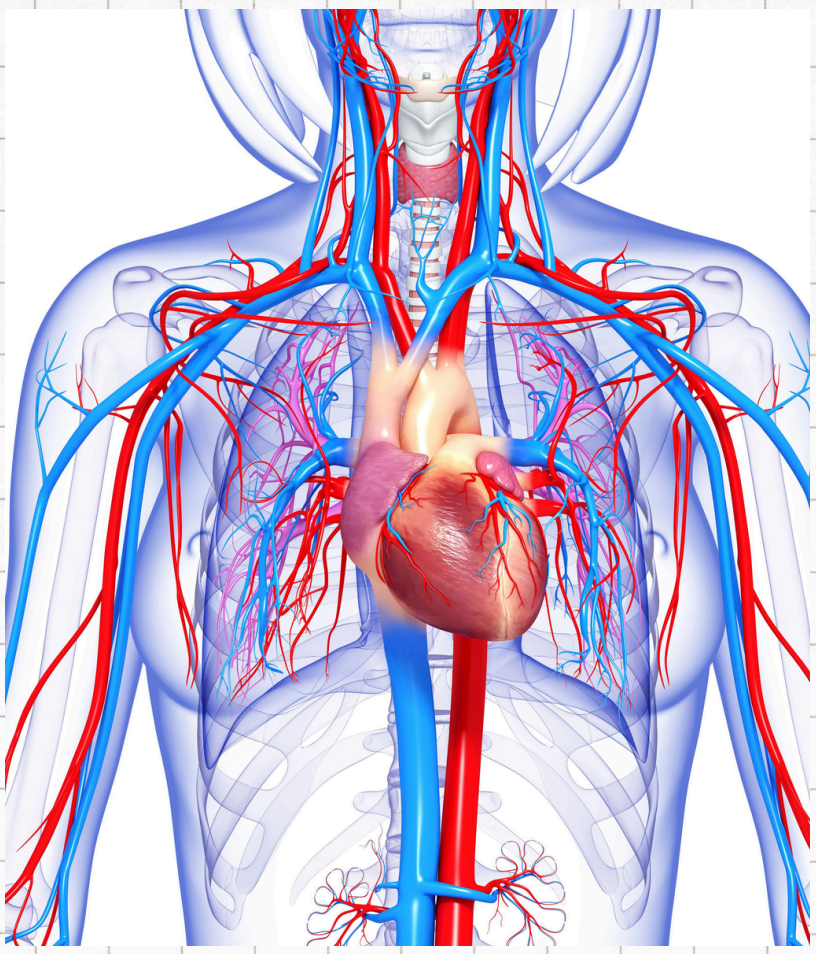
CIRCULATORY SYSTEM



Done by

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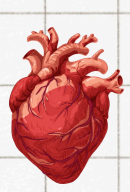
Circulatory system

Cardiovascular System

- **Heart**: serves as **pumping unit** of blood
- **Arteries**: Transport bl. **from heart to peripheral** tissues.
- **Capillaries**: where **exchange** of materials Occurs.
- **Veins**:return blood **back to heart**

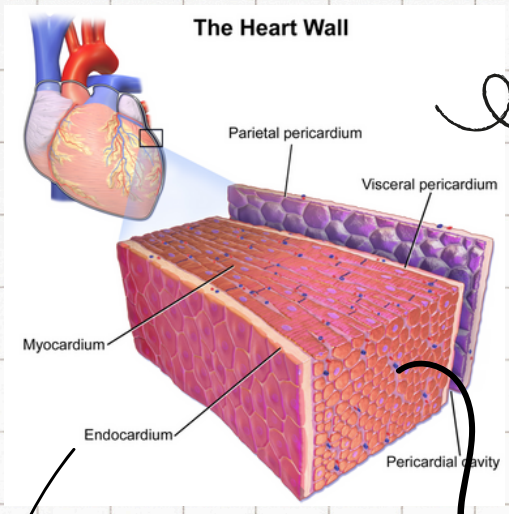
Lymphatic system

Heart



- Heart is **muscular** organ
- consists of **four chambers**.
- Wall of the heart is formed of **three coats: endocardial, myocardial and epicardium layer**
- Covered by **pericardium**

Microscopic structure of heart wall



Pericardium

Parietal pericardium

- fibrous layer **tough**, **white** fibrous
- serous layer a **thin** fibrous layer on **top** of a simple squamous mesothelium

Visceral pericardium= **epicardium** =**serous** layer

- Covers **outer surface**.
- Rests on **loose C.I.** which contains **Fat cells** and **coronary blood vessels.**

Endocardium

- **inner** lining layer
- **formed of:**

a. **Endothelium**:

- simple squamous layer.
- Cells are joined with tight and gap junctions
- resting on a continuous basal lamina.

b. **Subendothelial C.T**.:

loose C.I.,
contains **elastic** and **collagen** fibers.

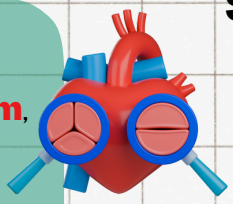
Myocardium

- Forms **main** the wall.
- **formed of:**
- **network of cardiac muscle** fibers

that are **thinner** in atria than ventricle.

- It contains in-between **rich Capillary network.**

Valves of the heart:



They are folds of **endocadium**, **covered** with **endothelium** from both sides, with **middle supporting plate of dense fibrous C.T.** and **elastic fibers**.

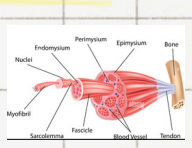
They are present **between atria and ventricles,** at **openings of pulmonary artery and aorta.** They are similar in structure.

