

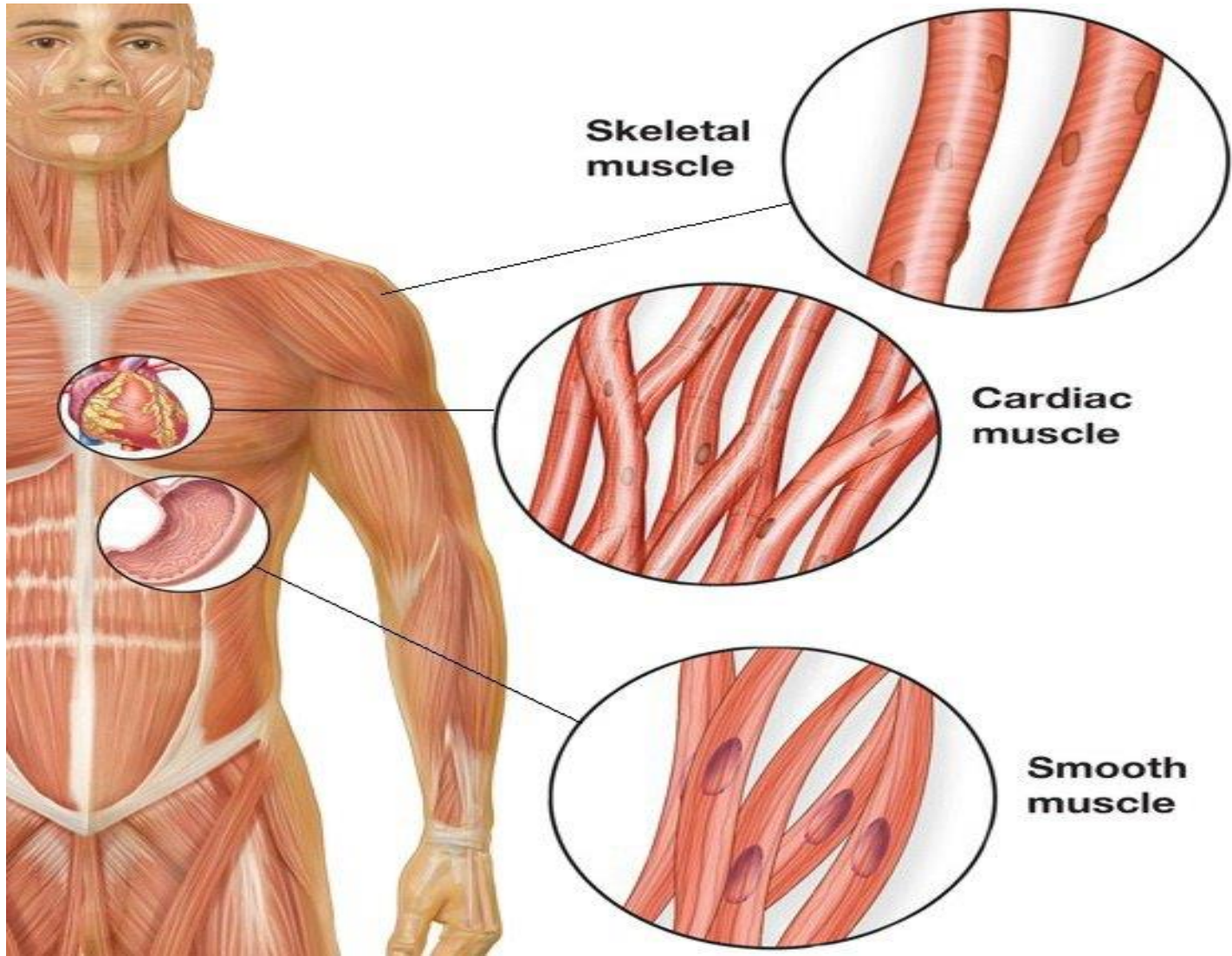
Muscle II

(Cardiac & Smooth Muscle)

