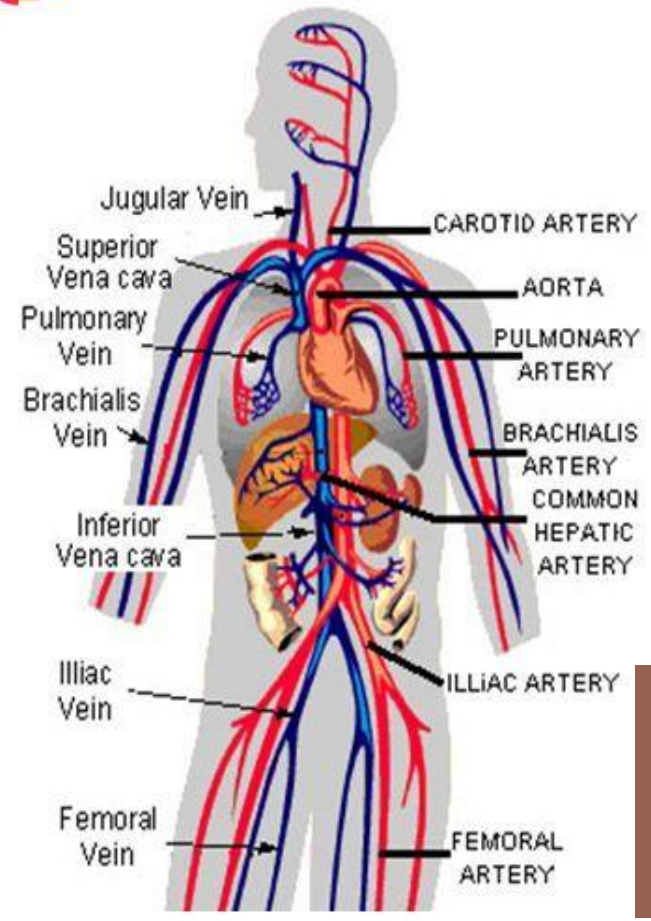
Circulatory system



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INTRODUCTION

Circulation is a process through which oxygen, Minerals, vitamins, &digested food materials are supplied to various tissues of the body and carbondioxide & other nitrogenous waste materials formed in the body are carried to lungs & kidneys respectively. This is done through a system called **CIRCULATORY SYSTEM** which includes the blood, blood vessels called arteries, veins & capillaries.

Types of hearts

Physiologists have recognized two types of hearts based on rhythmic activity they are

MYOGENIC HEART

NEUROGENIC HEART

MYOGENIC HEART

The rhythmic activity of the heart is due to the inherent power of muscles. Which means the heart can performs its functions on it's own with out the influence of nervous system **Ex. heart muscles of chick embryos** . The research of **RINGER & LOCKE** has brought forth the importance of organic constituents of the percolating fluids in bringing about the rhythmicity seen in the heart beat

the experiments of **W.H.LEWIS** lend some importance to the above experiment, he also shown the importance of potassium chloride for longer period of pulsations.

also found in mollusks, do not have pace maker, acetyl choline seems to have an adverse effect on heart beat among lamelli branchs & cephalopods .

Neurogenic heart :

The heart of most of the arthropods and in the general invertebrates heart are known for the rich supply of the nervous elements. Acetylcholine seems to accelerate the heart beat in these animals, it is the chemical produced by the stimulated nerves. In these animals the pace makers are made up of nerve cells and initiate the contraction of heart , hence these hearts are referred to as **NEUROGENIC HEART**.

STRUCTURE OF MAMALIAN HEART

Position

Mesodermal in origin .Reddish in color and lies in between two lungs in the space called *mediastinum* of thoracic cavity close to ventral wall.

Histology

The walls of heart is made up of three layers namely epicardium or mesocardium, and endocardium.

