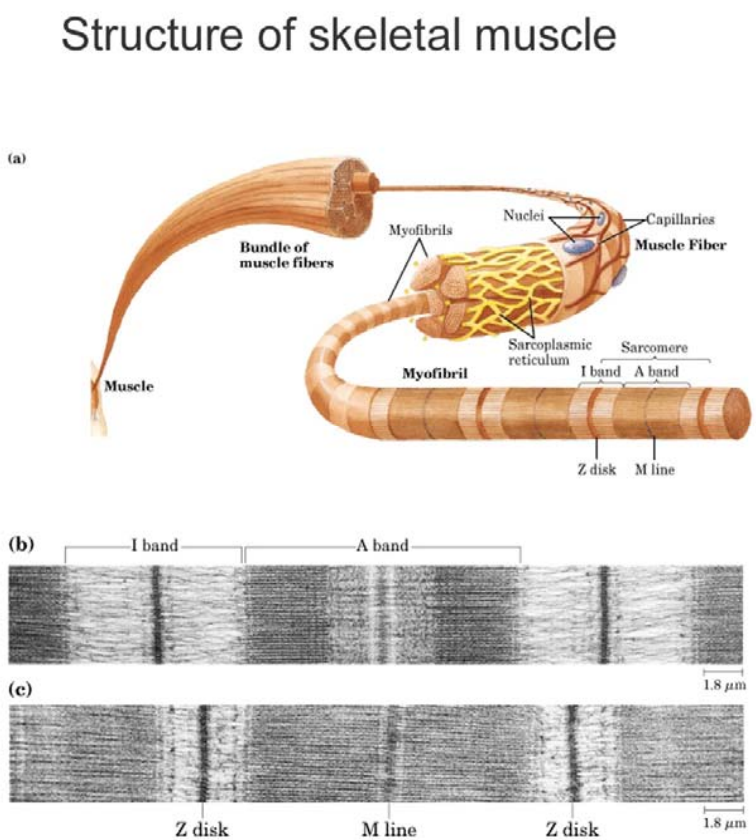
- **The thin filaments are composed mainly of protein actin that is associated with two other proteins, tropomyosin and troponin.**
- **They are attached to both sides of the Z-lines to form the I-band.**





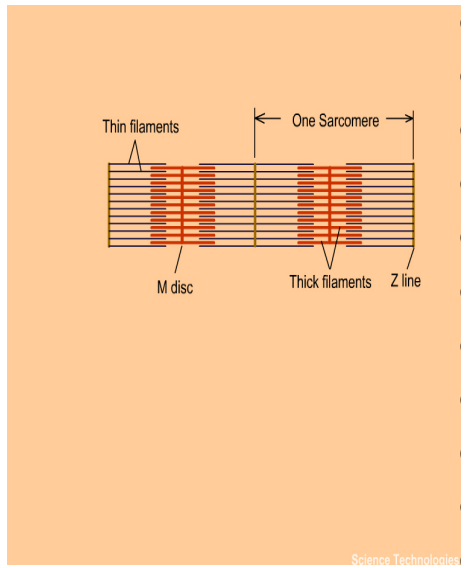
Structure of skeletal myofiber (EM)

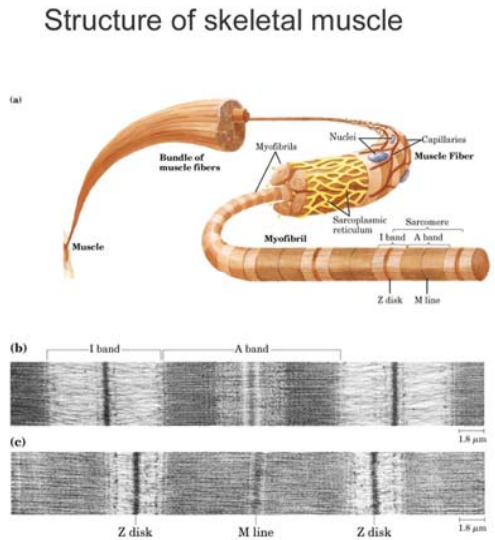
- **The A-bands are electron-dense and appear dark because they contain two types of filaments.**



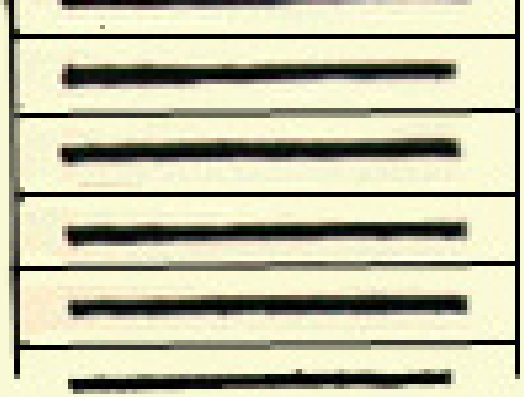
Structure of skeletal myofiber (EM)

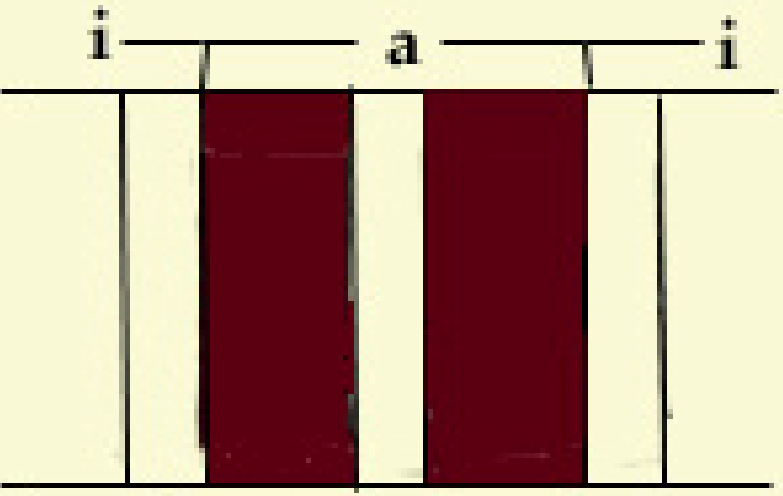
- **The H-bands and I are of low electron density and appear light because the thin and thick filaments do not overlap one another.**





