

CIRCULATORY SYSTEM

Big Picture

The circulatory system's main job is to transport materials throughout the body. Such materials include hormones, oxygen, cellular wastes, and nutrients from digested food. The main components of the circulatory system are the heart, blood vessels, and blood. The heart pumps blood into two separate circuits that run simultaneously: the pulmonary circuit and the systemic circuit. Understanding how the circulatory system works and the importance of its functions better helps us prevent cardiovascular disease and keep ourselves healthy.

Key Terms

Circulatory System: The organ system consisting of the heart, blood vessels, and blood that transports materials around the body.

Artery: Type of blood vessel that carries blood away from the heart toward the lungs or body.

Vein: Type of blood vessel that carries blood toward the heart from the lungs or body.

Capillary: Smallest type of blood vessel that connects very small arteries and veins.

Blood Pressure: Force exerted by circulating blood on the walls of blood vessels.

Blood: Fluid connective tissue that circulates throughout the body through blood vessels.

Plasma: Golden-yellow fluid part of blood that contains many dissolved substances and blood cells.

Red Blood Cell: Type of cell in blood that contains hemoglobin and carries oxygen.

White Blood Cells: Type of cell in blood that defends the body against invading microorganisms or other threats in blood or extracellular fluid.

Platelet: Cell fragment in blood that helps blood clot.

Blood Type: Genetic characteristic associated with the presence or absence of antigens on the surface of red blood cells.

Pulmonary Circulation: Part of the circulatory system that carries blood between the heart and lungs.

Systemic Circulation: Part of the circulatory system that carries blood between the heart and body.

Cardiovascular Disease (CVD): Any disease that affects the heart or blood vessels.

Heart

The heart is part of the **circulatory system**. It is a muscular organ consisting mainly of cardiac muscles. The four chambers of the human heart are the upper left and right atria (singular: atrium) and the lower left and right ventricles. Valves in the heart keep the blood going in one direction. The cardiac muscle cells of the heart send out electrical signals that keep the heart beating, which is why cardiac muscles do not require stimulation by the nervous system.

"Thump Thump, Thump Thump"

There are two sets of valves in the heart that keep the blood going in the right direction.

One set, called the atrioventricular valves (AV), is located between the atria and ventricles. The other set, called the semilunar valves, is located between the ventricles and the arteries.

The double heartbeat you hear is the sound produced by these valves as they close after the end of a heart contraction. The first "thump" is made when the AV closes and the second "thump" is made when the semilunar valves close.

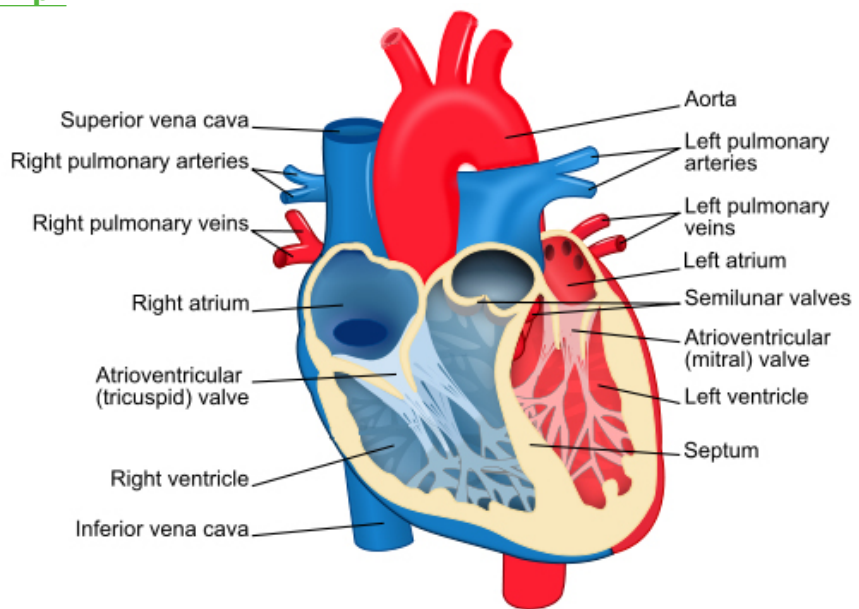


Image Credit: ZooFari, CC-BY-SA 3.0



To remember where the atria and ventricles are, think of it like this:
atrium starts with an 'a' and ventricle starts with a 'v.'
Since 'a' comes before 'v' in the alphabet, the atrium is above the ventricle.