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Types of muscles

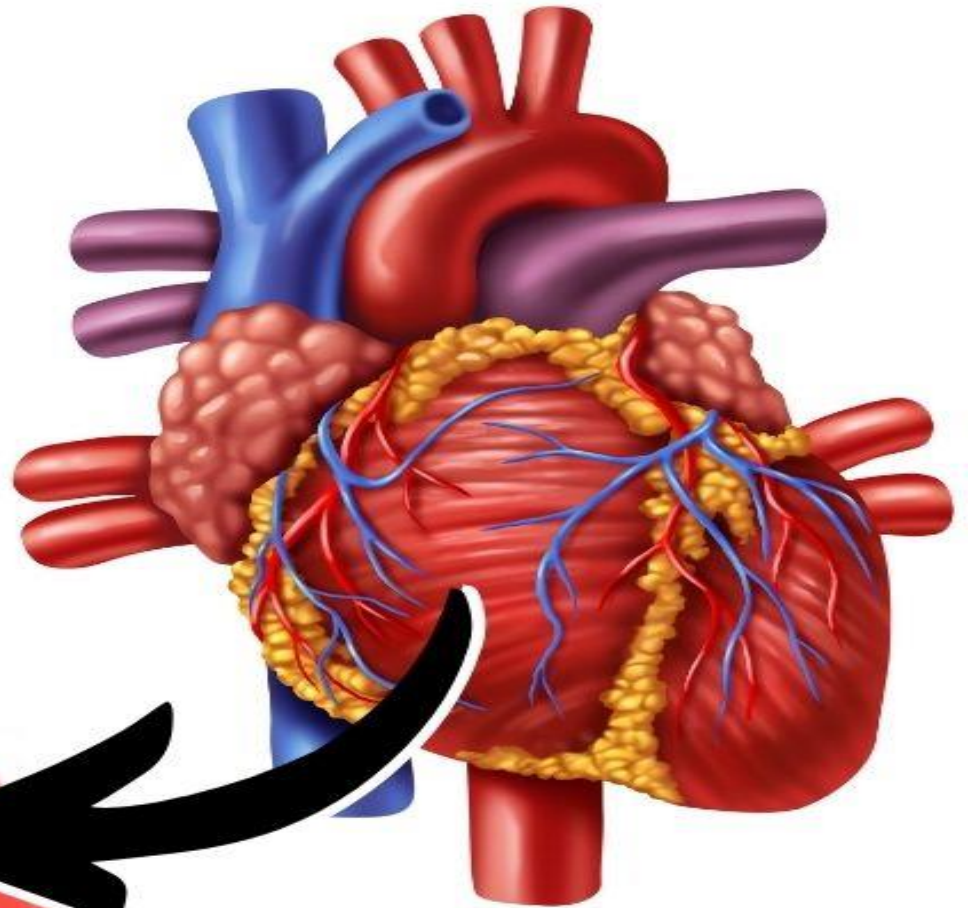
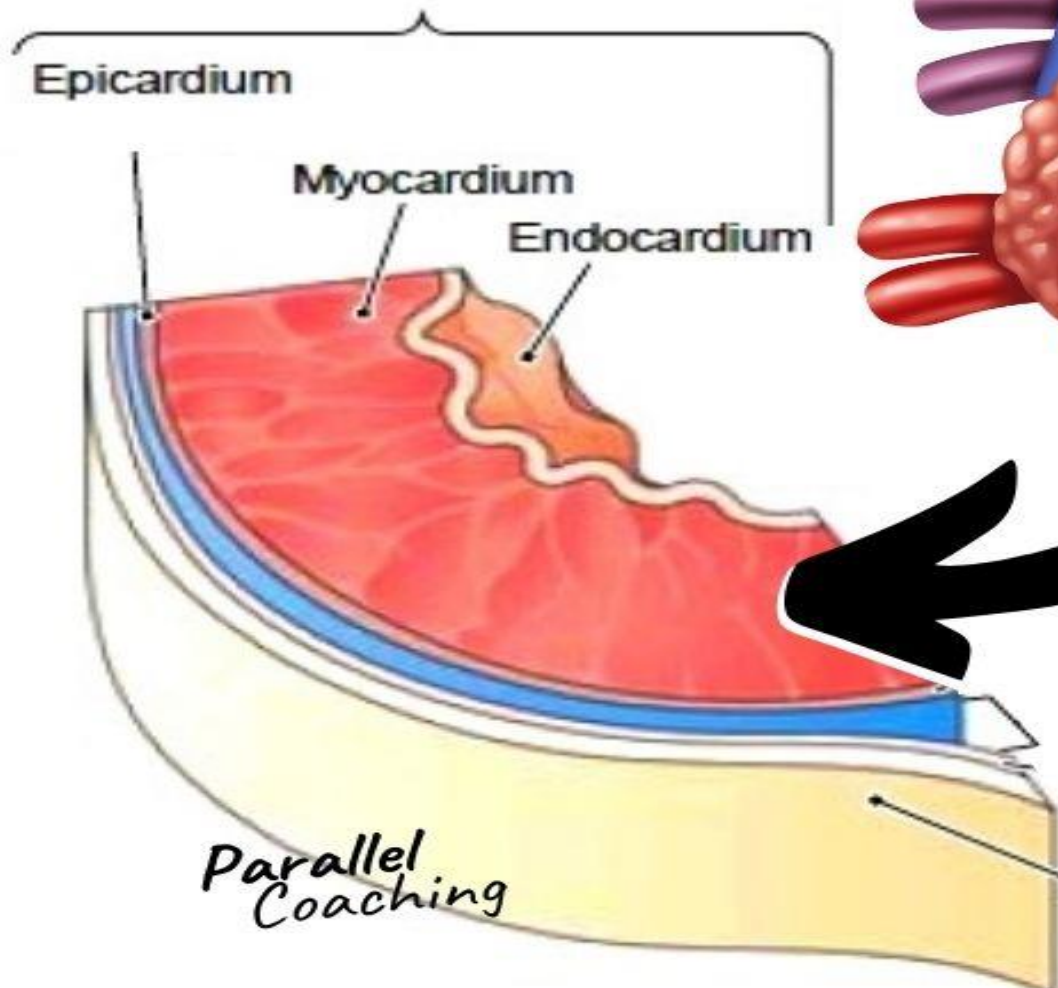


THE HEART

The wall of the heart consists of 3 layers :

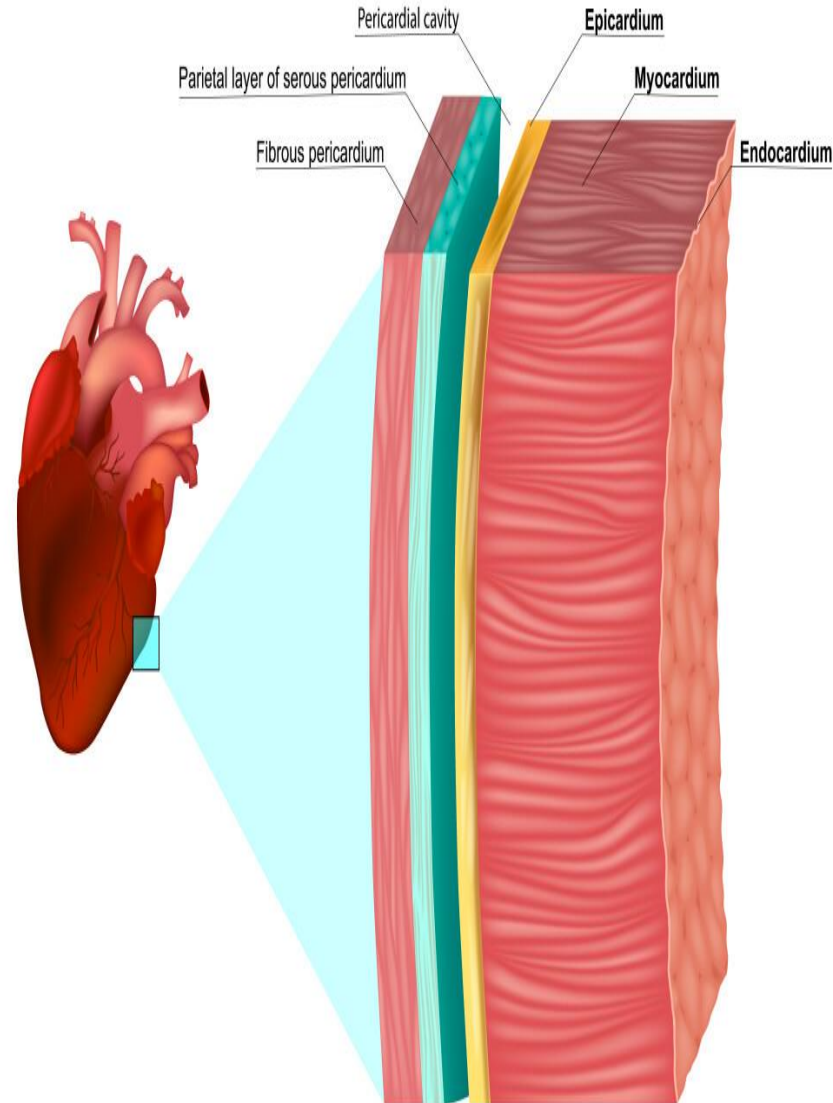
- **The endocardium:** (the inner layer) consists of simple squamous epithelial cells resting on thin layer of loose connective tissue + subendocardium (C.T).
- **The myocardium:** the middle and thickest muscular layer
- **The epicardium:** It is outer protective layer of the heart formed of simple squamous epithelial cells resting on loose connective tissue + subepicardium (C.T).

