Cardiovascular System

Heart – Anatomy of heart

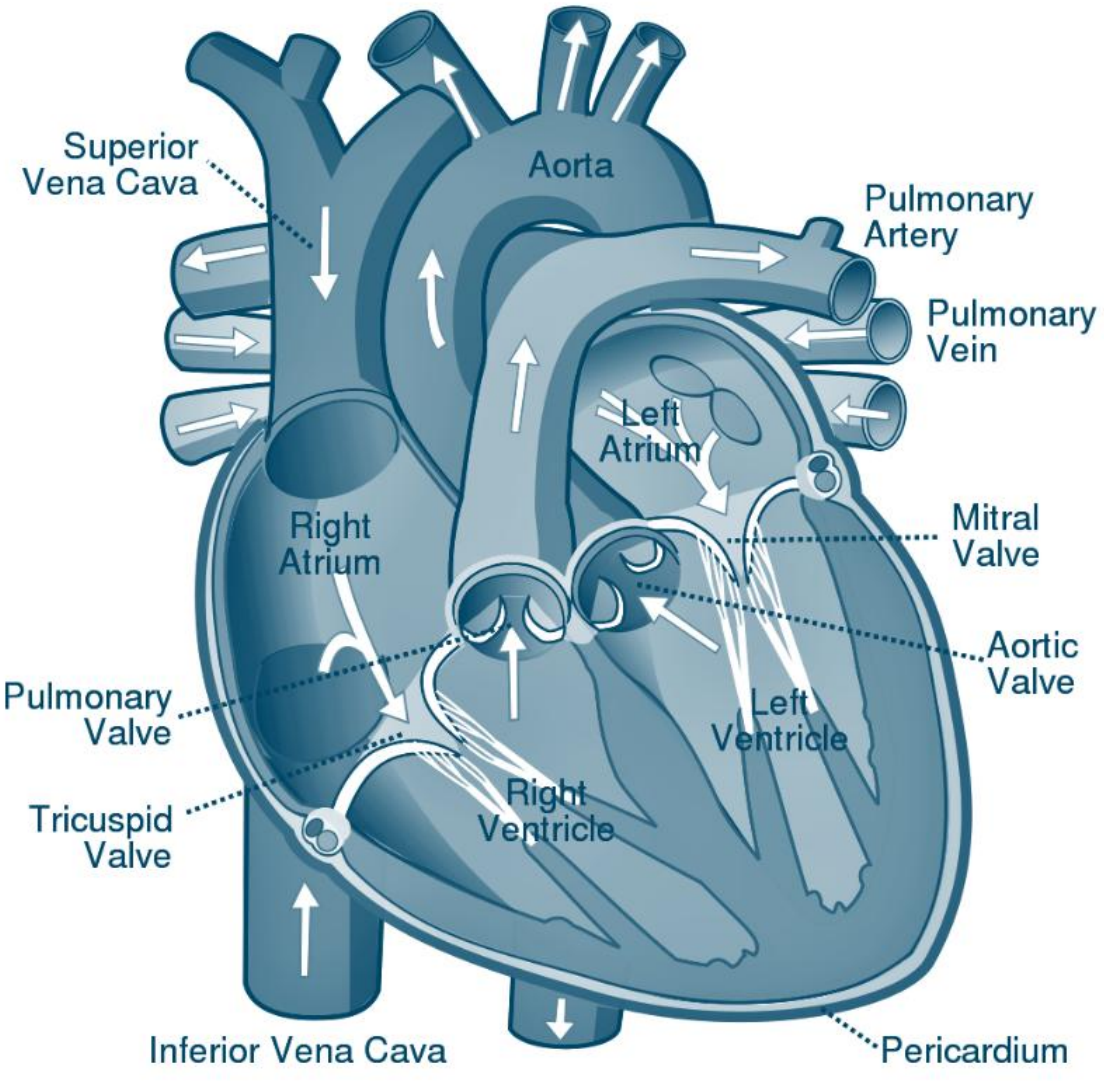
- The heart is a muscular, four-chambered organ responsible for pumping blood throughout the body.
- It is located within the thoracic cavity, specifically in the mediastinum, behind the sternum and between the lungs.
- The heart's anatomy can be described in terms of its position, wall structure, chambers, and valves.

Position:

- The heart is positioned slightly to the left of the midline in the mediastinum, with about two-thirds of its mass to the left of the body's midline.
- The base of the heart is directed upward, backward, and to the right, while the apex points downward, forward, and to the left, resting on the diaphragm.