CIRCULATORY SYSTEM CONT.

Blood Vessels

Blood vessels form a network through the body that allows for the transportation of blood, food, waste, and other materials. The three major types of blood vessels are **arteries**, **veins**, and **capillaries**.



Remember that the differences between arteries and veins are not the kind of blood they carry (oxygenated vs. deoxygenated) but the directions of the blood.

Arteries carry blood away from the heart (to either the body or the lungs) while veins carry blood to the heart. Blood vessels need to withstand the **blood pressure**. Since the blood pressure is higher in arteries, arteries tend to have thicker walls than veins do. The walls of blood vessels can either constrict (narrow down) or dilate (widen) to regulate blood flow as a response to stimulation from the nervous or endocrine system.

For example, during a “fight-or-flight” response, the hormone epinephrine is released and acts to restrict the blood vessels leading to the skin and intestines in order to increase blood flow toward your muscles.

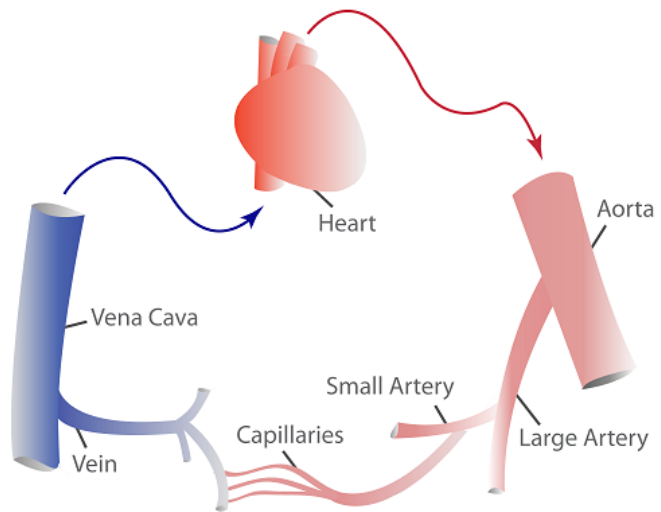


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Blood

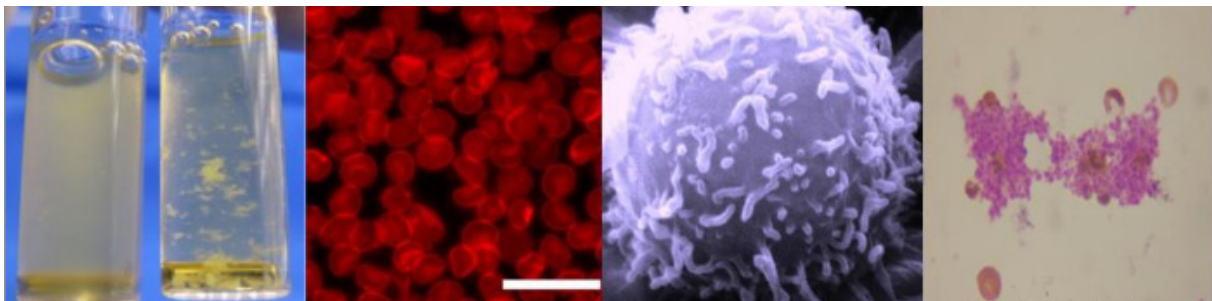


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Figure: An image of plasma, red blood cells, white blood cells, and platelets, respectively.

Blood is composed of **plasma**, **red blood cells**, **white blood cells**, and **platelets**. Blood is responsible for carrying the oxygen, hormones, and nutrients being transported. Blood also functions as a component of the immune system to protect against infection and repair body tissue as well as maintaining pH.