HEART WALL



Cardiac muscle

- Consists of cardiac red muscle fibers arranged in many different directions. They are involuntary in action.
- The muscle fibers of the heart are grouped into three populations, **contractile fibers**, specialized fibers for **endocrine secretions** and impulse generating and conducting fibers.



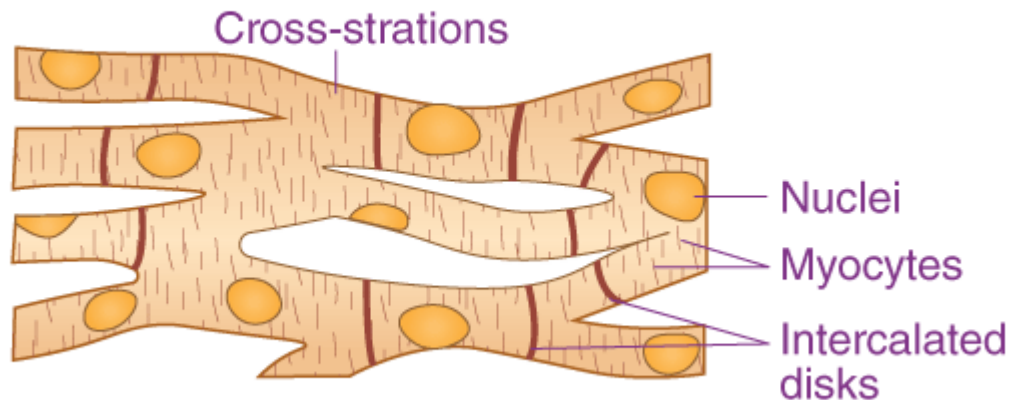
Cardiac muscle cells

L.M:

- Shape: They consisted of long fibers which branch and anastomose with neighbouring fibers. These fibers show faint indistinct transverse striations. Each fiber is formed of a successive cardiac muscle cells. That are joined together by intercalated discs (junctional complex)