Structure of cardiac muscle

1-Connective tissue

It consists of:

1- **Perimysium**: highly vascularized, formed of collagen and elastic fibers, which are **present between the bundles of cardiac muscle fibers.**



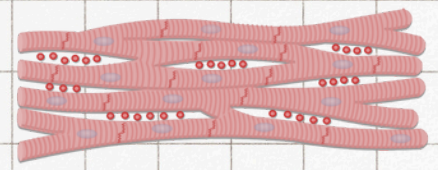
2- **Endomysium**; a network of reticular fibers **surrounds each muscle fiber**.

Definition

- Cardiac muscle fibers present in the wall of the heart
- **Mesodermal** in origin.
- Cannot **divide (Cannot regenerate: heal by fibrosis)**
- They are **involuntary** in action
- **faint** and **indistinct transverse striations**.
- The cardiac muscle fibers are **smaller in size** compared withskeletal muscle fibers.

Shape

- **LM Cardiac Muscle**

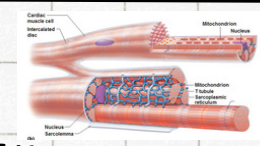


- Cardiac muscle fibers are composed of **several cardiac muscle cells** (**cardiomyocytes**).
- **cardiomyocytes** They are **cylindrical** and **branch** and **anastomose** with each other.
- **Cytoplasm show faint and indistinct transverse striations**.
- **Nucleus**: **one or two centrally** located, **oval** and **pale** stained nuclei
- Each fibre is formed of cells = myocytes
- separated by intercatated disc

- **EM Cardiac Muscle**

- **myofibrils few**
- **Mitochondria** more numerous, larger with more cristae
- **s- ER**: **one terminal tubule accompany T- tubule (Diad of tubular syst)**
- **Glycogen** granules **ipofuscin** pigments

2-T tubules (LM)



·**Definition**: inward extensions of the extracellular spaçe at the sarcolemma.

·**Site**: at the **Z line**.

· **Characteristic features**: large & numerous.

·**Function**:

- Excitation-contraction, coupling.
- Provide **additional surface area** for exchange of metabolites between cardiac muscle fibers and the extracellular space.

3- Sarcoplasmic reticulum (EM)

· It is **less organized** than the skeletal muscle.

· It consists of narrow anastomosing sarcotubules without the continuous terminal cisternae that **encircle** the **whole myofibrils, instead, scattered small expansions of sarcotubules are in close apposition with the T tubules forming diads.**

Structure of cardiac muscle

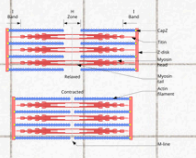
4- Intercalated discs

- **Definition**: **specialized junctions** of cell membranes of adjacent cardiomyocytes.
- **Site**: extend across the fiber at the level of the **Z lines.**
- **Shape :stepwise**.

- **Structure**:

Intercalated discs	Transverse portion	Longitudinal portion
Site	**Perpendicular** to myofilaments, at the level of **Z line**.	**Parallel** to myofilaments.
Stress of contraction	↑↑	↓
Structure	1- fascia **adherence**(zonula adherens) 2- **macula** adherence (desmosomes attached to desmin)	Gap junctions
Function	**Strong adhesion between the cells during contraction**	**Rapid spread of excitation from one cell to the other**

Sarcomere



1. It is the part of the **myofibril** between **two successive Z lines.**
2. It is the **functional unit** of the muscle fiber.
3. Each contains 1 **complete A(dark)** band **separating 2 halves I (white) bands.**
4. During contraction: actin glides over myosin ⇢ **shortening of sarcomere** & disappearance of H- zone.

Only **I- band is shortened while A- band is constant**

Types of cardiomyocytes

	Contractile cardiomyocytes	Endocrine cardiomyocytes	Cardiomyocytes of the conduction system **Nodal cells**	Cardiomyocytes of the conduction system **Purkinje fibers**
Definition	They are the **ordinary cardiomyocytes**	They are cardiomyocytes which have an **endocrine function**.	**modified** cardiomyocytes that are **specialized** in the **initiation and propagation** of **depolarization** through the myocardium **faster** than the **contractile cardiac muscle fibers.**	
Site	**majority** of the myocardiumof the atria and ventricles.	in the atria, especially the (**right atrium.**)	in the **sinoatrial node**, the **atrio-ventricular node and the trunk of the bunde of His**.	in the **subendocardial** layer of the **ventricles**.
Structure	-----	They **differ** from contractile cardiomyocytes in: 1- They have **fewer myofibrils**! 2- They have **numerous electron secretory granules**	1-They are **smaller** than the surrounding atrial muscle fibers. 2- Contain **fewer** myofibrils. 3- **Lack typical intercalated discs**	1- They are **present in groups** of two or more. 2- They are often **binucleated** 3- They are **larger** than the ventricular muscle fibers 4- They contain **fewer myofibrils** which are located **peripherally**. 5- Their cytoplasm is **rich in mitochondria** and **glycogen**, so they are **pale** in **H&E sections**. 6- They **do not** contain **typical intercalated** discs, although, they **contain many gap junctions more** than in contractile cardiomyocytes.
Function	**contraction**	containing the **atrial natriuretic factor** Which has a **role in control of blood pressure and electrolyte balance**.		

• The cardiac muscle fibers have no ability for regeneration, because:
1-They are static cell population (can not divide by mitosis).
2- Satellite cells are absent.
• The injured cardiac fibers are replaced by fibrous tissue.
The heart muscle responds to increased functional demands by compensatory hypertrophy.