Circulatory System

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Part 2

Histology

Second year

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Functional Correlations of the Circulatory System

Blood Vessels

The elastic arteries transport blood from the heart and move it along the systemic vascular path. The presence of an increased number of elastic fibers in their walls allows the elastic arteries to greatly expand in diameter during systole (heart contraction), when a large volume of blood is forcefully ejected from the ventricles into their lumina. During diastole (heart relaxation), the expanded elastic walls recoil upon the volume of blood in their lumina and force the blood to move forward through the vascular channels. As a result, a less variable systemic blood pressure is maintained, and blood flows more evenly through the body during heart beats.

In contrast, the muscular arteries control blood flow and blood pressure through vasoconstriction or vasodilation of their lumina. Vasoconstriction and vasodilation, owing to a high proportion of smooth muscle fibers in the artery walls, are controlled by unmyelinated axons of the sympathetic division of the autonomic nervous system. Similarly, by autonomic constriction or dilation of their lumina, the smooth muscle fibers in smaller muscular arteries or arterioles regulate blood flow into the capillary beds. Terminal arterioles give rise to the smallest blood vessels, called capillaries. Because of their very thin walls, capillaries are major sites for exchange of gases, metabolites, nutrients, and waste products between blood and interstitial tissues.

In veins, blood pressure is lower than in the arteries. As a result, venous blood flow is passive.

Venous blood flow in the head and trunk is primarily owing to negative pressures in the thorax and abdominal cavities resulting from respiratory movements. Venous blood return from the extremities is aided by surrounding muscle contractions and prevented from flowing back by numerous valves in the large veins of the extremities.

The Endothelium

The endothelium lining the lumina of blood vessels performs important functions in blood homeostasis. The endothelial cells form a permeability barrier between blood and the interstitial tissue. Also, the endothelium provides a smooth surface that allows blood cells and platelets to flow through the vessels without damage. The smooth lining of the blood vessels and the secretion of anticoagulants by the endothelial cells prevents blood clotting. Endothelium also produces vasoactive chemicals that stimulate the dilation or constriction of the blood vessels. When endothelium is damaged, platelets adhere at the site and form a blood clot.

Lymphatic Vessels

The main function of the lymph vascular system is to passively collect excess tissue fluid and proteins, called lymph, from the intercellular spaces of the connective tissue and return it into the venous portion of the blood vascular system. Lymph is a clear fluid and an ultra filtrate of the blood plasma. Numerous lymph nodes are located along the route of the lymph vessels. In the maze of lymph node channels, the collected lymph is filtered of cells and particulate matter.

Lymph that flows through the lymph nodes is also exposed to the numerous macrophages that reside here. These engulf any foreign microorganisms, as well as other suspended matter. The lymph vessels also bring to the systemic bloodstream lymphocytes, fatty acids absorbed through the capillary lymph vessels called lacteals in the small intestine, and immunoglobulins (antibodies) produced in the lymph nodes. Thus, the lymphatic vessels are an integral part of the immune system of the body.

The heart

is an extraordinary organ. It is about the size of a clenched fist, and is shaped like a cone. Along with the circulatory system, the heart works to supply blood and oxygen to all parts of the body. The heart is located in the chest cavity just posterior to the breastbone, between the lungs, and superior to the diaphragm. It is surrounded by a fluid-filled sac called the pericardium, which serves to protect this vital organ.

The heart wall is composed of connective tissue, endothelium, and cardiac muscle. It is the cardiac muscle that enables the heart to contract and allows for the synchronization of the heartbeat. The heart wall is divided into three layers: epicardium, myocardium, and endocardium.

1. **Epicardium**— outer protective layer of the heart.
2. **Myocardium**—muscular middle layer wall of the heart.
3. **Endocardium**—inner layer of the heart.

Epicardium

is the outer layer of the heart wall. It is also known as visceral pericardium as it forms the inner layer of the pericardium. The epicardium is composed primarily of loose connective tissue, including elastic fibers and adipose tissue. The epicardium functions to protect the inner heart layers and also assists in the production of pericardial fluid. This fluid fills the pericardial cavity and helps to reduce friction between pericardial membranes. Also found in this heart layer are the coronary blood vessels, which supply the heart wall with blood. The inner layer of the epicardium is in direct contact with the myocardium.