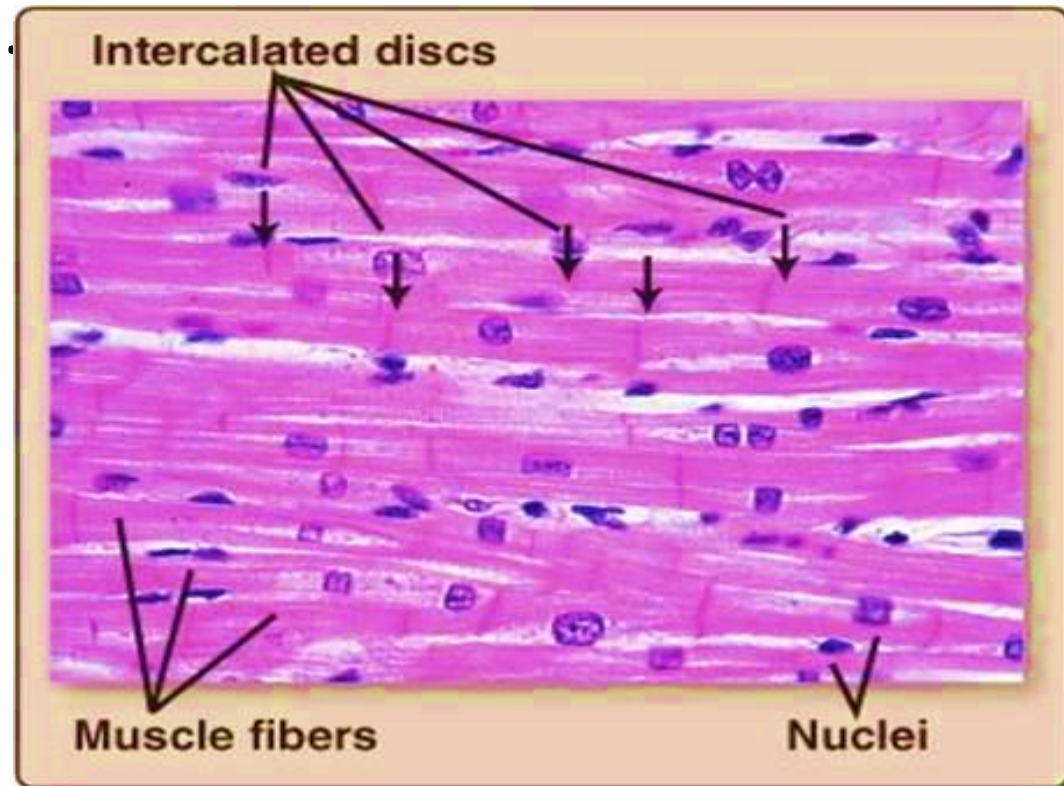
CARDIAC MUSCLE

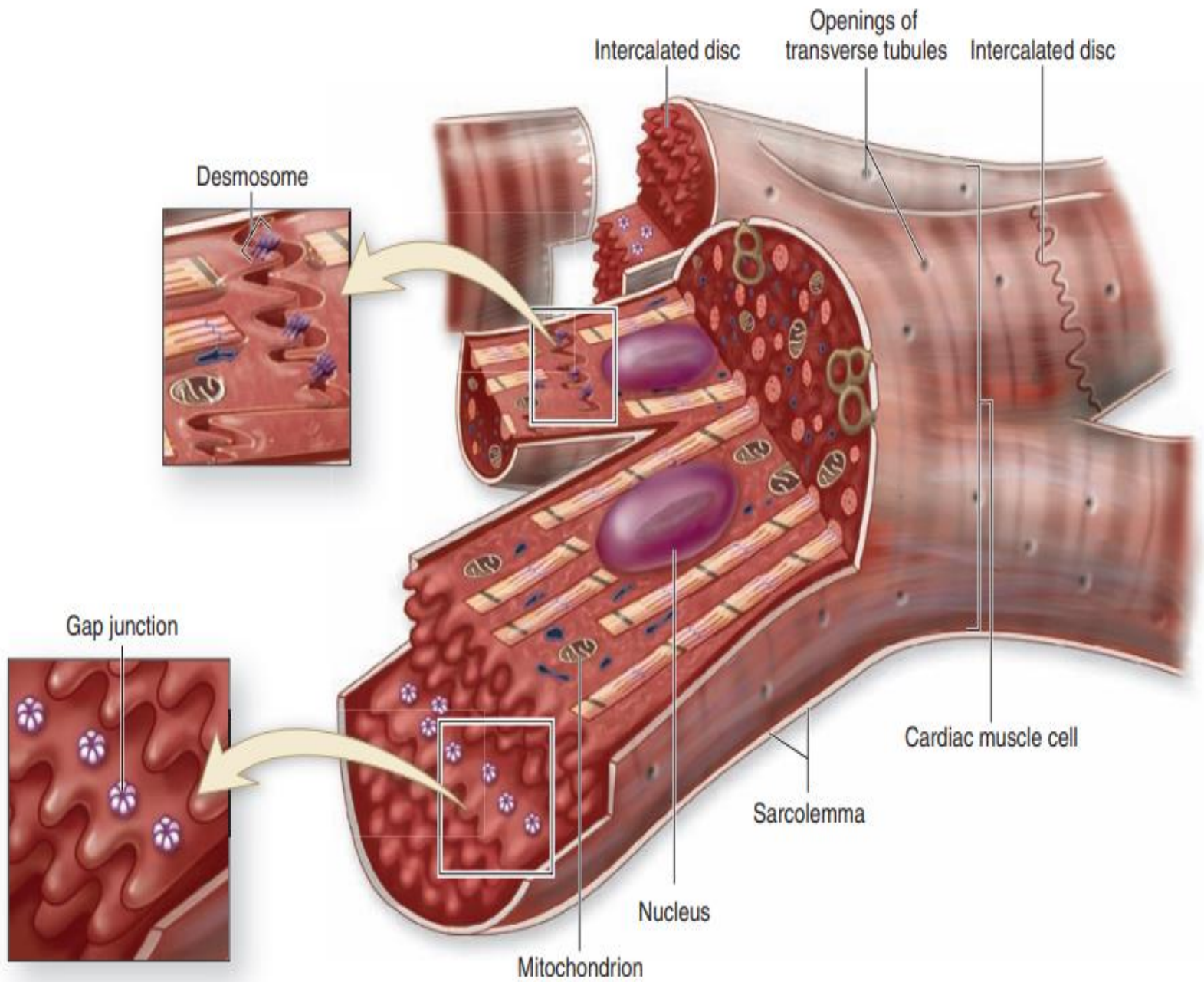
Surrounding the cardiac muscle cells is a delicate sheath of endomysium with a rich capillary network.



Cardiac muscle cells

- Nucleus: Each cardiac muscle cell (myocyte) has one or two oval nuclei. These nuclei are centrally located and are lightly (pale) stained.
- Cytoplasm: The cardiac muscle cells have acidophilic sarcoplasm (cytoplasm).