Each component of blood is responsible for certain functions of blood:

	Plasma	Red Blood Cells	White Blood Cells	Platelets
Description	Fluid part of blood; watery golden-yellow; makes up ~50% of blood	Contains hemoglobin, a protein with iron; makes up ~45% of blood	Many different types; larger than red blood cells	Very small structures
Functions	Allows blood to flow; carries all the other components of blood	Hemoglobin helps molecules carry oxygen around the body	Defend the body from pathogens (works for the immune system)	Secretes a substance that convert a soluble protein into insoluble threads for blood clotting

Red blood cells can also be classified by **blood type**. The two most important classifications are the ABO and Rhesus blood types.

- ABO blood type is determined by the presence of antigens A and B. Blood type A has only antigen A, blood type B has only antigen B, blood type AB has both, and blood type O has neither.
- Rhesus blood type is determined by one antigen. Blood type Rh⁺ has the antigen and blood type Rh⁻ does not.

Whenever a person receives blood, the received blood must be the same type or a compatible one. Receiving incompatible blood can be life-threatening!

Path of Blood Through the Body

The Pulmonary Circuit

The right side of the heart takes blood returning from tissues of the body and pumps it to the lungs through the **pulmonary circuit**. The blood, upon entering the pulmonary circuit, has lost most of its oxygen to the body and now carries carbon dioxide. The carbon dioxide must be dumped from the body and oxygen picked up via gas exchange at the lungs.

Blood travels through the pulmonary circuit in the following way:

1. O₂-poor blood travels through the anterior (aka superior) vena cava and the posterior (aka the inferior) vena cava, the two largest veins in the body.
2. The blood then enters the right atrium and then into the right ventricle.
3. From the right ventricle, blood enters the pulmonary artery and to the lungs. At the lungs, gas exchange occurs.
4. The O₂-rich blood then returns to the heart through the pulmonary veins.

Cardiovascular Disease

Cardiovascular diseases (CVD) are diseases that affect the heart and blood vessels. The leading cause of CVD, atherosclerosis, occurs when plaque builds up in the arteries, which reduces blood flow. Plaque consists of cell debris, cholesterol, and other substances. Atherosclerosis that occurs in the arteries of the heart muscles is called coronary heart disease. Coronary heart disease can lead to a heart attack. A heart attack happens when not enough blood supply reaches the cardiac muscles and the muscles die.

Interesting Facts

If you've ever watched a soap opera or medical TV show, you may have seen a doctor yelling "Clear!" and then using a defibrillator to shock an unconscious patient. As mentioned previously, the heart is not stimulated by the nervous system and instead follows the electrical impulses sent from the cardiac muscles. So when the heartbeat is off due to abnormal electrical impulses, a defibrillator is used to "shock" the heart with electrical impulses to reestablish a normal heart rhythm.

From this point, the blood then proceeds to the beginning of the **systemic circuit**.

The Systemic Circuit

Blood is pumped through the systemic circuit by the left side of the heart. This pathway carries the blood, which is carrying the new supply of oxygen, to all the tissues of the body. Blood goes through the systemic pathway in the following order:

- O₂-rich blood is emptied into the left atrium, which then passes into the left ventricle.
- The blood then exits the heart through the aorta, the largest artery in the body.
- Starting at the aorta, arteries repeatedly branch out until ultimately becoming capillaries that expose the blood to all of the body.
- After the blood has exchanged oxygen for carbon dioxide with body tissue, it returns to the pulmonary circuit.

Hypertension is another word for high blood pressure, or too much force on the walls of the arteries as the heart pumps blood through the body. Older patients tend to have hypertension as arteries stiffen as one ages. A diet consisting of too much salt and cholesterol can also lead to high blood pressure.

While certain factors leading to CVD, such as age, gender, and genetics, can't be controlled, exercising and a healthy diet can keep your cardiovascular system clear and healthy.



Figure: Defibrillator. Image Credit: Yury Maslobev, CC-BY-SA 3.0

Notes