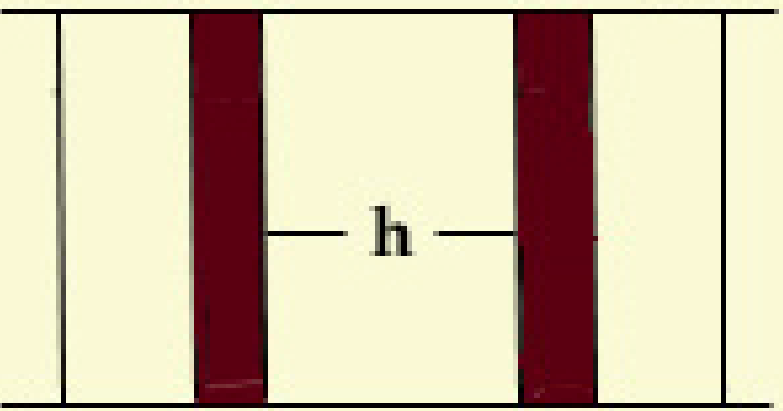
Contracted





Rest Length

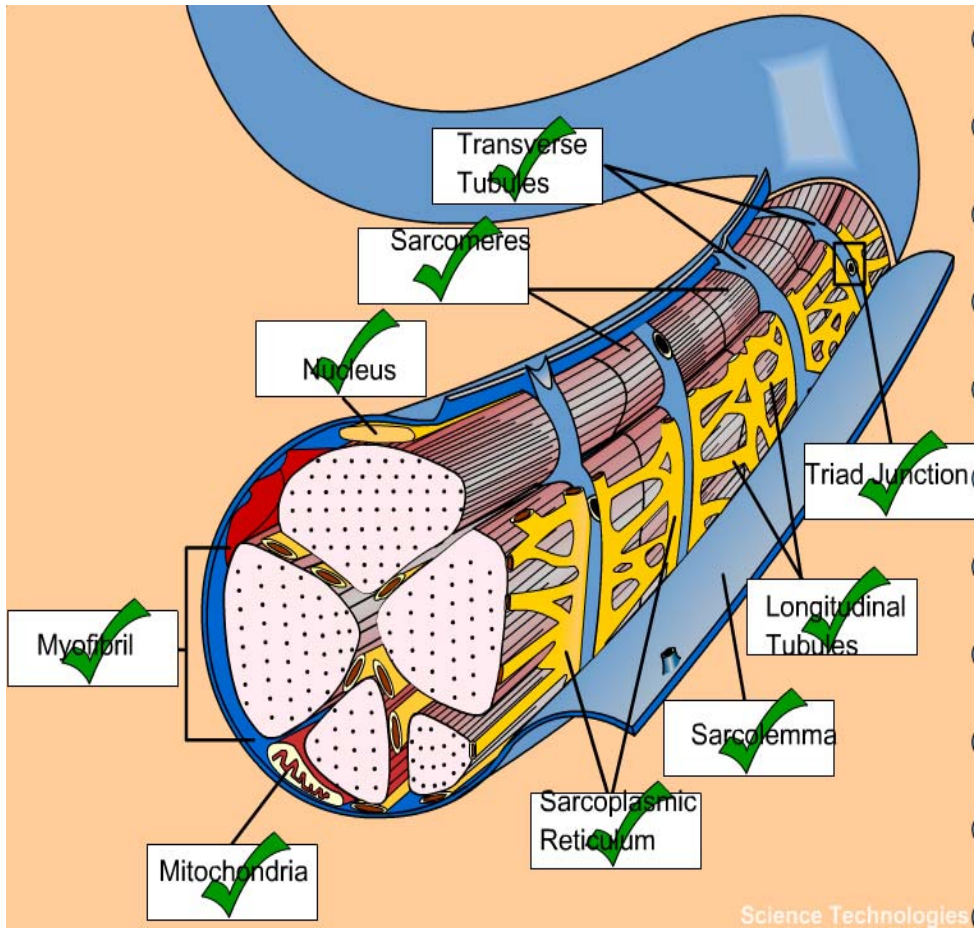
z z

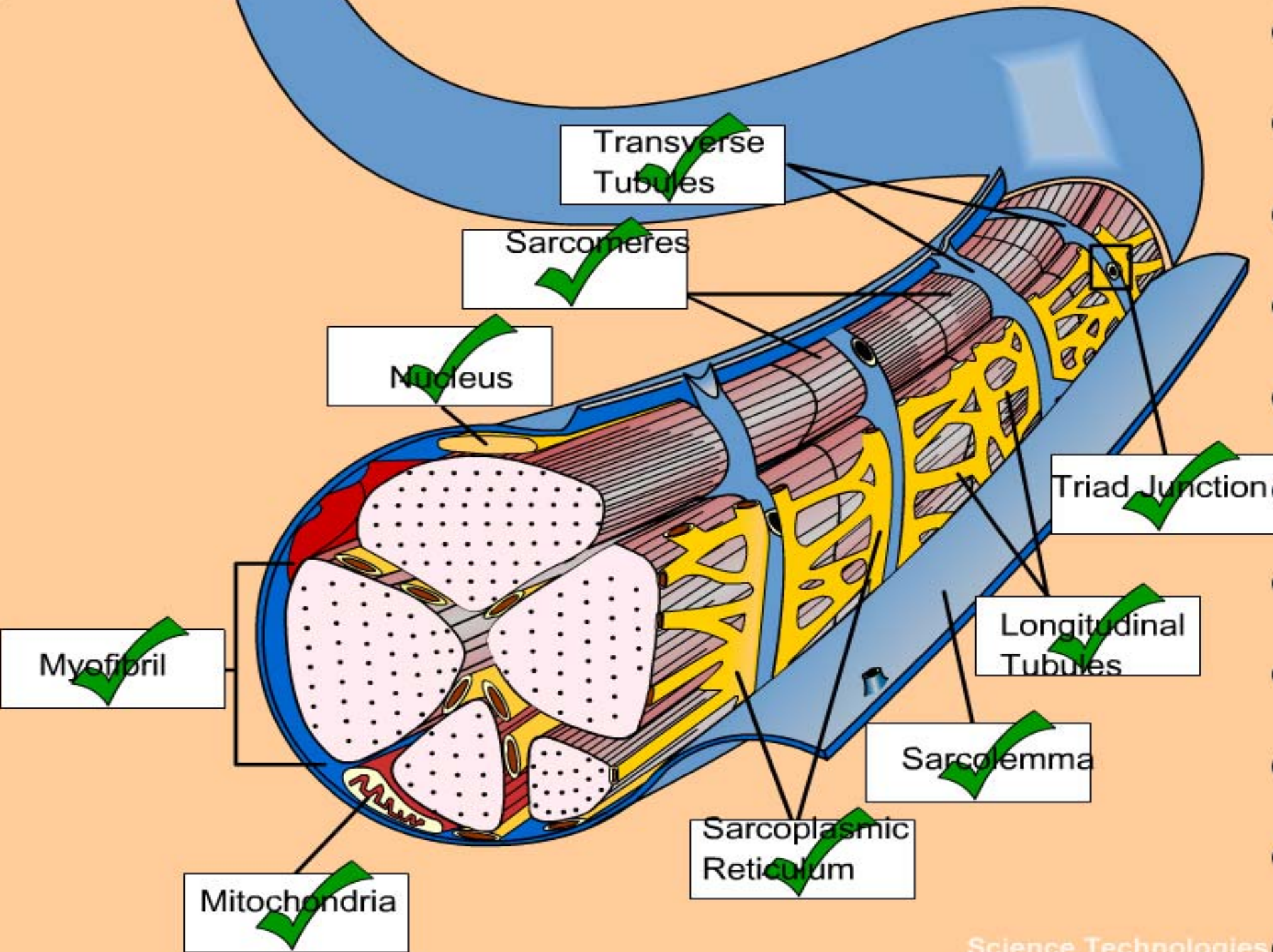


Stretched

Structure of skeletal myofiber (EM)

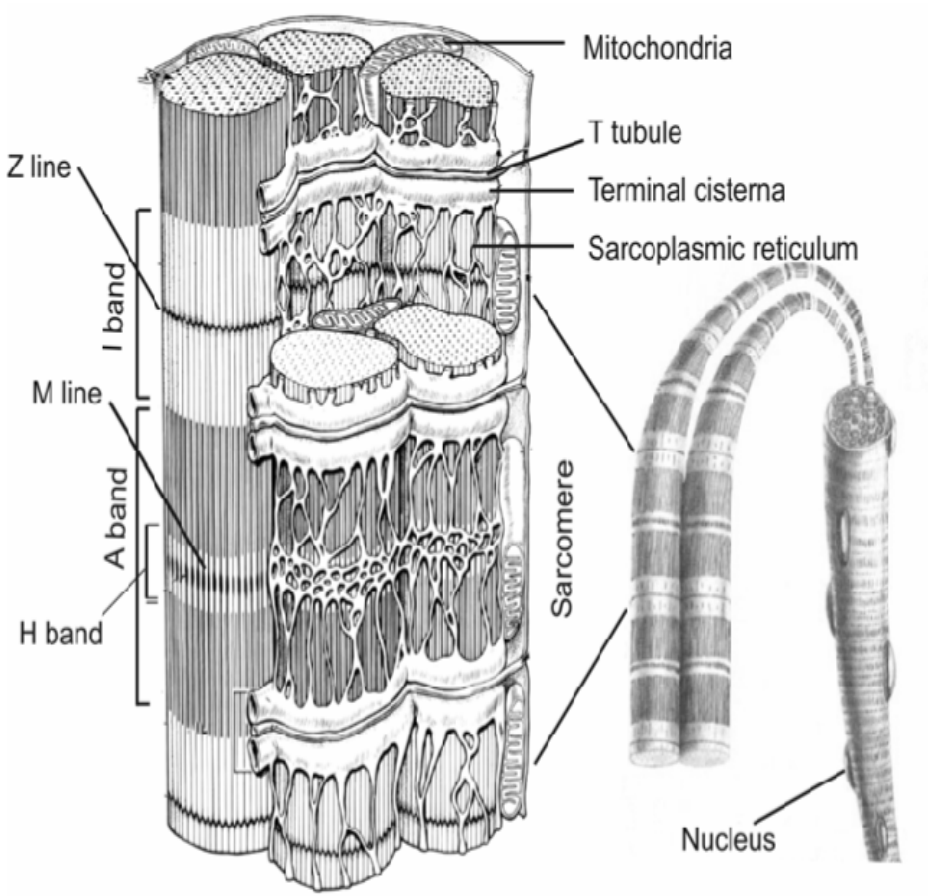
- **The sarcolemma gives rise to tubular extensions (T-tubules) that extend transversely in the sarcoplasm to surround each myofibril at the region of A-I junctions.**

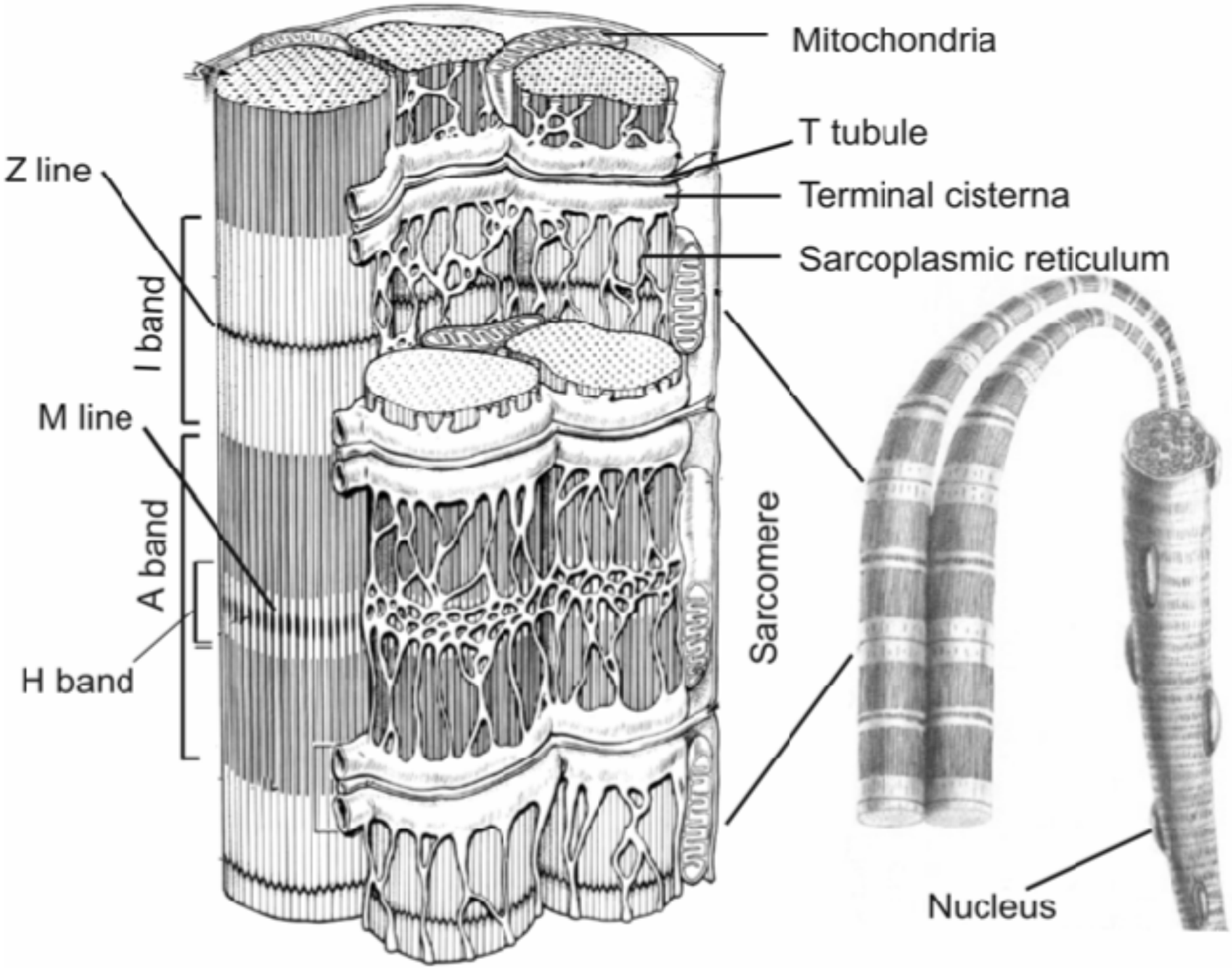



Transverse Tubules
Sarcomeres
Nucleus
Triad Junction
Longitudinal Tubules
Myofibril
Sarcolemma
Sarcoplasmic Reticulum
Mitochondria

Structure of skeletal myofiber (EM)

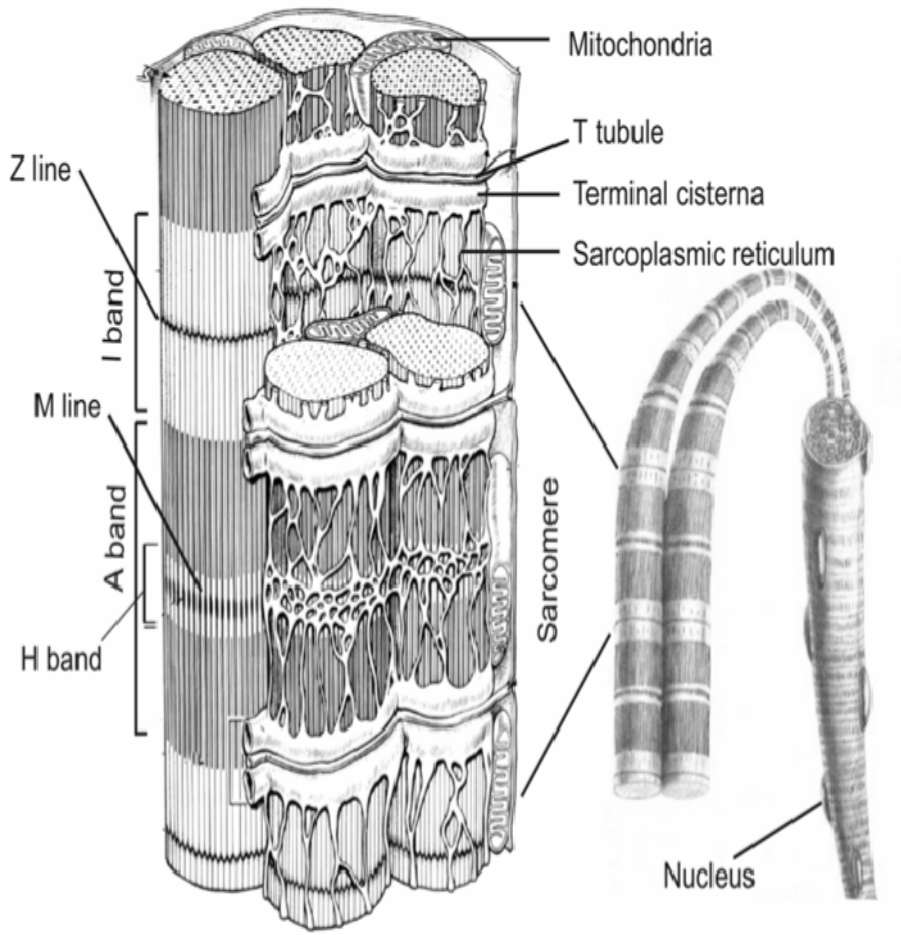
- **Each tubule is associated with <u>two dilated cisternae</u> of the sarcoplasmic reticulum to form a structure called <u>triad</u>.**