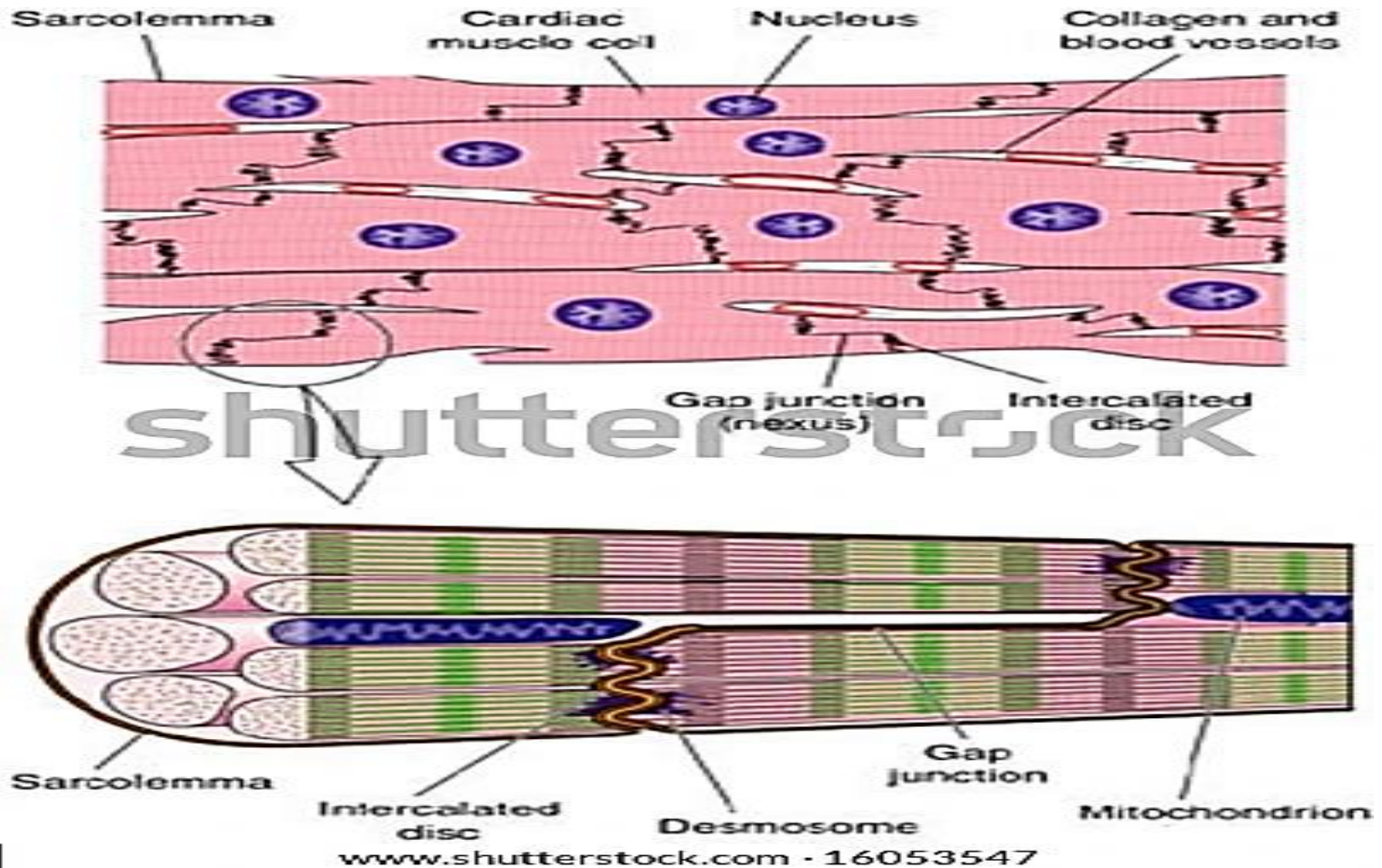




E.M

- **The cell membrane** (sarcolemma) surrounds the cardiac muscle cell and form tubular invagination at irregular interval called T-tubules. T tubules are more numerous and larger in cardiac muscle.
- **The sarcoplasm** (cytoplasm) contains myofibrils that show alternating dark and light transverse bands which are responsible for transverse striations of the muscle fiber.
- The sarcoplasm also contains less developed (SER), numerous mitochondria, lipofuscin pigment are often found near the nuclei of cardiac muscle cells, glycogen granules and myoglobin.

The intercalated discs



- **The intercalated discs** are dark-staining lines, unique and distinguishing characteristic for cardiac muscle.
- They cross the fiber in stepwise fashion at Z line at irregular intervals. Each composed of **a transverse portion** (*fascia adherens* & *desmosomes*) so it prevents separation of cardiac muscle during contraction and **longitudinal portions** of each disc have many gap junctions providing ionic continuity between cells. These serve as “electrical synapses” with contraction signals passing in a wave from cell to cell.

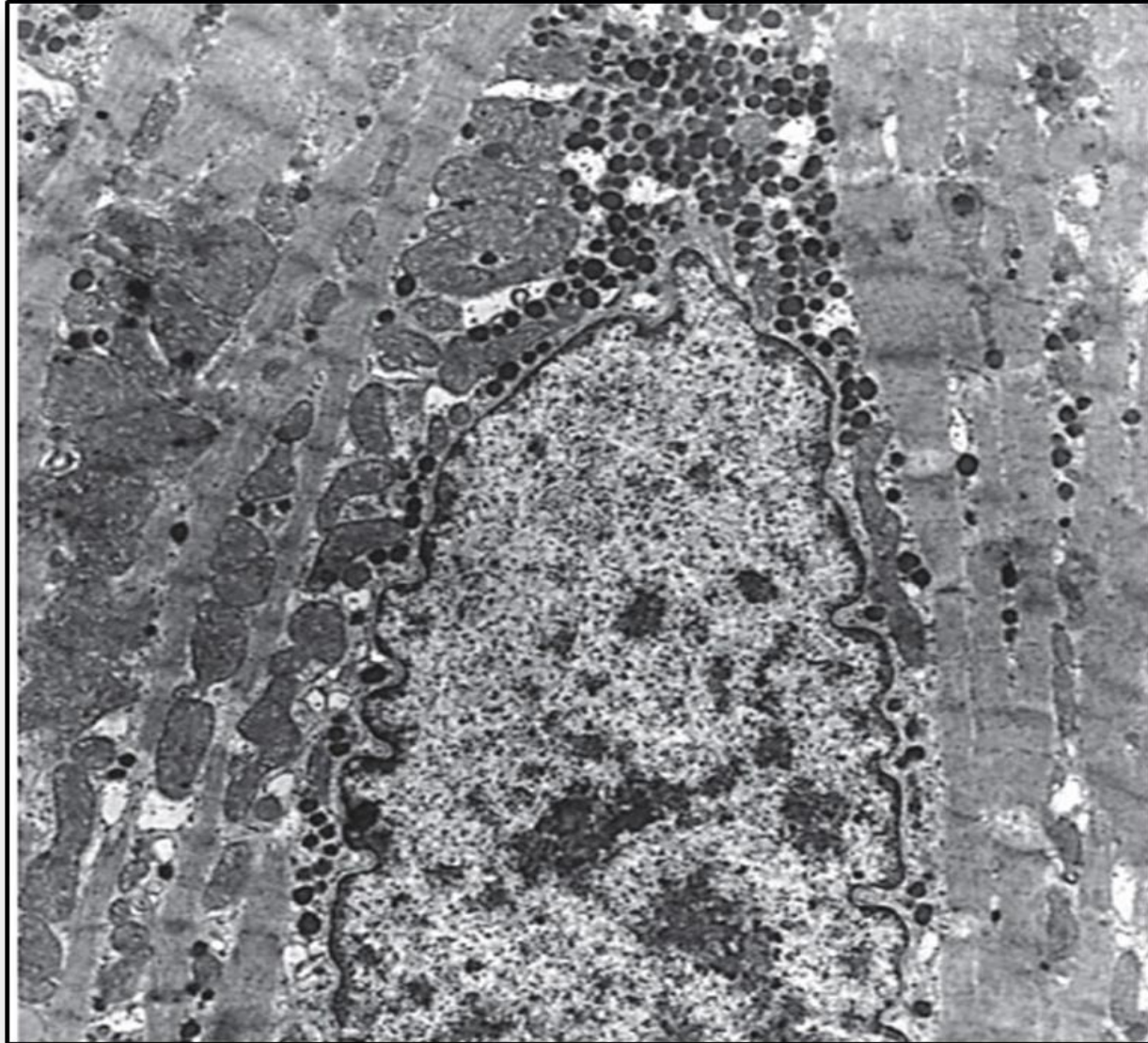
The intercalated discs



Cardiac fiber specialized for endocrine secretions:

- These fibers are located in the atrial wall, at EM level, they have the same structure of contractile fibers in addition to electron dense membranous granules near the poles of their nuclei. These granules contain polypeptide diuretic hormones as atrial natriuretic factor (ANF) that acts on target cells in the kidney to affect Na^+ excretion and water balance.