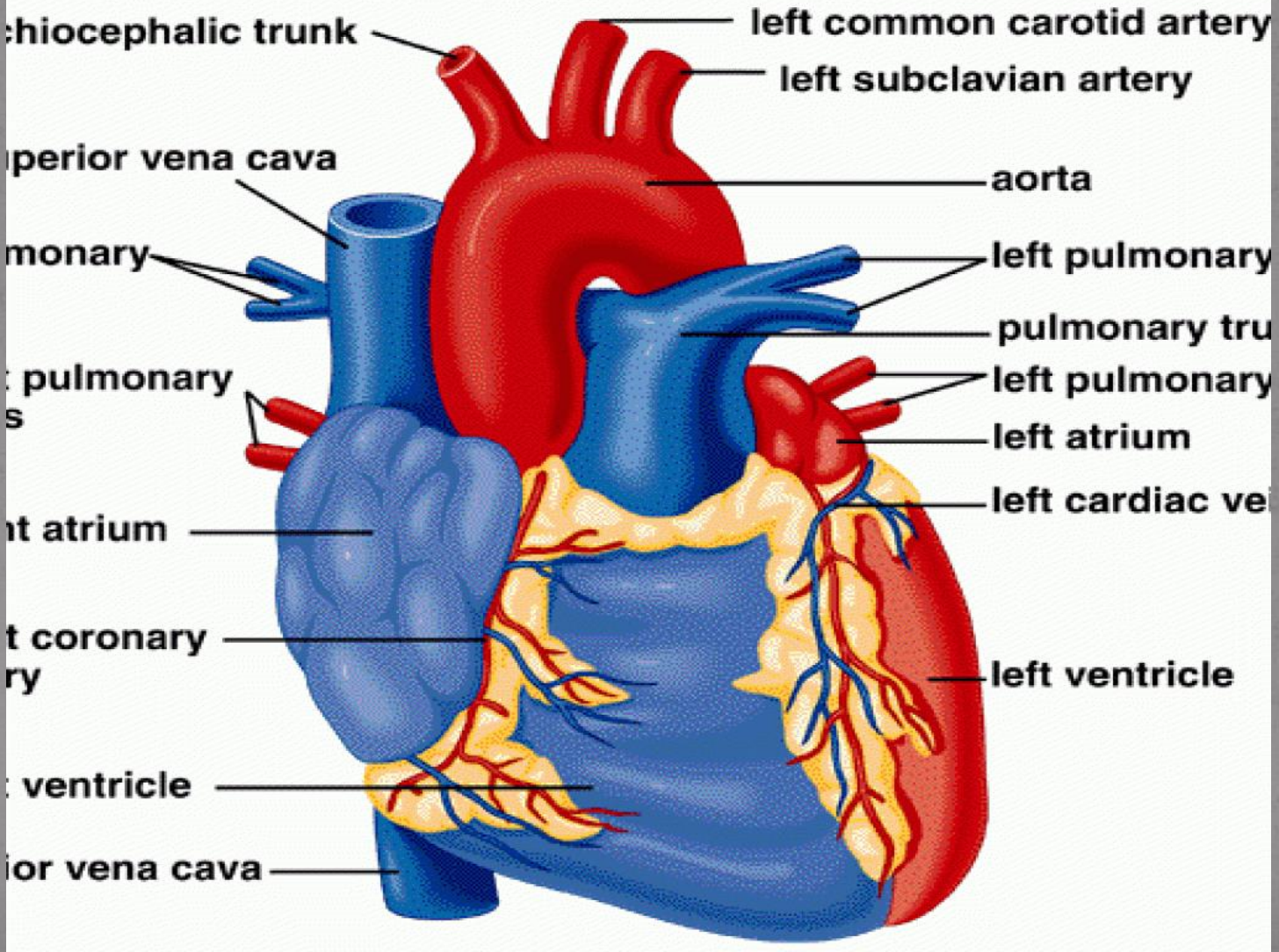
Epicrdium :

This is outermost layers of tissue that form the heart wall. It is composed of a single sheet of squamous epithelial cells overlying delicate connective tissue.

Myocardium :

A thick contractile middle layer of uniquely constructed and arranged muscle cells that forms the bulk of the heart wall. The myocardium contains other tissue, except blood vessels, and is covered interiorly by the endocardium.

External Heart Anatomy



Endocardium

The endocardium is the innermost layer of tissue that lines the chambers of the heart. Its cells are embryologically and biologically similar to the endothelial cells that line blood vesseles. The endocardium also provides protection to the valves and heart chambers.

Functions of heart layers

1. To protect the heart from external shock and mechanical injury.
2. Keeps the heart always moist
3. Reduces friction during contraction and expansion of heart.

External structure

Cardiac Septum

- A muscular tissue, the cardiac septum, divides the heart into a right and left side. Each side of the heart has an upper chamber or atrium, lower chamber, or ventricle. The two sides of the heart have different functions, but they work together to shuttle the blood to all parts of the body.

Chambers

- The right atrium is a thin-walled chamber that receives oxygen-poor, or deoxygenated, blood from the upper and lower parts of the body. It also receives deoxygenated blood from the muscular walls of the heart.
- The right ventricle fills with the deoxygenated blood from the right atrium and pushes the blood into the pulmonary arteries, which lead into the lungs. The blood is oxygenated in the lungs.
- The left atrium is also a thin-walled chamber that receives oxygenated blood from the lungs by means of four pulmonary veins.
- The left ventricle has a very thick muscular wall. When this ventricle contracts, oxygenated blood is forced through the aorta and its artery branches to all parts of the body.