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

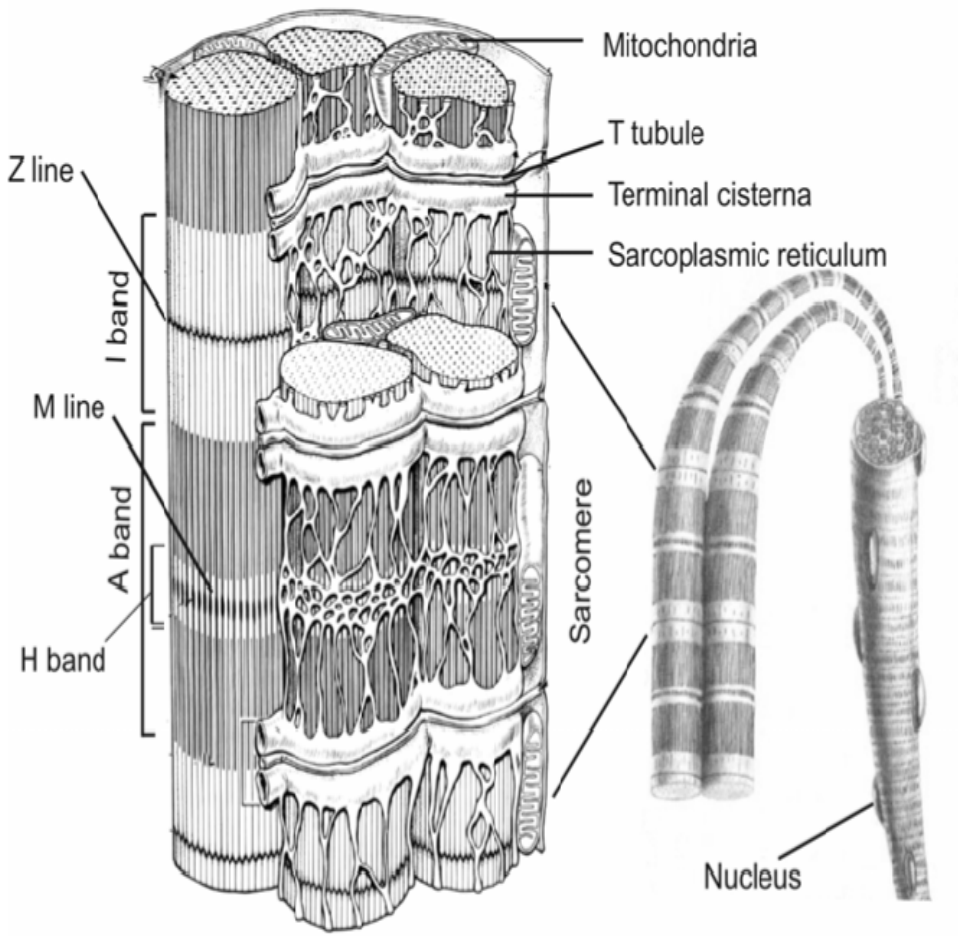
Structure of skeletal myofiber (EM)

- **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.**



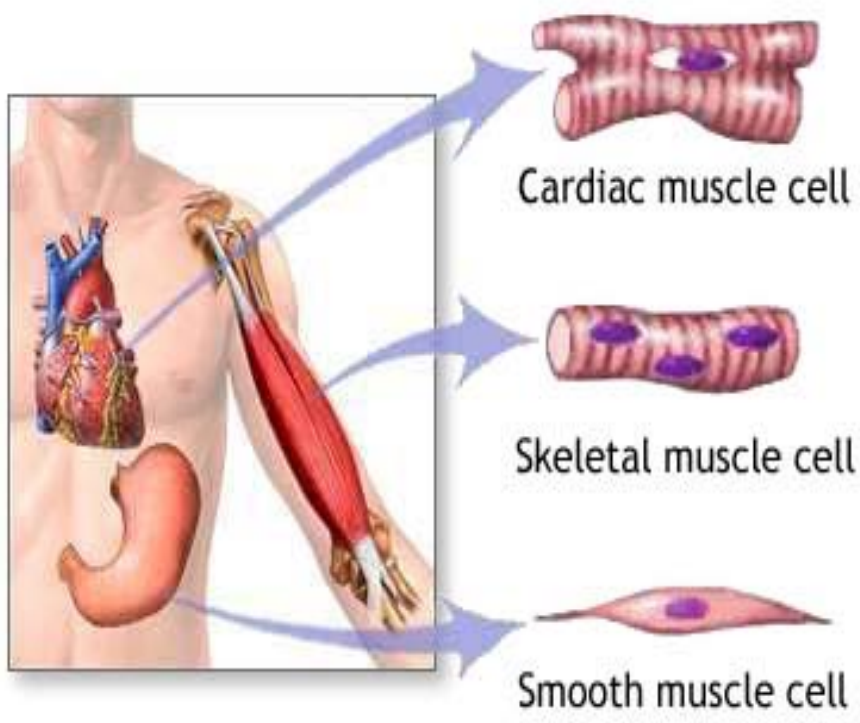
Structure of skeletal myofiber (EM)

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



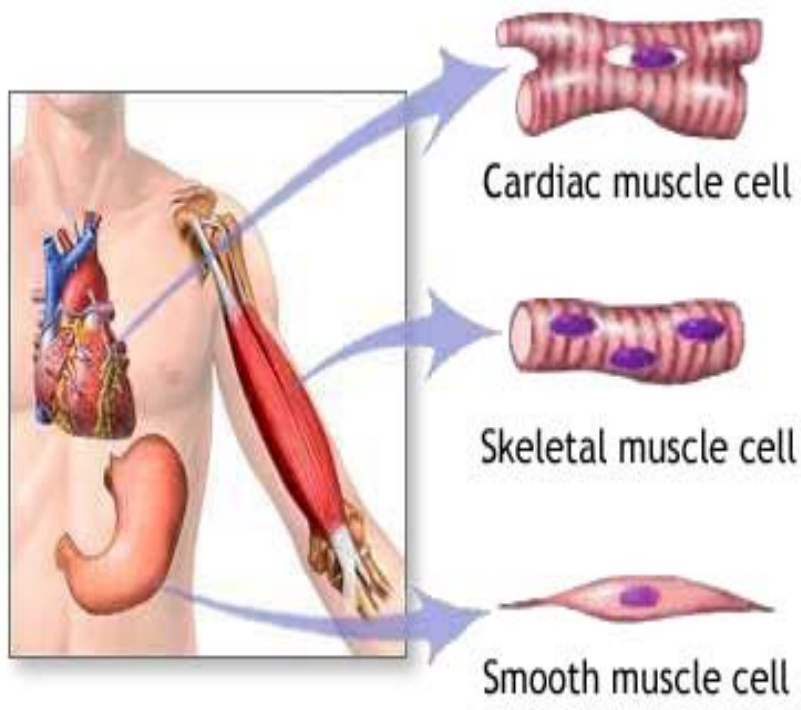
Cardiac muscle (Striated and involuntary)

- **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.**

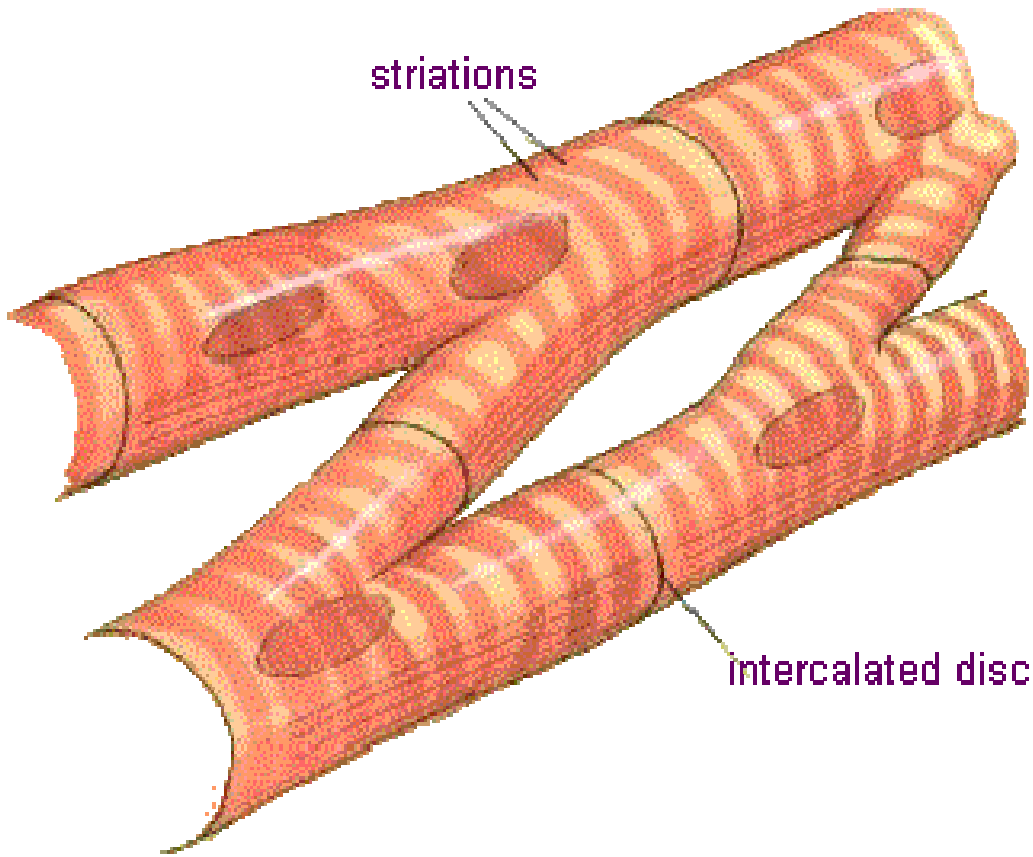


Cardiac muscle (Striated and involuntary)