Atrial natriuretic factor (ANF).

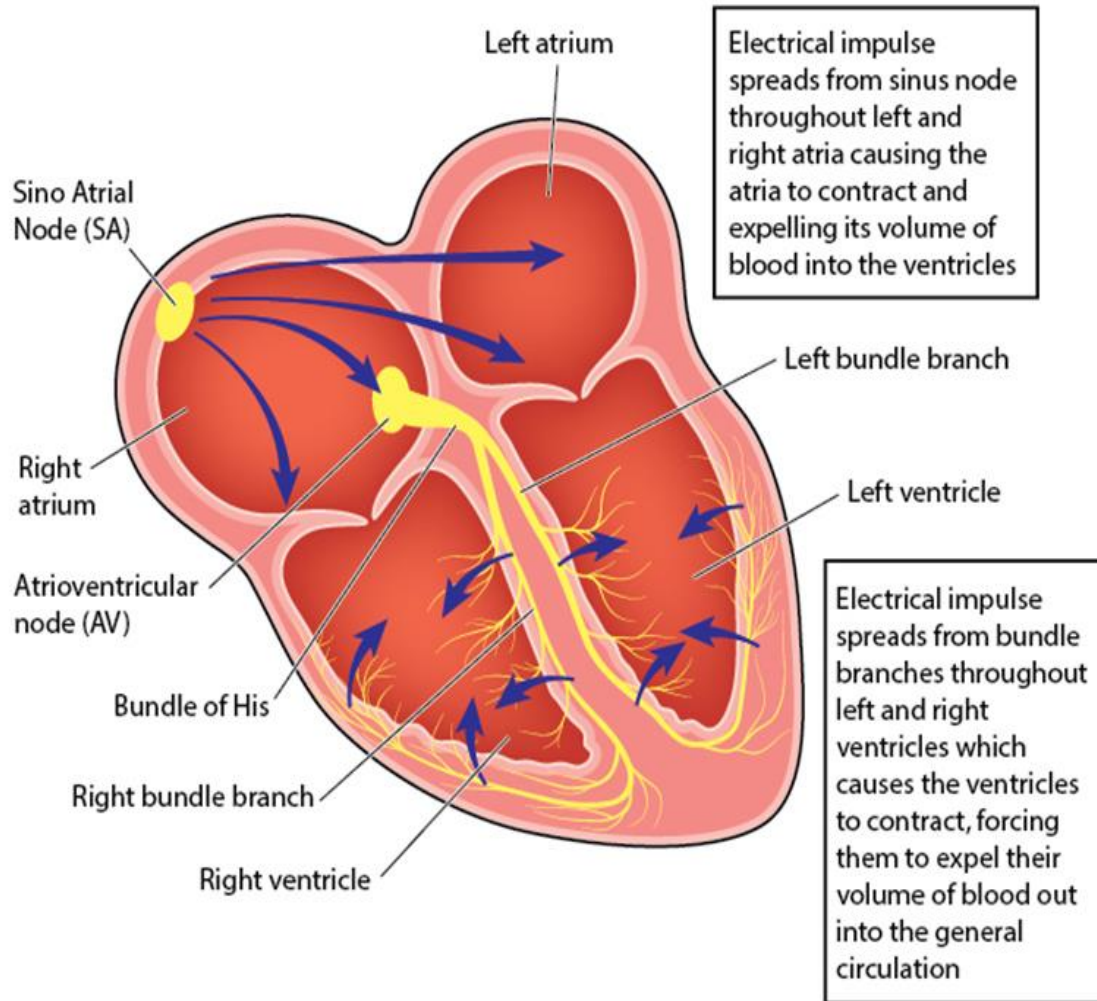


- **Cardiac fiber specialized for impulse generation and conduction:**

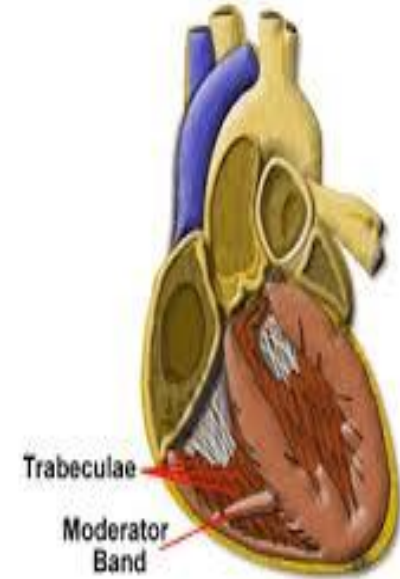
- This is a specialized cardiac muscle fibers concerned with the initiation and conduction of the impulse for myocardial contraction.

- 1) **Sino-Atrial (S.A. node):** in the right atrium
- 2) **Atrio-ventricular (A.V.) node:** in the lower part of the septal wall of the right atrium.
- 3) **Atrio-ventricular (A.V.) bundle:** It arises from the A.V. node and descends in interventricular septum, then it divides into:

Heart Conduction System



Right bundle branch (R.B.B.): descends down the right side of the septum and passes through the moderator band and ends by forming Purkinje fibres.



Left bundle branch (L.B.B.): descends as 2 fascicles down the left side of the septum. At the apex the 2 fascicles break up into Purkinje fibres.

Moderator band

- It is the right branch of the A-V bundle.
- It is formed of **Purkinje fibers** which are specialized cardiac muscle cells for conduction of impulse to the ordinary muscle cells of the ventricles in order to contract.
- The cells of Purkinje fibers are larger in diameter than the ordinary cardiac muscle fibers.
- Each cell contains single central deeply stained nucleus. Sometimes it is binucleated.
- The cells contain abundant glycogen mainly located in the center of the cell. This glycogen dissolves during preparation and staining, so the cytoplasm appears vacuolated and pale stained.
- They contain fewer myofibrils which are mostly peripheral in position.

