



Circulatory system physiology

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Circulatory system physiology

1. Blood vascular system: this system removes metabolites and blood vessels, which are characterized by the heart, veins, arteries, and blood capillaries, and distributes nutrients, oxygen, and hormones to every area of the body.
2. Lymphatic vascular system: made up of lymphatic capillaries, the lymphatic system begins in the tissue as obstructed veins. Via the major veins in the neck, it returns fluid (lymph) from the tissue space to the bloodstream.

Heart

Heart is a muscular pump that is located within the mediastinum in the thoracic cavity. It lies between the lungs and just superior to the diaphragm. The apex of the heart is the inferior pointed end, which extends toward the left side of the thoracic cavity at the level of the fifth rib. The base of the heart is the superior portion, which is attached to several large blood vessels at the level of the second rib. The heart is about the size of a closed fist.

A protective membrane called the pericardium surrounds the heart and the bases of the large blood vessels. This allows the heart to move and expand as it beats.

The pericardium has two main layers:

1. Fibrous pericardium (outer layer):

A tough, inflexible layer made of dense connective tissue. It connects to the diaphragm, spine, and nearby tissues.

2. Serous pericardium (inner layer):

- o Parietal layer: lines the inside of the fibrous pericardium.

- o Epicardium layer: sticks closely to the surface of the heart.

Between the parietal and epicardium layers is the pericardial cavity, which contains pericardial fluid. This fluid reduces friction as the heart contracts and relaxes.

Heart wall

The heart wall has three layers:

1. Epicardium – the outer thin layer that covers the heart and contains blood vessels that supply the heart.
2. Myocardium – the thick middle layer made of cardiac muscle; it pumps the blood.
3. Endocardium – the inner thin layer that lines the heart chambers and valves, and connects with the inner lining of the blood vessels.

Heart Chambers

The heart has four chambers:

Atria (upper chambers) – receive blood from the veins.

Ventricles (lower chambers) – pump blood into the arteries.

Atria have thin walls because they do not need much force to move blood to the ventricles (the flow is mostly passive).

Ventricles have thicker walls because they need strong force to pump blood out of the heart.

- The left ventricle is the thickest because it pumps blood to the whole body.
- The right ventricle is thinner because it only pumps blood to the lungs.

Heart Valves

Like all pumps, the heart contains valves that allow the blood to flow in only one direction through the heart. The two types of heart valves are atrioventricular valves (AV valves) and semilunar valves (SV Valves).

The pulmonary circulations

1. Low-oxygen blood comes to the right atrium from the body.
2. It moves to the right ventricle, which pumps it to the lungs through the pulmonary arteries.
3. In the lungs, blood picks up oxygen and releases carbon dioxide.
4. Oxygen-rich blood returns to the left atrium through the pulmonary veins.

The systemic circulation

1. The left ventricle pumps oxygen-rich blood into the aorta.
2. The arteries and capillaries deliver oxygen to body cells and pick up carbon dioxide.
3. The deoxygenated blood then returns to the right atrium through the superior and inferior vena cava.
4. The coronary sinus also brings blood from the heart muscle itself back to the right atrium.

Types of Blood Vessels

There are three basic types of blood vessels: arteries, capillaries, and veins.

1- Arteries

Definition:

Arteries are strong, elastic blood vessels that carry blood away from the heart to the body's tissues. They have thick walls made of smooth muscle and elastic fibers to withstand the high pressure of blood pumped by the heart.

Function:

- They distribute oxygen-rich blood from the heart to all parts of the body (except the pulmonary arteries, which carry deoxygenated blood to the lungs).
- The elastic and muscular walls help regulate blood pressure and flow by expanding and contracting.
- Arterioles (small arteries) control the amount of blood that reaches different tissues by adjusting their diameter.

2- Capillaries

Definition:

Capillaries are the smallest and thinnest blood vessels, connecting arterioles to veins . Their walls are made of only one layer of endothelial cells, allowing easy exchange of materials.

Function:

- They are the main site of exchange between the blood and the body's cells.
- Oxygen and nutrients pass from the blood into the tissues, while carbon dioxide and wastes move from the tissues into the blood.
- The number of capillaries varies depending on tissue activity — they are very abundant in muscles and nervous tissue, but fewer in connective tissue, and absent in cartilage.
- Control blood flow into capillary networks based on the needs of the tissue (for example, more blood to muscles during exercise).

3- Veins

Definition:

Veins are blood vessels that carry blood back toward the heart after it has passed through the capillaries. Their walls are thinner and less muscular than arteries because blood pressure is much lower in veins.

Function:

- They return deoxygenated blood to the heart for reoxygenation (except the pulmonary veins, which carry oxygenated blood from the lungs).
- Veins have large lumens to hold more blood — they act as blood reservoirs.
- Valves inside veins prevent blood from flowing backward and help blood move upward against gravity, especially from the legs.

Regulation of heart functions

1. Nervous control:

The medulla oblongata in the brain controls the heart rate.

2. Ions (Calcium & Potassium):

- o Low calcium → slower and weaker heart contractions.
- o High calcium → stronger and faster contractions (too high can be dangerous).

3. Hormones:

Thyroid hormones (as in hyperthyroidism) increase heart rate.

4. Temperature:

Higher body temperature increases heart rate.

5. Physiological state:

- o During sleep: heart rate decreases (about 60 bpm).
- o During stress or activity: heart rate increases (can reach up to 200 bpm).