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

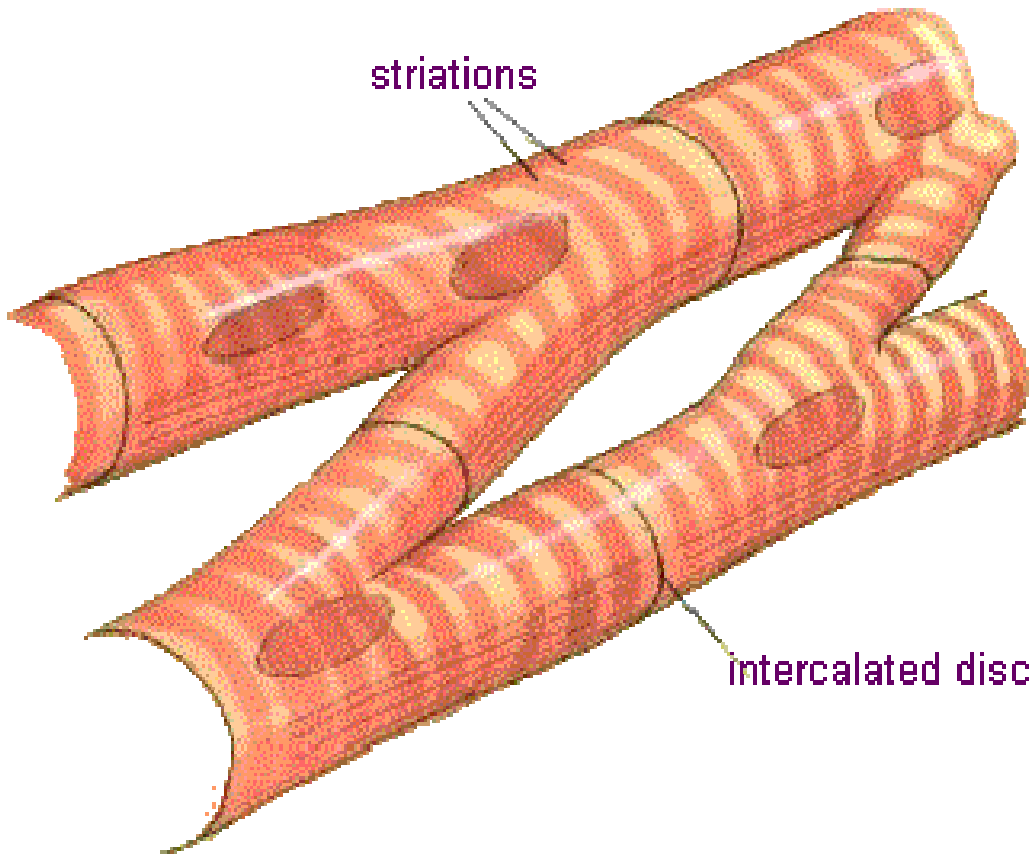
Structure of cardiac muscle (LM)

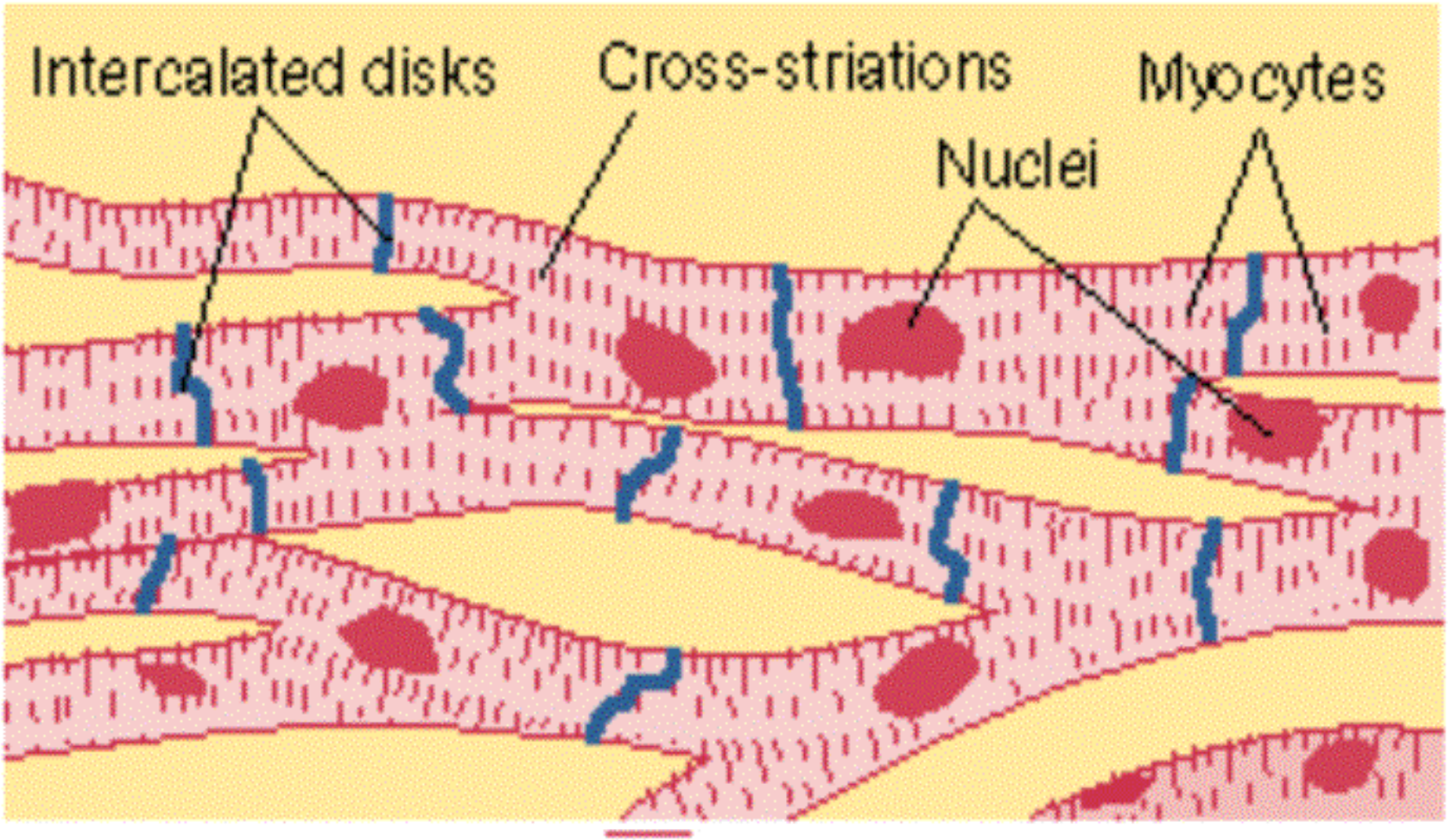
- **<u>At the LM level</u>, the cardiac myofibers are long (50-100 μm) cylindrical cells that are branched and anastomosed forming a network.**



Structure of cardiac muscle (LM)

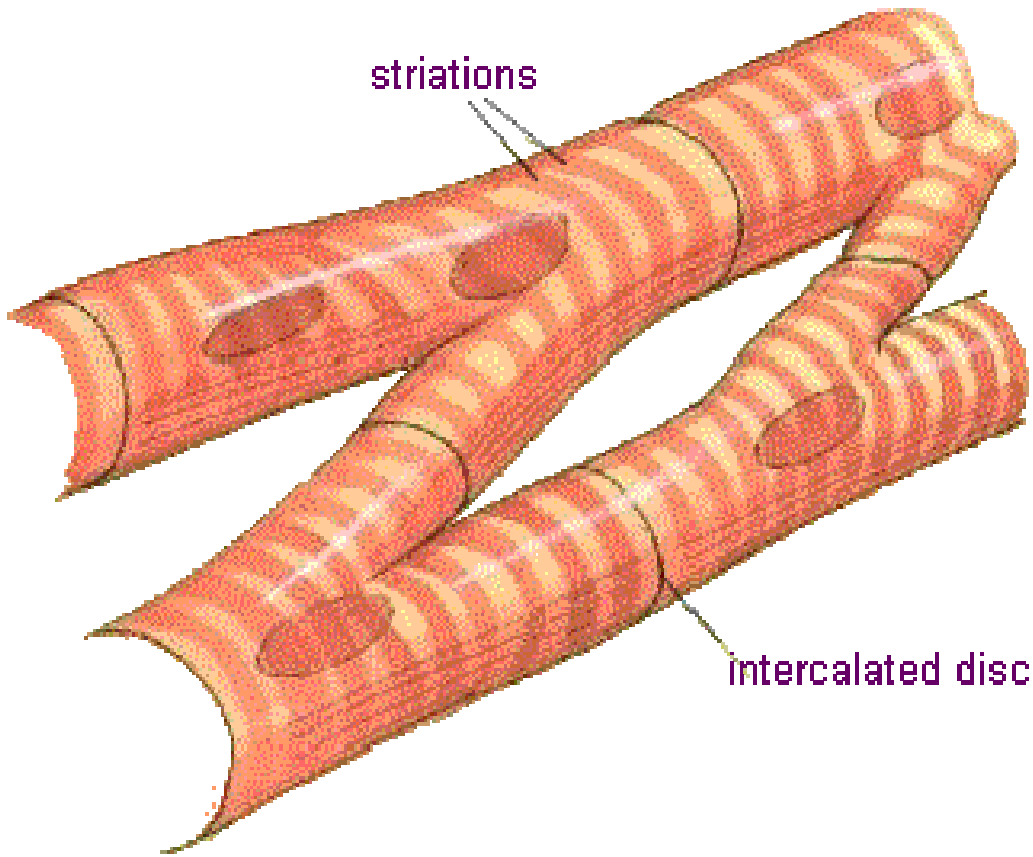
- **They are traversed at intervals by dark-staining structures called intercalated discs that extend across the fiber in a stepwise manner.**




Intercalated disks
Cross-striations
Myocytes
Nuclei

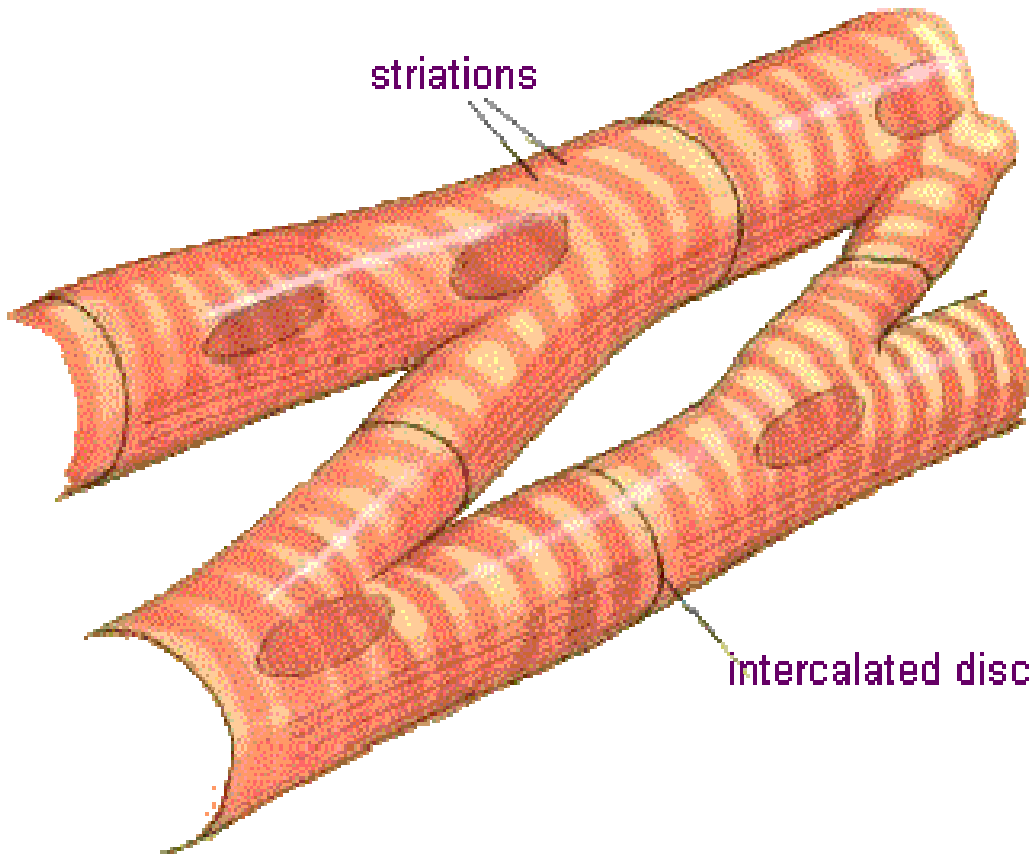
Structure of cardiac muscle (LM)