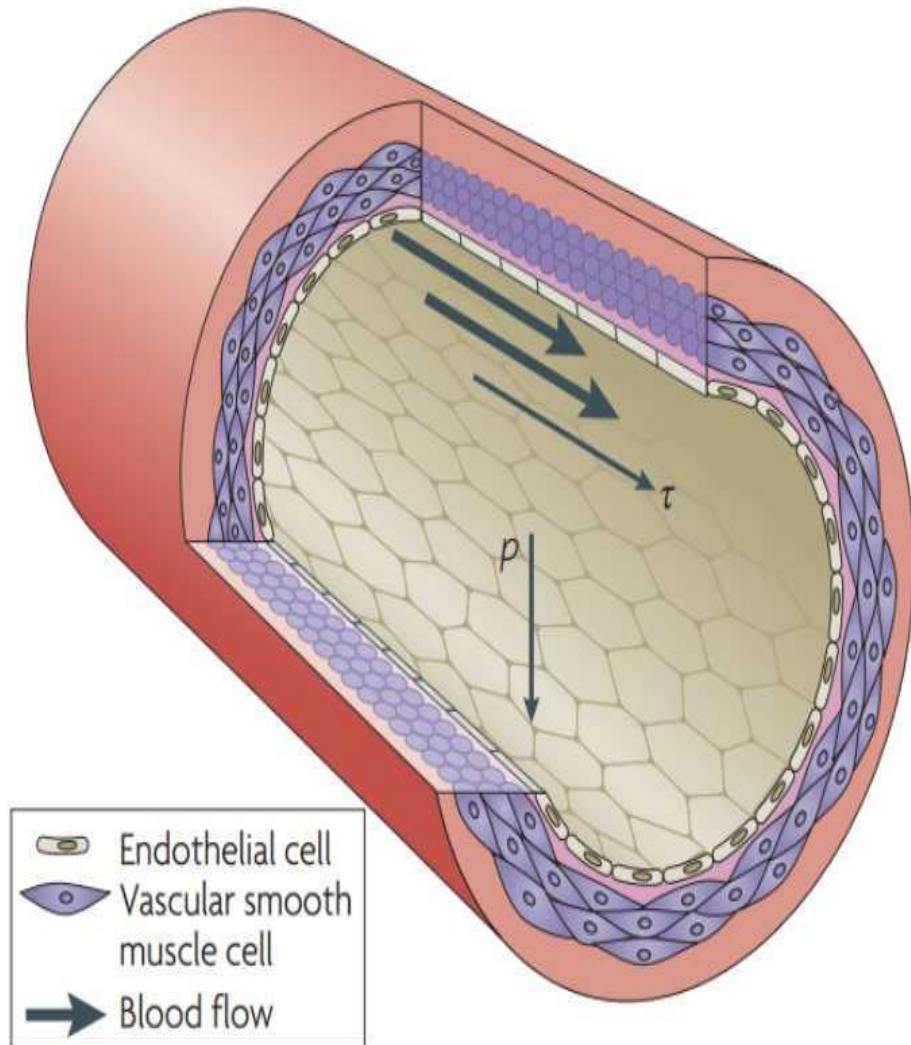
Moderator band (apex of right ventricle)



- C.T containing blood capillaries, fat cells and nerves separates groups of Purkinje fibers from each other and from the surrounding cardiac muscle

Smooth Muscle

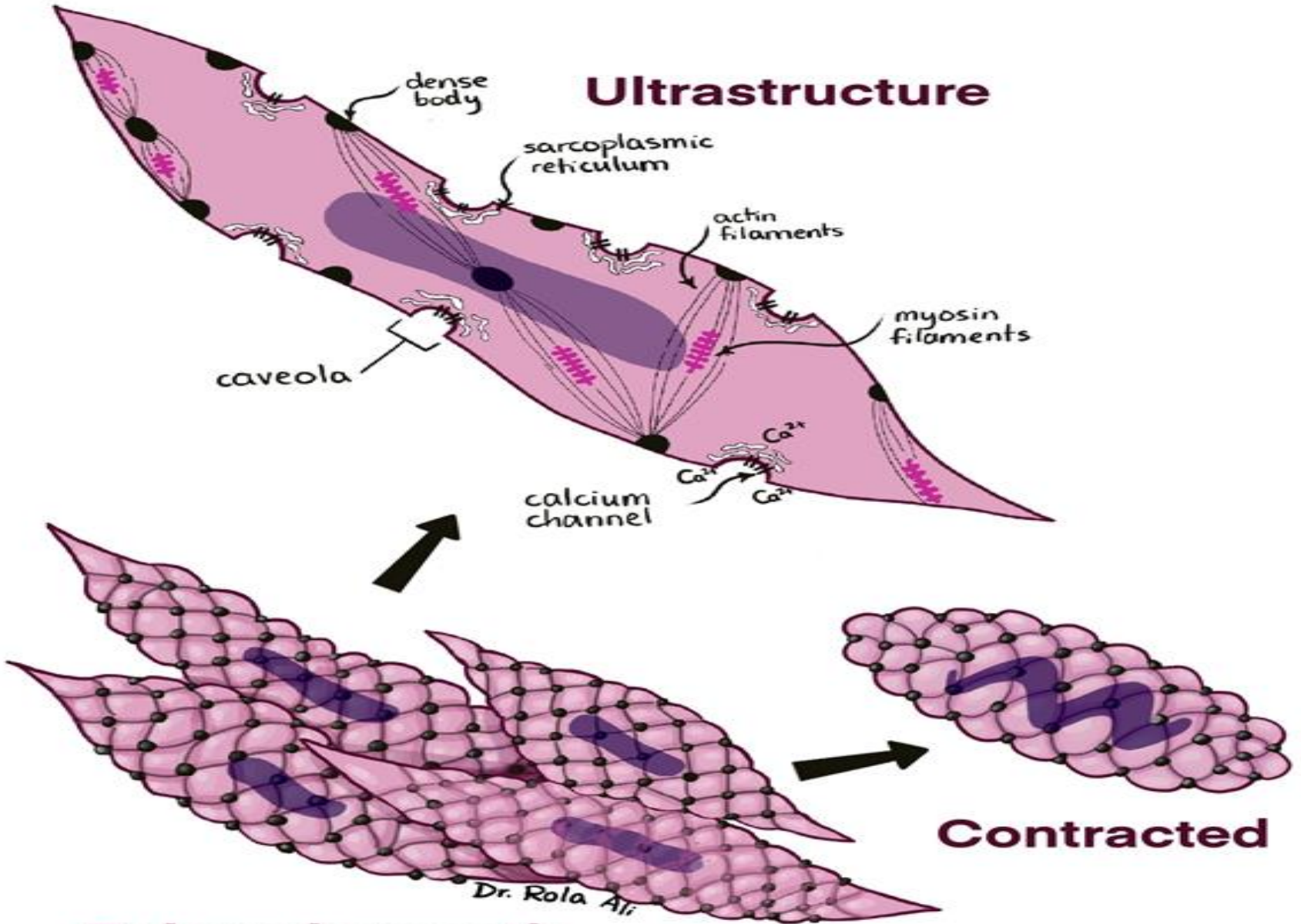
- It is involuntary in action and is adapted for weak and slow contraction for long duration. It has no striations. It is present in the wall of hollow viscera, wall of blood vessels and respiratory passages.



