

## **The circulatory system :**

### **Lecture Objectives**

**By the end of this lecture, students are expected to:**

- 1. Summarize the structural layers of the walls of all four heart chambers .**
- 3. Outline the histological features of the pericardium, endocardium.**
- 4. Outline of the innate cardiac conducting system.**
- 5. Differentiate between the layers of arteries .**
- 6. summarize the differences between types of veins .**
- 7. Differentiate between the types of capillaries.**

### **Introduction:**

The circulatory system pumps and directs blood cells and substances carried in blood to all tissues of the body.

It includes both the blood and lymphatic vascular systems, The blood vascular system , or cardiovascular system , consists of the following structures:

- The heart propels blood through the system.

■ Arteries , a series of vessels efferent from the heart that become smaller as they branch into the various organs, carry blood to the tissues.

■ Capillaries , the smallest vessels, are the sites of  $O_2$  ,  $CO_2$  , nutrient, and waste product exchange between blood and tissues. Together with the smallest arterial and venous branches carrying blood to and from them, capillaries in almost every organ form a complex network of thin, anastomosing tubules called the microvasculature or microvascular bed.

■ Veins result from the convergence of venules into a system of larger channels that continue enlarging as they approach the heart, toward which they carry the blood to be pumped again.

## **Heart:**

Cardiac muscle in the four chambers of the heart wall contracts rhythmically, pumping the blood through the circulatory system . The right and left ventricles propel blood to the pulmonary and systemic circulation, respectively; right and left atria receive blood from the body and the pulmonary veins, respectively. The walls of all four heart chambers consist of three major layers: the internal endocardium; the middle myocardium; and the external epicardium.

**The endocardium** consists of a very thin inner layer of endothelium and supporting connective tissue, a middle myoelastic layer of smooth muscle fibers and connective tissue, and a deep layer of connective tissue called the subendocardial layer that merges with the myocardium. Branches of the heart's impulse-conducting system, consisting of modified cardiac muscle fibers, are also located in the subendocardial layer .

**The myocardium**, consists mainly of cardiac muscle with its fibers arranged spirally around each heart chamber. Because strong force is required to pump blood through the systemic and pulmonary circulations, the myocardium is much thicker in the walls of the ventricles, particularly the left, than in the atrial walls .

**The epicardium** is a simple squamous mesothelium supported by a layer of loose connective tissue containing blood vessels and nerves . The epicardium corresponds to the visceral layer of the pericardium, the membrane surrounding the heart. Where the large vessels enter and leave the heart, the epicardium is reflected back as the parietal layer lining the pericardium. During heart movements, underlying structures are cushioned by deposits of adipose tissue in the epicardium and friction within the pericardium is prevented by lubricant fluid produced by both layers of serous mesothelial cells.

Within these major layers the heart contains other structures important for its overall function of moving blood. Dense fibrous connective tissue of the cardiac skeleton forms part of the interventricular and interatrial septa, surrounds all valves of the heart, and extends into the valve cusps and the chordae tendineae to which they are attached .

These regions of dense irregular connective tissue perform the following functions:

- Anchoring and supporting the heart valves
- Providing firm points of insertion for cardiac muscle
- Helping coordinate the heartbeat by acting as electrical insulation between atria and ventricles.

Within the subendocardial layer and adjacent myocardium, modified cardiac muscle cells make up the impulse **conducting system** of the heart, which generates and propagates waves of depolarization that spread through the myocardium to stimulate rhythmic contractions. This system (consists of two nodes of specialized myocardial tissue in the right atrium: the sinoatrial (SA) node (or pacemaker) and the atrioventricular (AV) node, followed by the AV bundle (of His) and the subendocardial conducting network.

Located in the right atrial wall near the superior vena cava, the SA node is a 6– to 7–mm<sup>3</sup> mass of cardiac muscle cells with smaller size, fewer myofibrils, and fewer typical intercalated disks than the neighboring muscle fibers. Impulses initiated by these cells move along the myocardial fibers of both atria, stimulating their contraction. When the impulses reach the slightly smaller AV node, located in the floor of the right atrium near the AV valve and composed of cells similar to those of the SA node, they stimulate depolarization of those cells. Conducting muscle fibers from the AV node form the AV bundle, pass through an opening in the cardiac skeleton into the interventricular septum, and bifurcate into the wall of each ventricle.

At the apex of the heart, the bundles branch further into a subendocardial conducting network of myofibers, usually called Purkinje fibers. These are pale–staining fibers, larger than the adjacent contractile muscle fibers, with sparse, peripheral myofibrils and much glycogen . Purkinje fibers mingle distally with contractile fibers of

both ventricles and trigger waves of contraction through both ventricles simultaneously.

Both parasympathetic and sympathetic neural components innervate the heart. Ganglionic nerve cells and nerve fibers are present in the regions

close to the SA and AV nodes, where they affect heart rate and rhythm, such as during physical exercise and emotional stress. Stimulation of the parasympathetic division (vagus nerve) slows the heartbeat, whereas stimulation of the sympathetic nerve accelerates activity of the pacemaker. Between fibers of the myocardium are afferent free nerve endings that register pain, such as the discomfort called angina pectoris that occurs when partially occluded coronary arteries cause local oxygen deprivation.