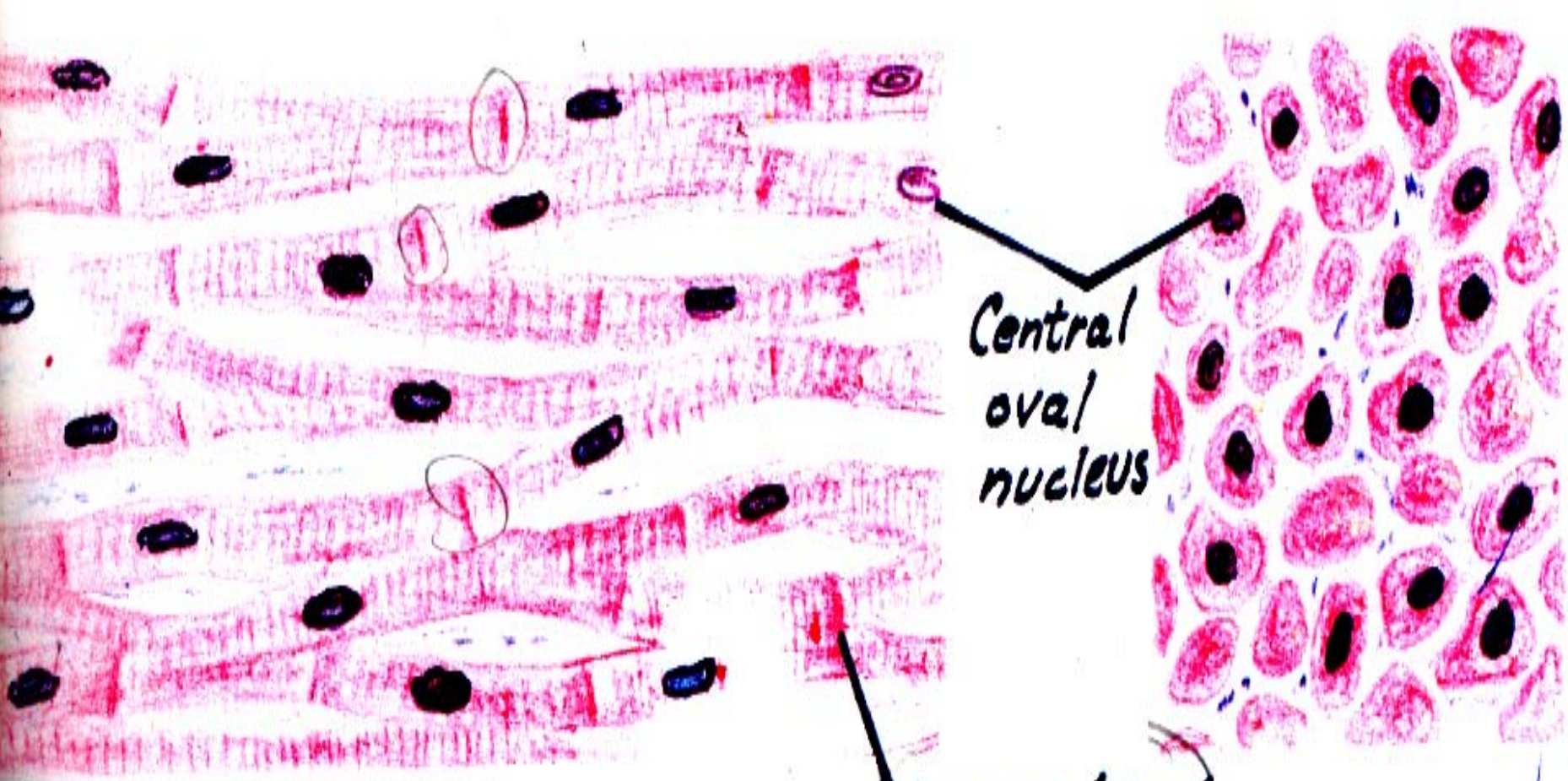
- **Most of the cells have one nucleus and at most two nuclei.**
- **The nuclei are oval and centrally located within the cell.**



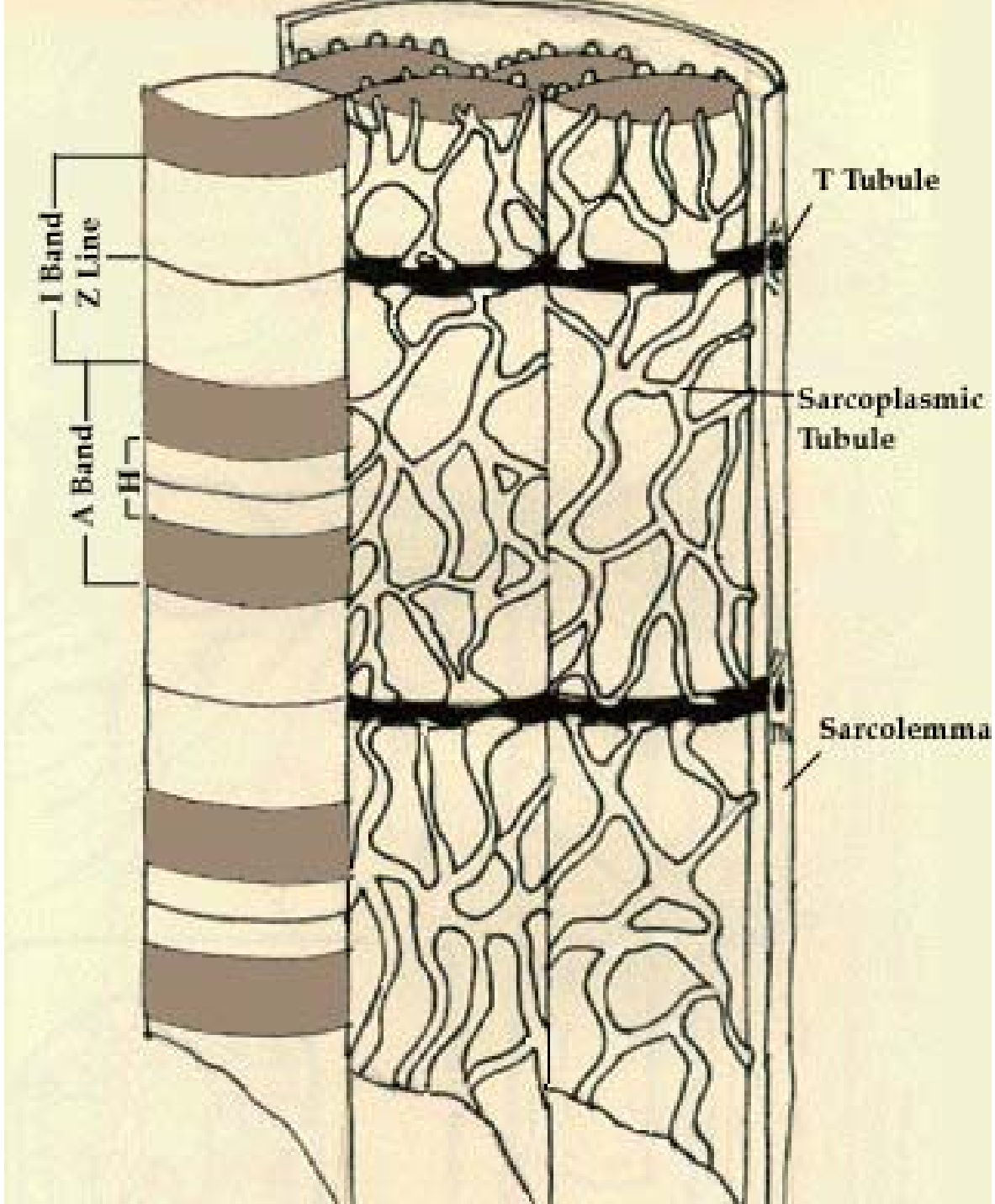
Structure of cardiac muscle (LM)