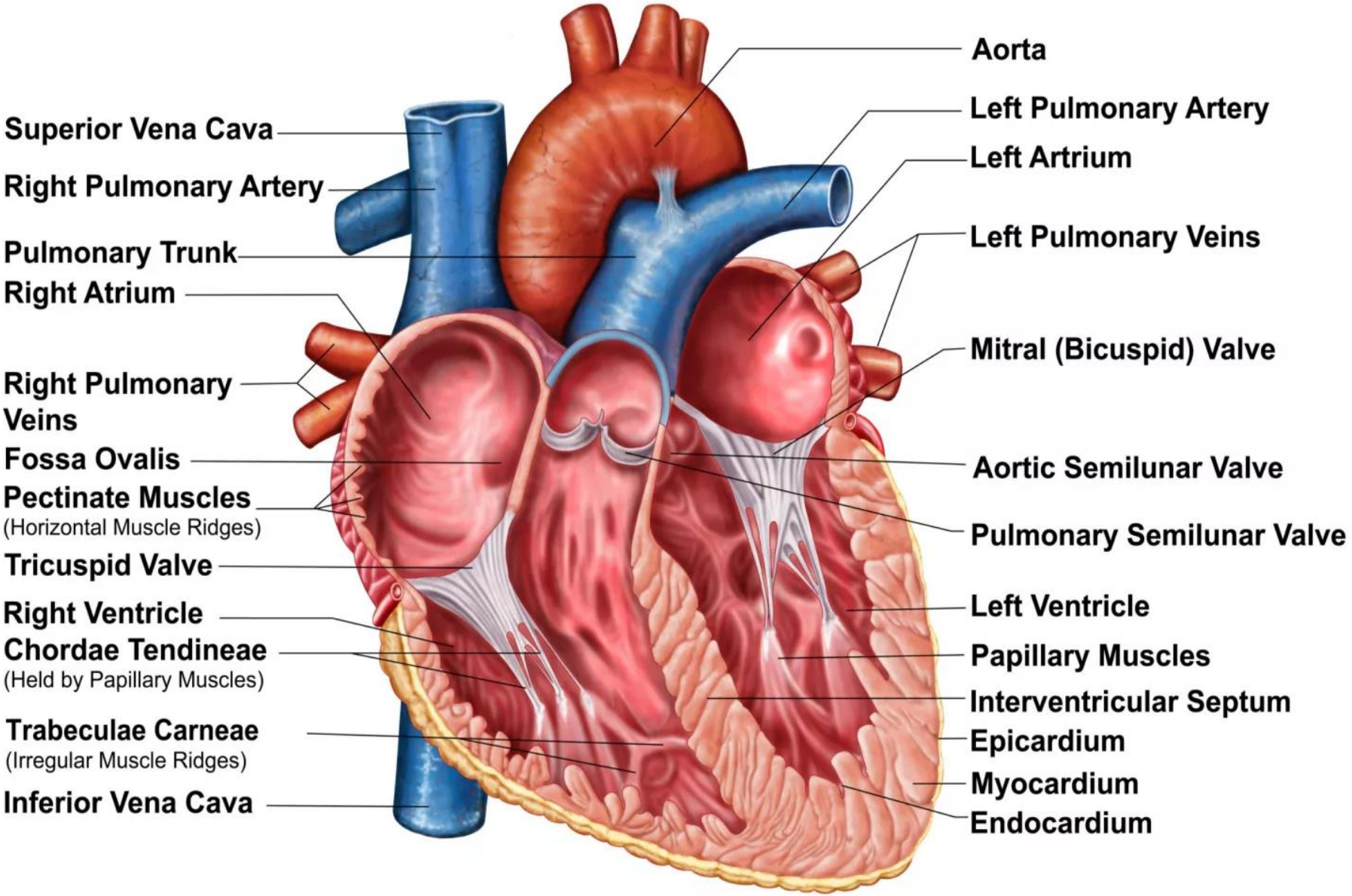
Myocardium

is the middle layer of the heart wall. It is composed of cardiac muscle fibers, which enable heart contractions. The myocardium is the thickest layer of the heart wall, with its thickness varying in different parts of the heart. The myocardium of the left ventricle is the thickest as this ventricle is responsible for generating the power needed to pump oxygenated blood from the heart to the rest of the body. Cardiac muscle contractions are under the control of the peripheral nervous system, which directs involuntary functions including heart rate.

Cardiac conduction is made possible by specialized myocardial muscle fibers. These fiber bundles, consisting of the atrioventricular bundle and Purkinje fibers, carry electrical impulses down the center of the heart to the ventricles. These impulses trigger the muscle fibers in the ventricles to contract.

Endocardium

is the thin inner layer of the heart wall. This layer lines the inner heart chambers, covers heart valves and is continuous with the endothelium of large blood vessels. The endocardium of heart atria consists of smooth muscle, as well as elastic fibers.


Aorta
Left Pulmonary Artery
Left Artrium
Left Pulmonary Veins
Mitral (Bicuspid) Valve
Aortic Semilunar Valve
Pulmonary Semilunar Valve
Left Ventricle
Papillary Muscles
Interventricular Septum
Epicardium
Myocardium
Endocardium
Superior Vena Cava
Right Pulmonary Artery
Pulmonary Trunk
Right Atrium
Right Pulmonary Veins
Fossa Ovalis
Pectinate Muscles
(Horizontal Muscle Ridges)
Tricuspid Valve
Right Ventricle
Chordae Tendineae
(Held by Papillary Muscles)
Trabeculae Carneae
(Irregular Muscle Ridges)
Inferior Vena Cava