Valves

- The heart has four valves that open to let the blood flow when the heart contracts. Each valve has a set of flaps, called cusps or leaflets.
- The valves allow the blood to flow in only one direction and healthy valves close tightly to stop the blood from flowing backwards.
- A stethoscope can detect the sound of the heart valves opening and closing. The tricuspid valve is located between the right atrium and the right ventricle and the pulmonary valve on the right ventricle regulates the opening to the pulmonary artery.
- The mitral valve is situated between the left atrium and the left ventricle, while the aortic valve on the left ventricle controls the opening to the aorta.

Pacemaker

- The rate at which the heart beats is controlled by electrical impulses mediated by the involuntary, or autonomic, nervous system. One nerve, coming from the brain, speeds up the heart beat, while another slows it down.
- The nerves terminate in a group of cells, located in the wall of the right atrium, called the sinus node or pacemaker.

Internal structure

- The heart has four chambers, two upper atria, the receiving chambers, and two lower ventricles, the discharging chambers. The atria open into the ventricles via the atrioventricular valves, present in the atrioventricular septum.
- This distinction is visible also on the surface of the heart as the coronary sulcus. There is an ear-shaped structure in the upper right atrium called the right atrial appendage, or auricle, and another in the upper left atrium, the left atrial appendage.
- The right atrium and the right ventricle together are sometimes referred to as the *right heart*. Similarly, the left atrium and the left ventricle together are sometimes referred to as the *left heart*.
- The ventricles are separated from each other by the interventricular septum, visible on the surface of the heart as the anterior longitudinal sulcus and the posterior interventricular sulcus.

- The cardiac skeleton is made of dense connective tissue and this gives structure to the heart. It forms the atrioventricular septum which separates the atria from the ventricles, and the fibrous rings which serve as bases for the four heart valves.
- The cardiac skeleton also provides an important boundary in the heart's electrical conduction system since collagen cannot conduct electricity. The interatrial septum separates the atria and the interventricular septum separates the ventricles.
- The interventricular septum is much thicker than the interatrial septum, since the ventricles need to generate greater pressure when they contract.

Working of heart

- The heart functions as a pump in the circulatory system to provide a continuous flow of blood throughout the body. This circulation consists of the systemic circulation to and from the body and the pulmonary circulation to and from the lungs.
- Blood in the pulmonary circulation exchanges carbon dioxide for oxygen in the lungs through the process of respiration. The systemic circulation then transports oxygen to the body and returns carbon dioxide and relatively deoxygenated blood to the heart for transfer to the lungs.
- The **right heart** collects deoxygenated blood from two large veins, the superior and inferior venae cavae. Blood collects in the right and left atrium continuously. The superior vena cava drains blood from above the diaphragm and empties into the upper back part of the right atrium.

- The inferior vena cava drains the blood from below the diaphragm and empties into the back part of the atrium below the opening for the superior vena cava. Immediately above and to the middle of the opening of the inferior vena cava is the opening of the thin-walled coronary sinus.
- Additionally, the coronary sinus returns deoxygenated blood from the myocardium to the right atrium. The blood collects in the right atrium. When the right atrium contracts, the blood is pumped through the tricuspid valve into the right ventricle.
- As the right ventricle contracts, the tricuspid valve closes and the blood is pumped into the pulmonary trunk through the pulmonary valve.
- The pulmonary trunk divides into pulmonary arteries and progressivelysmaller arteries throughout the lungs, until it reaches capillaries. As these pass by alveoli carbon dioxide is exchanged for oxygen. This happens through the passive process of diffusion.

- In the **left heart**, oxygenated blood is returned to the left atrium via the pulmonary veins. It is then pumped into the left ventricle through the mitral valve and into the aorta through the aortic valve for systemic circulation. The aorta is a large artery that branches into many smaller arteries, arterioles, and ultimately capillaries. In the capillaries, oxygen and nutrients from blood are supplied to body cells for metabolism, and exchanged for carbon dioxide and waste products.Capillary blood, now deoxygenated, travels into venules and veins that ultimately collect in the superior and inferior vena cavae, and into the right heart.