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



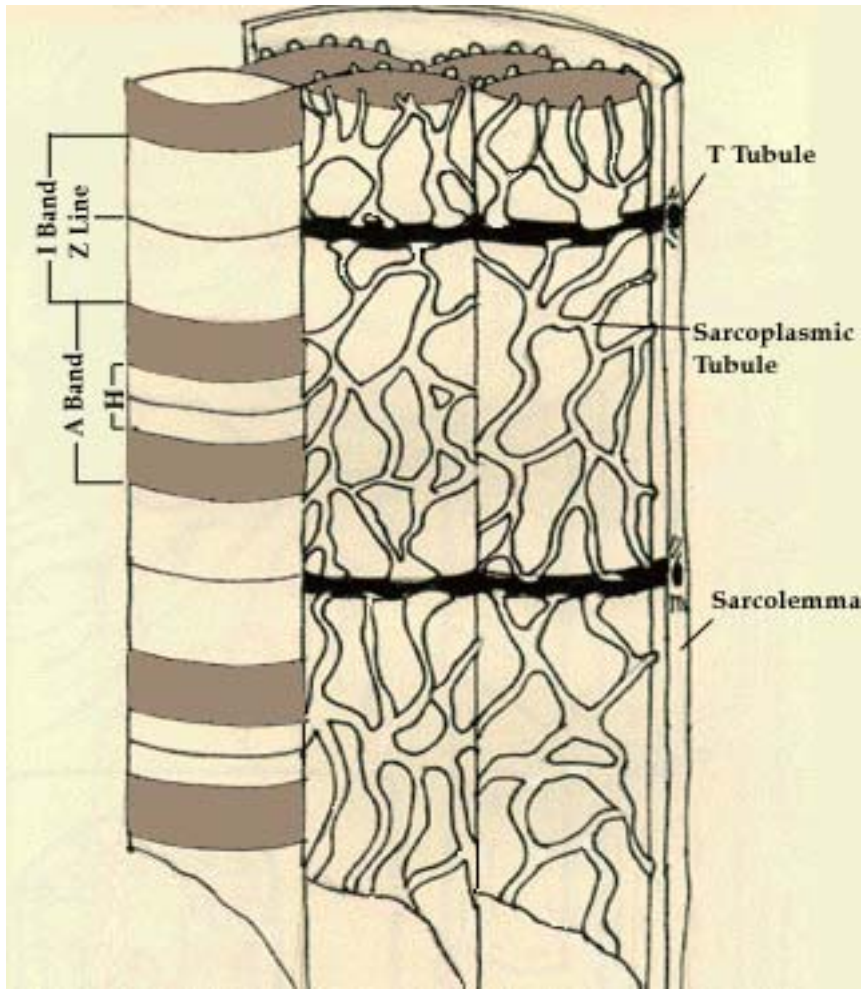


CARDIAC MUSCLE FIBRES


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

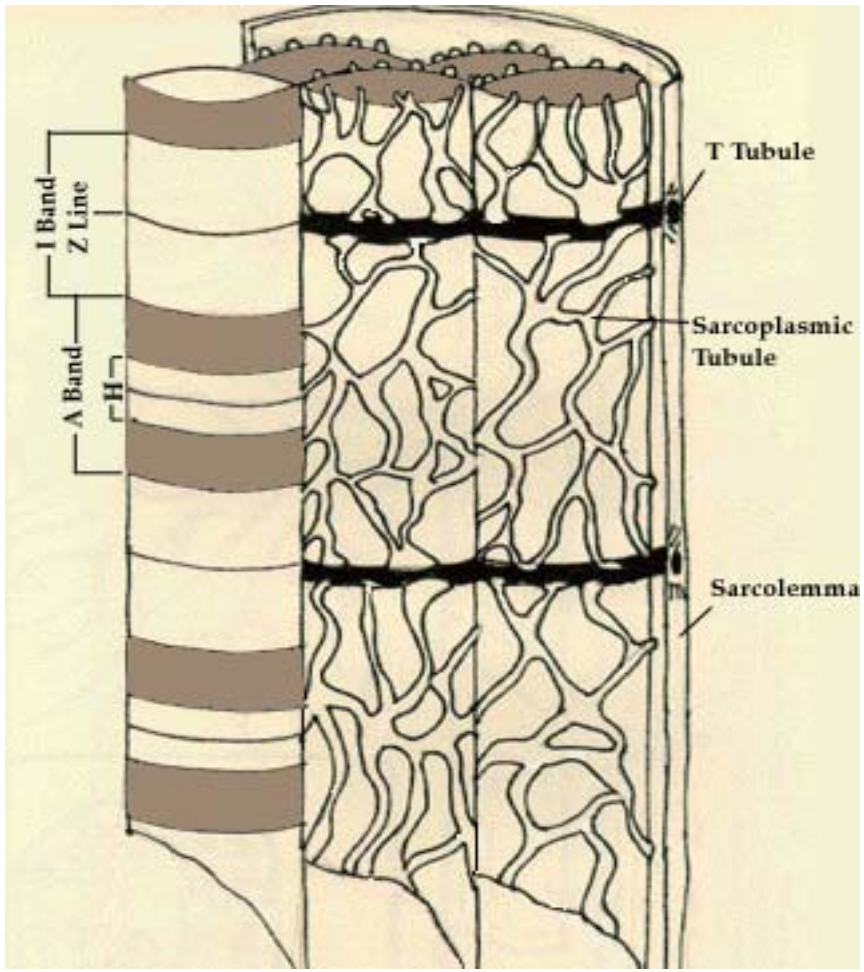
Structure of cardiac muscle (EM)

- **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.**



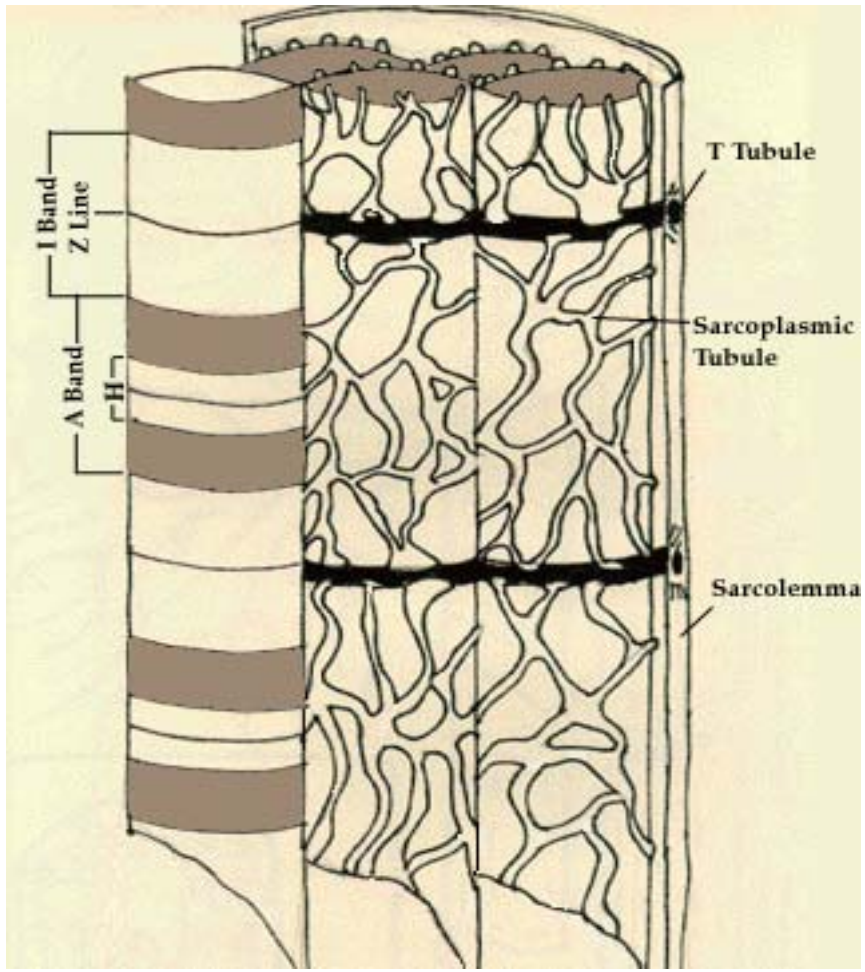
Structure of cardiac muscle (EM)

- **3) Each tubule is associated with <u>single cisternae</u> of sarcoplasmic reticulum forming a structure called <u>diad</u>.**



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)

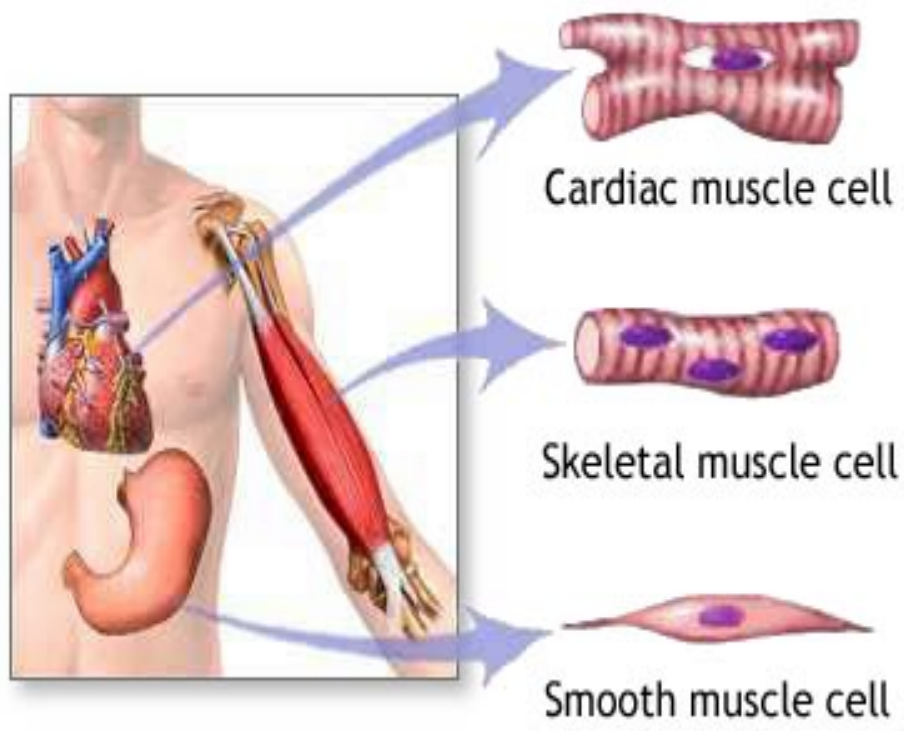
- **7) The cardiac myofibers are formed of several cells connected end-to-end by intercalated discs.**
- **Each intercalated disc crosses a cardiac fiber at the Z-line level in a stepwise manner.**

Smooth muscle (Visceral muscle)

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

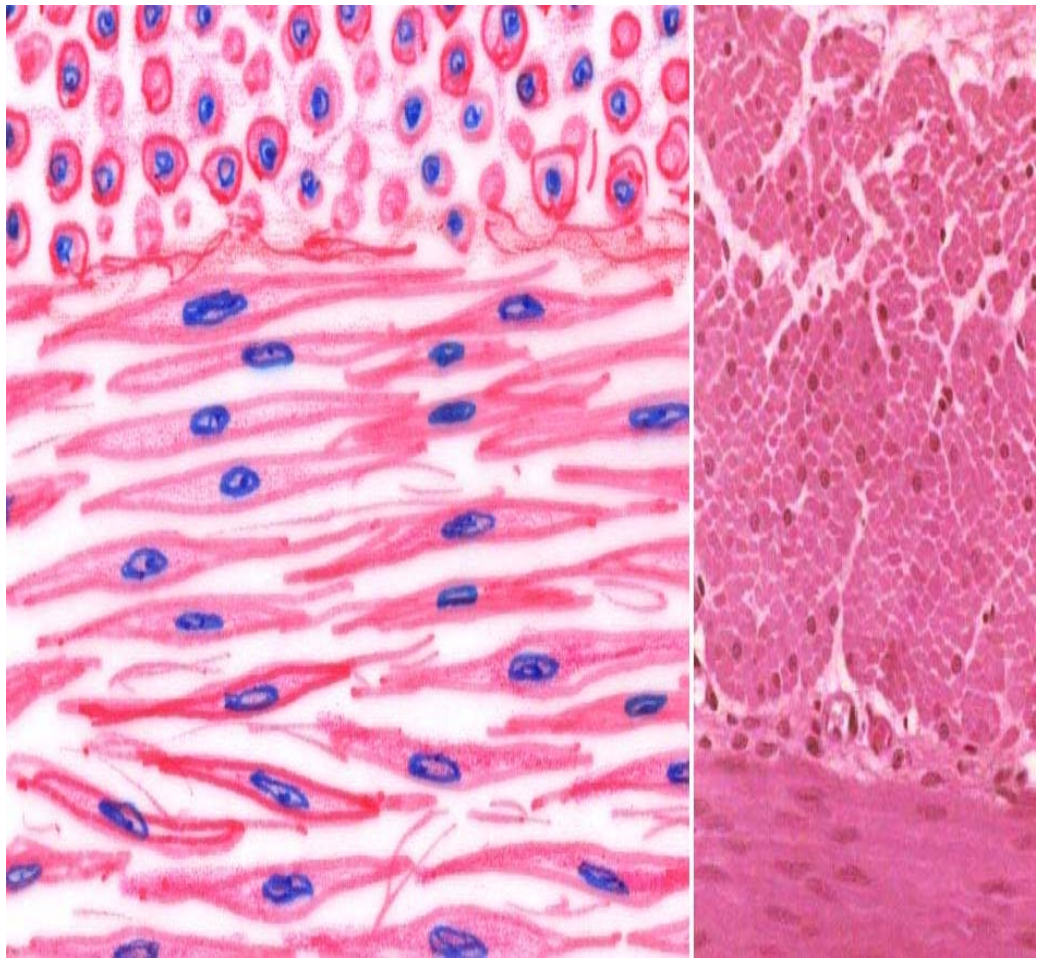
Smooth muscle (Visceral muscle)