L/M:

- Smooth muscle fibers are fusiform and elongated with centrally located oval nucleus occupies the broadest part of the cell.
- Basal lamina and reticular fibers (endomysium) surround each smooth muscle fiber.
- Their diameters are smaller than that of skeletal and cardiac muscles. The sarcoplasm of smooth muscle is homogenous (non-striated) and acidophilic.

Ultrastructure



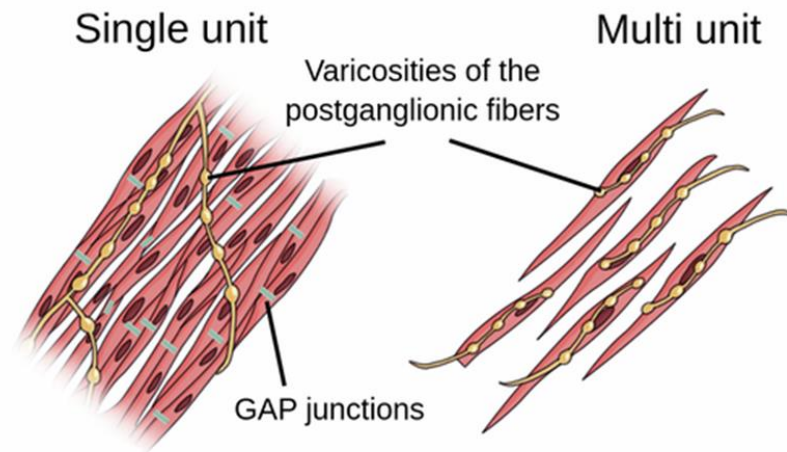
**Relaxed smooth
muscle cells**

Contracted

Dr. Rola Ali

E/M:

- Smooth muscle fibers make contact with each other by gap junction (nexus).
- The sarcoplasm near the nucleus contains numerous mitochondria, small Golgi, RER, free ribosomes and glycogen granules.
- **The SER** of smooth muscle is less developed than that of skeletal and cardiac muscles (does not form sarcoplasmic reticulum).
- **The sarcoplasm** contains:
 - Thin actin filaments.
 - Thick myosin filaments.
 - Intermediate desmin filaments.

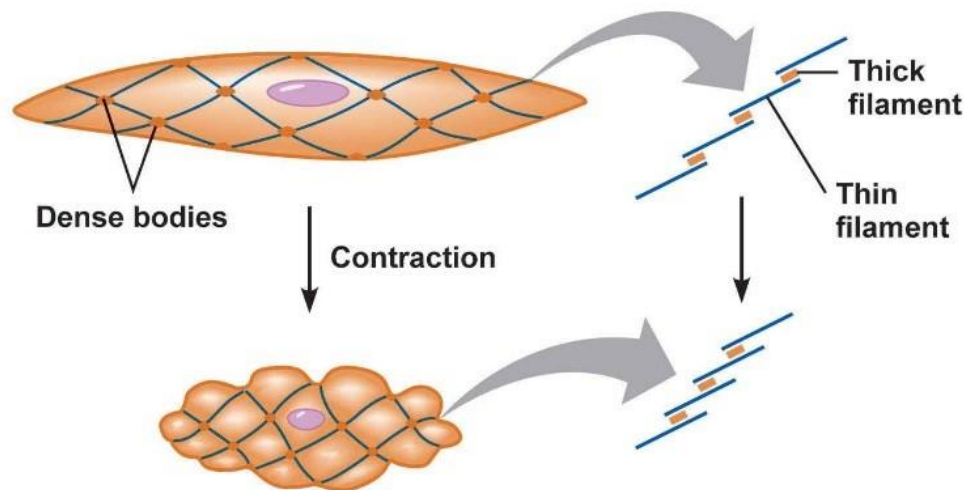


- **Dense bodies:**

- They resemble Z lines in function.
- They are located in the sarcoplasm or associated with the sarcolemma.
- Intermediate filaments as well as thin filaments (actin) inserted into the dense bodies.
- helps transmit contractile force to adjacent smooth muscle cells

- **Caveolae** "sarcolemmal vesicles" present beneath the sarcolemma, contain several pumps and ion channels and may serve to organize release and sequestering of Ca^{++} .

In smooth muscle cells, bundles of thin and thick myofilaments cross obliquely through the cell. Myosin filaments have a less regular arrangement among the thin filaments and fewer cross-bridges than in striated muscle, and the actin filaments lack troponin, using instead calmodulin and Ca²⁺-sensitive myosin light-chain kinase (MLCK) in the contraction mechanism. The sliding filament mechanism of contraction, however, is basically similar to that in striated muscle.



- **Regeneration:**

Smooth muscles are capable of regeneration through mitotic division of the smooth muscle fibers or the pericytes that are present outside the blood vessels to replace the damaged tissue.

- **Function**

- 1- Contractile functions.

- 2- Some smooth muscle cells synthesize exogenous protein e.g. collagen, elastin proteoglycans and growth factors.