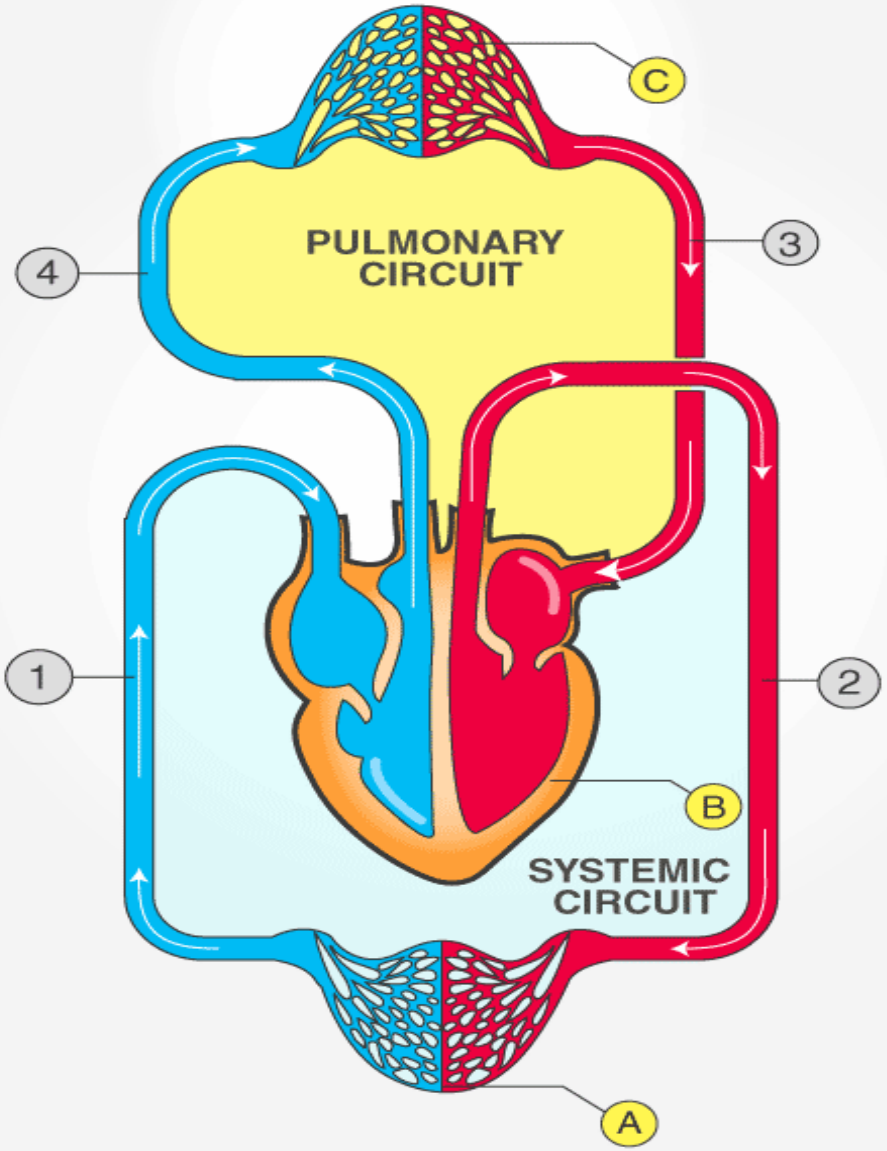
Cardiac cycle

- Contraction of heart chambers is known as systole while their relaxation is called diastole. Thus one complete systole and diastole of the heart makes one heart beat or cardiac cycle.

DOUBLE CIRCULATION

The heart is the key organ for blood circulation and the double circulation is an efficient way of circulation as it provides an effective way of circulation. The main difference is that the blood follows two routes – one for oxygenated blood and the other for deoxygenated blood. Hence the name "double circulation." The majority of mammals, including humans utilize double circulatory system.

DOUBLE CIRCULATION



1. Vena cava from body
2. Aorta to body
3. Pulmonary vein to lungs
4. Pulmonary artery to lungs

A. Capillaries of body organs apart from the lungs
B. Heart
C. Lung capillaries

Circulatory system diseases

- High blood pressure
- Atherosclerosis and coronary artery disease
- Heart attacks
- Heart failure
- Strokes
- Abdominal aortic aneurisms
- Peripheral artery disease

Atherosclerosis and coronary artery disease

- Atherosclerosis, also known as hardening of the arteries, occurs when plaque builds up on the walls of your arteries and eventually blocks blood flow.
- Plaque is made of cholesterol, fat, and calcium.

Abdominal aortic aneurisms

- An abdominal aortic aneurism is a bulge in a weakened part of the aorta.
- The aorta is the largest blood vessel in your body. It carries blood from your heart to your abdomen, legs, and pelvis.
- An abdominal aortic aneurism can stay small and never cause problems
- . When it becomes larger, you may experience pain in the abdomen or back.
- Large and rapidly growing abdominal aortic aneurisms are at greatest risk of rupturing.

Peripheral artery disease

- Peripheral artery disease (PAD) is atherosclerosis that occurs in the extremities, usually in your legs.
- It reduces blood flow to your legs, as well as to your heart and brain.

symptoms may include:

- pain or cramping in the legs, especially when walking
- coolness in legs or feet
- sores that don't heal on the feet or legs
- redness or other changes in skin color