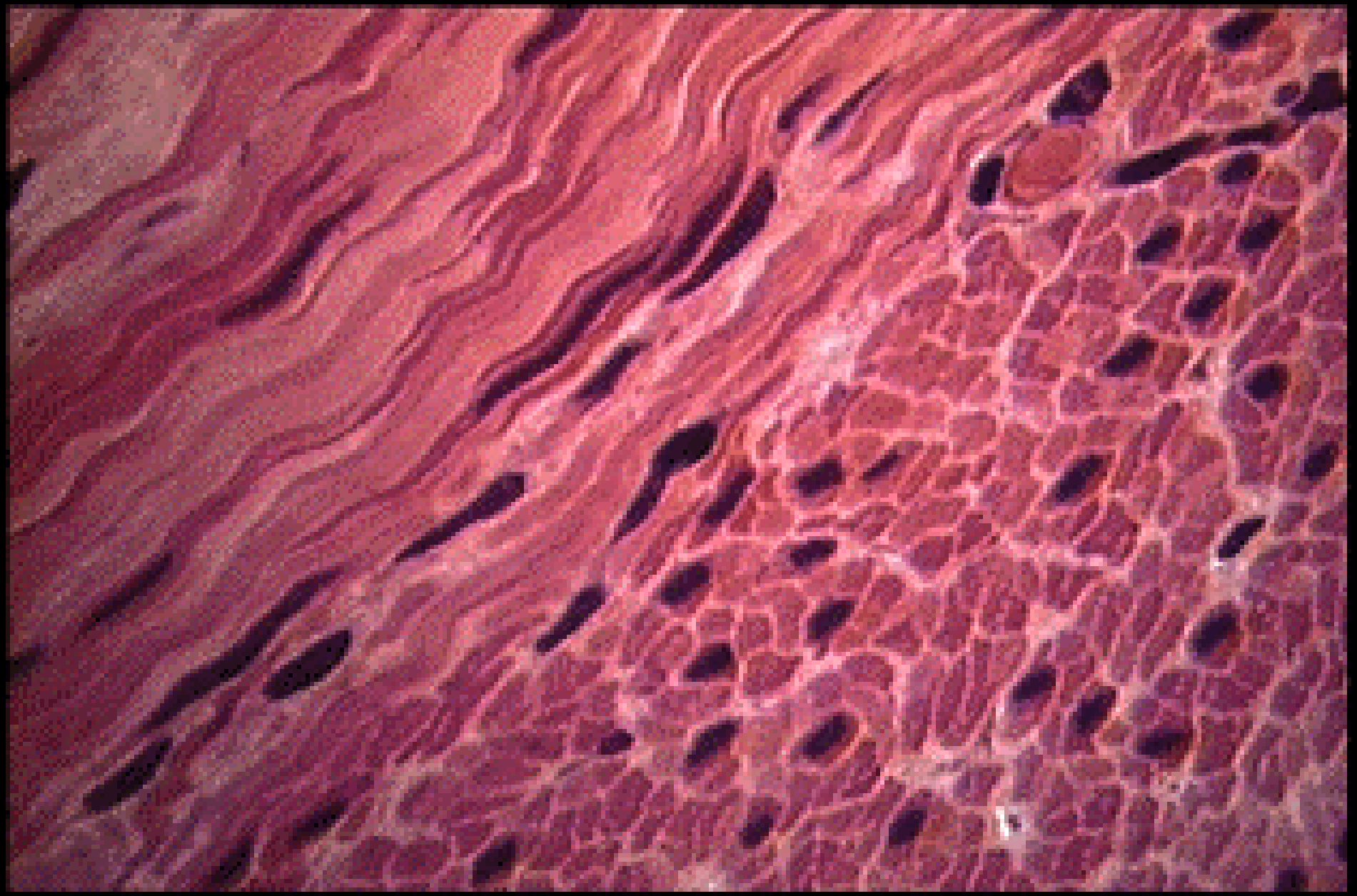
- **Smooth: it has no cross striations.**
- **Involuntary: its contraction can not be elicited at will.**
- **Visceral: found in visceral organs.**

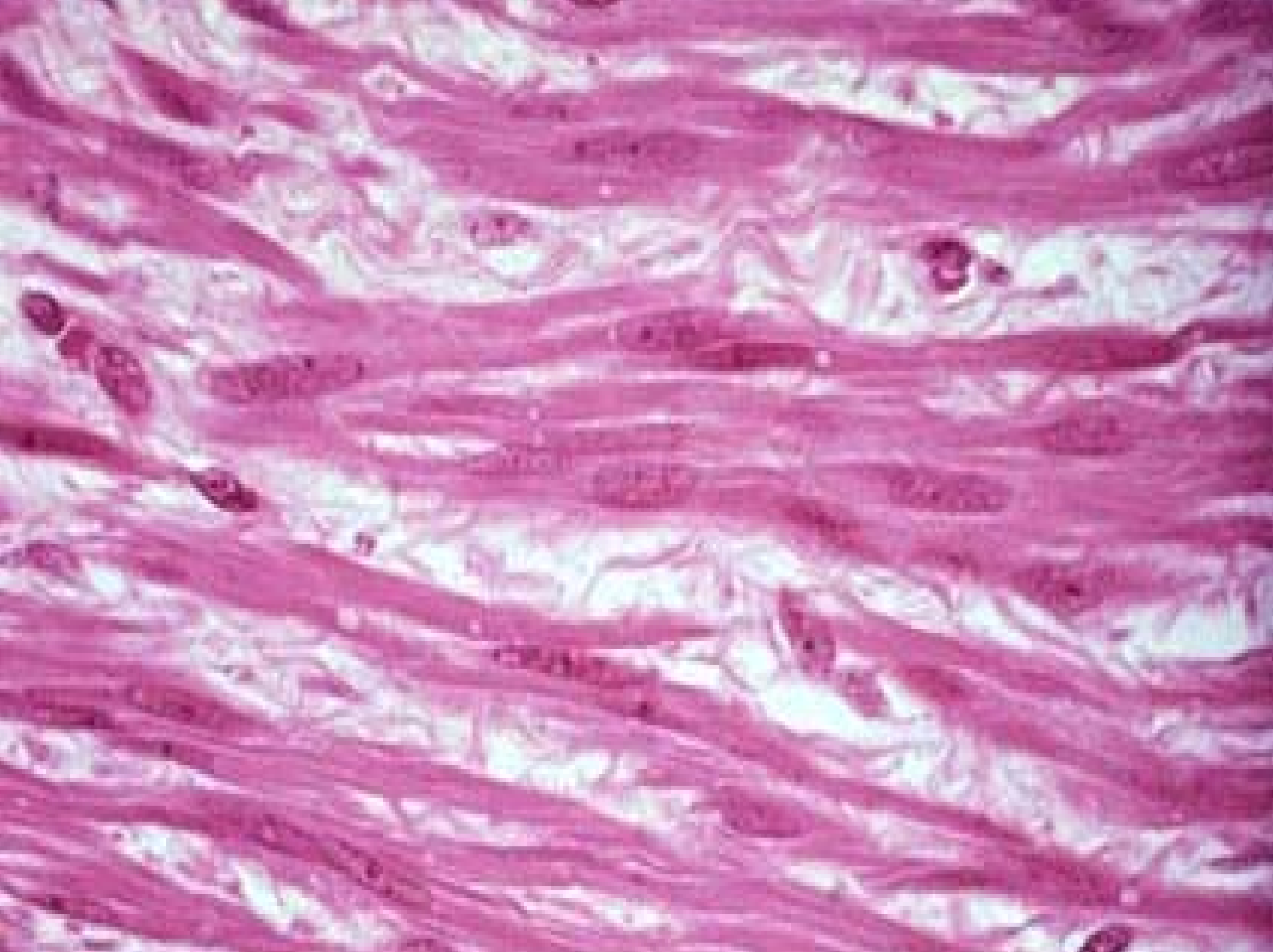


Structure of smooth myofibers (LM)