Structure of the Heart Wall:

The wall of the heart consists of **three** layers:



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1. **Epicardium:**
   - The outermost layer of the heart wall, also known as the visceral layer of the serous pericardium, is composed of a thin layer of connective tissue and a layer of epithelial cells.
   - It covers the heart and the outer surfaces of the great vessels.
2. **Myocardium:**
   - The myocardium is the middle and thickest layer of the heart wall, composed of cardiac muscle tissue.
   - This layer is responsible for the heart's contraction and relaxation, which generates the pumping action necessary for blood circulation.
3. **Endocardium:**
   - The endocardium is the innermost layer of the heart wall, consisting of a thin layer of endothelial cells that line the heart chambers and the valves.
   - This smooth layer minimizes friction as blood flows through the heart.

Chambers of the Heart:

The heart has **four** chambers – **two atria and two ventricles:**

1. **Right Atrium:**
   - The right atrium is the upper right chamber of the heart. It receives oxygen-poor blood returning from the body via the superior and inferior vena cava.
2. **Right Ventricle:**
   - The right ventricle is the lower right chamber of the heart. It pumps the oxygen-poor blood received from the right atrium to the lungs through the pulmonary artery, where the blood picks up oxygen and releases carbon dioxide.
3. **Left Atrium:**
   - The left atrium is the upper left chamber of the heart. It receives oxygen-rich blood from the lungs via the pulmonary veins.
4. **Left Ventricle:**
   - The left ventricle is the lower left chamber of the heart. It pumps the oxygen-rich blood received from the left atrium to the rest of the body through the aorta.
   - The left ventricle has the thickest walls among the heart chambers, as it needs to generate enough pressure to push blood through the entire body.

Valves of the Heart:

The heart has four valves that regulate the flow of blood between the chambers and prevent backflow:

1. **Tricuspid Valve:**
   - The tricuspid valve is located between the right atrium and the right ventricle.

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- It has three leaflets or cusps and prevents the backflow of blood from the right ventricle to the right atrium when the ventricle contracts.

2. Pulmonary Valve:

- The pulmonary valve is located between the right ventricle and the pulmonary artery.
- It prevents the backflow of blood from the pulmonary artery to the right ventricle after the ventricle contracts.

3. Mitral Valve (Bicuspid Valve):

- The mitral valve is located between the left atrium and the left ventricle.
- It has two leaflets or cusps and prevents the backflow of blood from the left ventricle to the left atrium when the ventricle contracts.

4. Aortic Valve:

- The aortic valve is located between the left ventricle and the aorta.
- It prevents the backflow of blood from the aorta to the left ventricle after the ventricle contracts.

Functions of the Heart

The heart functions as a **dual pump** and ensures continuous circulation of blood.

A. Circulatory Functions

1. Pulmonary Circulation

- Right side pumps deoxygenated blood to lungs for gas exchange (**CO_2 out, O_2 in**).

2. Systemic Circulation

- Left side pumps oxygenated blood to the rest of the body, supplying oxygen and nutrients.

B. Mechanical Functions

- Maintains **unidirectional blood flow** using valves
- Generates **blood pressure** to circulate blood
- Maintains **adequate perfusion** of all tissues

C. Electrical Functions

- The **conduction system** allows automatic generation of impulses (**autorhythmicity**)
- Coordinates atrial and ventricular contractions (systole and diastole)
- Maintains **normal heart rhythm**

D. Protective and Adaptive Functions

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- **Adapts cardiac output** to meet body's demands (rest, exercise, stress)
- Acts as a **blood reservoir** via atrial contraction
- Supports circulation of blood in emergencies (e.g., sympathetic stimulation increases rate and force)

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Blood Vessels

- Blood vessels form a vital network in the circulatory system, transporting blood throughout the body to deliver oxygen and nutrients and remove waste products.

There are three main types: arteries, veins, and capillaries.

1. Arteries

Function:

- Arteries carry oxygen-rich blood away from the heart (except the pulmonary artery) and withstand high pressure from the heart's contractions.
- They branch into smaller arterioles, which connect to capillaries.

Structure:

- Thick, muscular walls with three layers: **tunica intima** (inner), **tunica media** (middle, with smooth muscle and elastic fibers), and **tunica adventitia** (outer).

Key Features:

- **Aorta**: The largest artery, originating from the left ventricle.
- Arteries help regulate blood pressure through contraction and relaxation of smooth muscle.

2. Veins

Function:

- Veins return oxygen-poor blood to the heart (except the pulmonary veins, which carry oxygen-rich blood).
- They contain valves that prevent backflow and rely on skeletal muscle contractions to aid blood flow, especially against gravity.

Structure:

- Thinner walls than arteries, with fewer smooth muscle cells and elastic fibers.
- Like arteries, they have three layers but less pronounced tunica media.
- Valves throughout their length help prevent backflow.

Key Features:

- **Superior and Inferior Vena Cavae**: The largest veins, delivering blood to the heart's right atrium.

3. Capillaries

Function:

- Capillaries facilitate the exchange of oxygen, nutrients, and waste between the blood and tissues.

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