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

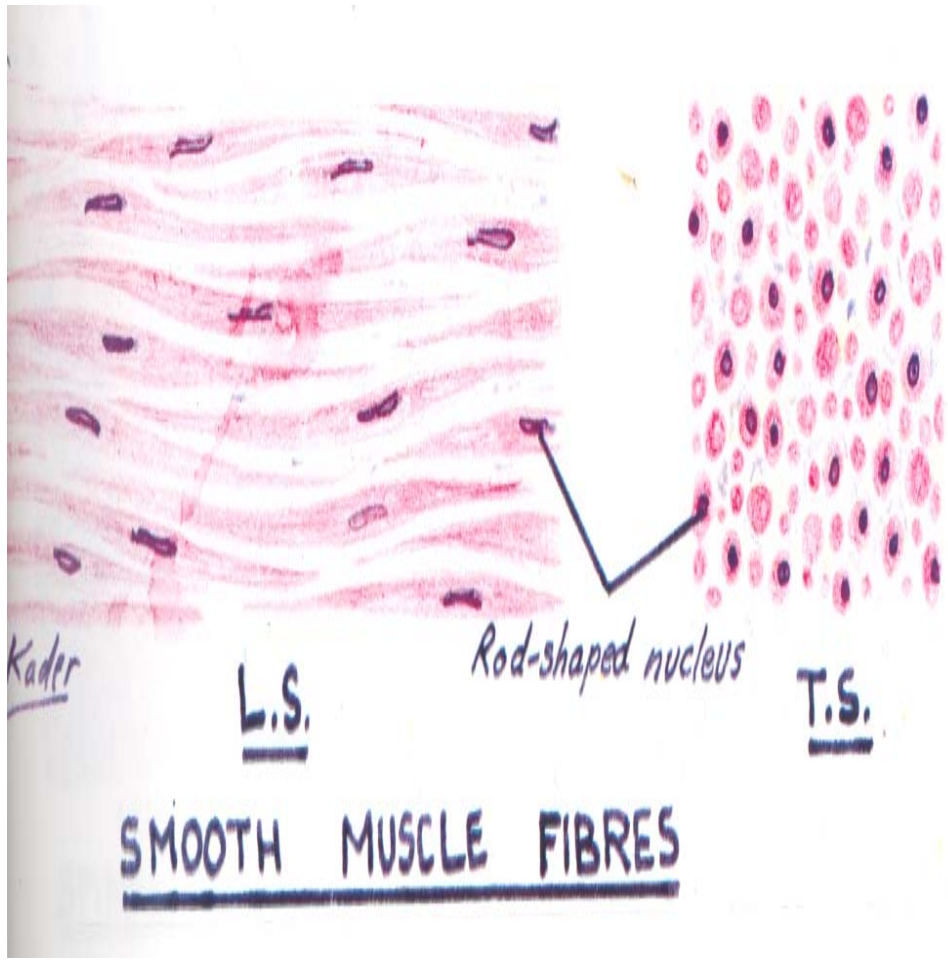


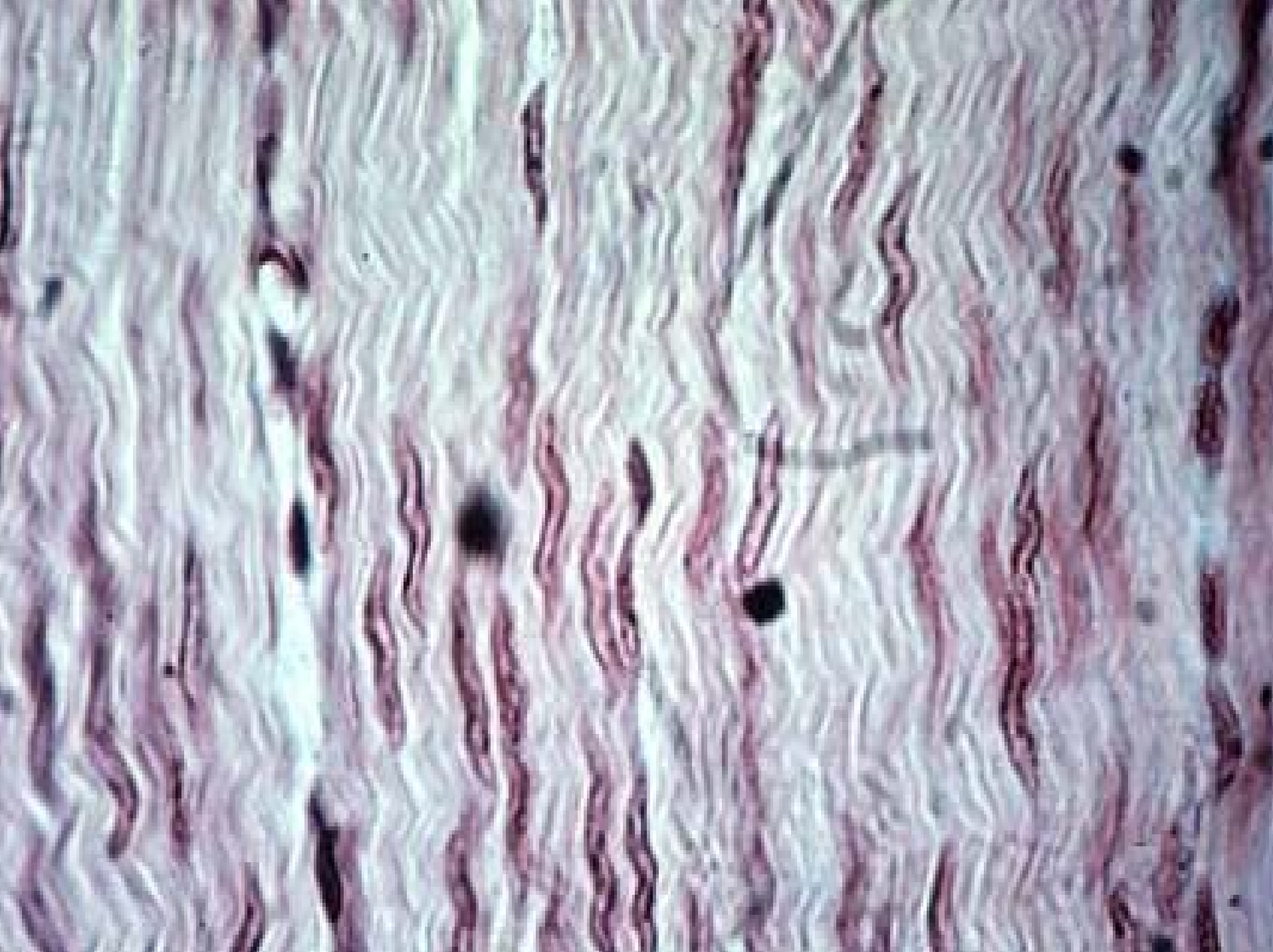




Structure of smooth myofibers (LM)

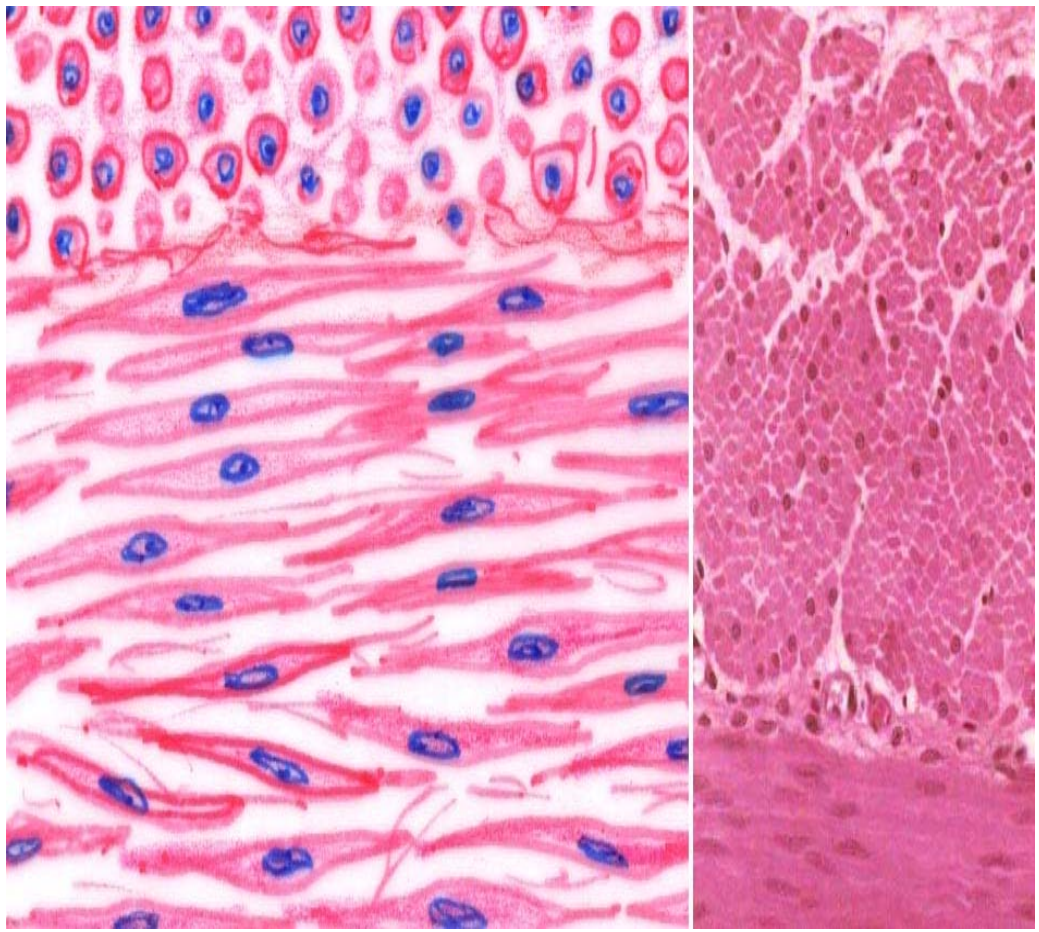
- **The cytoplasm is acidophilic and contains <u>only one nucleus.</u>**
- **The nucleus is elongated and centrally located in the cytoplasm at the widest part of the cell. During contraction, the nuclei may appear spiral in shape.**





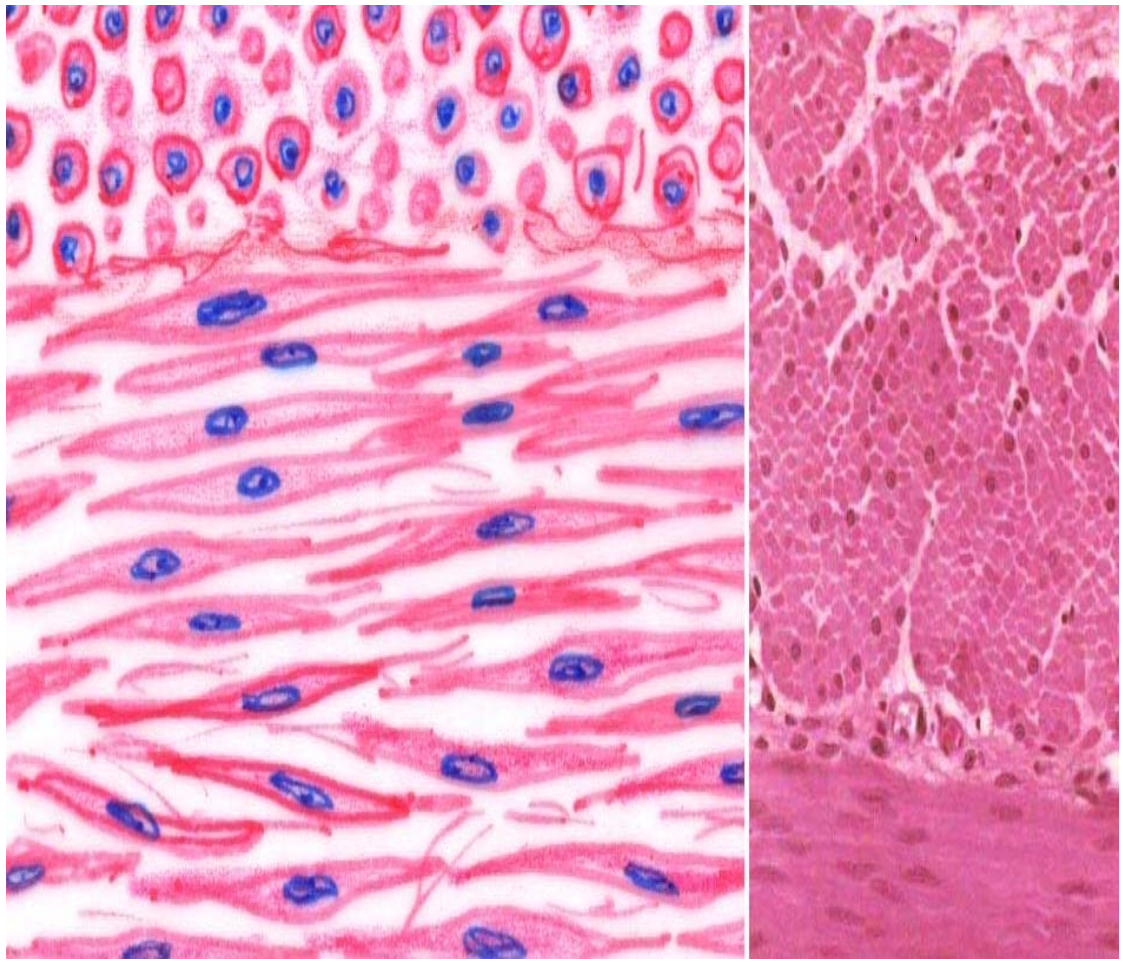
Structure of smooth myofibers (LM)

- **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 <u>their widest portion and is located centrally.</u>**



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.**