



Circulatory System

Its Components

- 1 Heart
- 2 Blood vessels (arteries, veins, and capillaries)
- 3 Blood
- 4 Lymphatic system

Functions

- 1 Delivers nutrients and oxygen to body cells.
- 2 Removes wastes from cells.
- 3 Transports hormones, enzymes, and substances produced by the immune system.
- 4 Distributes heat throughout the body.

The Heart

A hollow muscular organ surrounded by the pericardium. It pumps blood and consists of four chambers (two atria and two ventricles).



- ▶ **Right atrium:** receives deoxygenated blood returning from body parts.
- ▶ **Left atrium:** receives oxygenated blood returning from the lungs.
- ▶ **Right ventricle:** pumps deoxygenated blood to the lungs through the pulmonary artery.
- ▶ **Left ventricle:** pumps oxygenated blood to the body through the aorta.

Note: Sinoatrial node (the heart pacemaker)

It is located in the right atrium and is a group of cells that send signals that cause the heart muscle to contract.



Blood Vessels

Arteries



- ◀ Carry oxygenated blood to body parts except the pulmonary artery.
- ◀ Have a pulse.
- ▶ Have thick, elastic, strong walls.
- ▶ Can withstand the high blood pressure pumped by the heart.

Veins

- ▶ Carry deoxygenated blood back to the heart except the pulmonary vein.
- ▶ Have no pulse.
- ▶ Large veins contain valves.
- ▶ The middle layer is thinner than that of arteries.

Capillaries

- ▶ Tiny blood vessels whose walls are made of one cell layer.
- ▶ Through them, materials are exchanged between blood and body cells.

Valves

They prevent blood from flowing backward and allow it to flow in one direction only. They are four:

- ▶ **Tricuspid valve:** between the right ventricle and the right atrium.
- ▶ **Bicuspid (mitral) valve:** between the left atrium and the left ventricle.
- ▶ **Aortic valve:** one of the most important heart valves; between the left ventricle and the aorta.
- ▶ **Pulmonary valve:** between the right ventricle and the pulmonary artery.

Heart Sounds

They are natural sounds produced by the closing of the heart valves. Two sounds can be heard:

(b) Diastolic sound:

A short, sharp sound caused by closure of the aortic and pulmonary valves during ventricular relaxation.

(a) Systolic sound:

A long, dull sound caused by closure of the valves between the atria and ventricles during ventricular contraction.

- ▶ **Note:** Blood returns to the heart with the help of valves, contraction of nearby skeletal muscles, and breathing movements in the chest.
- ▶ **Pulse:** The heart beats about 70 times per minute, and it can be felt by touching the artery on the inner side of the wrist.



Blood Components

Red Blood Cells

Function:

Carry oxygen from the lungs to body tissues.
Carry CO₂ from body tissues to the lungs.



Properties:

Biconcave.
No nucleus.

Red because they contain hemoglobin.

Count in men: 4.6–6.2 million/mm³

Count in women: 4.2–5.4 million/mm³

Life span: 120 days

White Blood Cells

Function:

They are cells that resist disease. Their number is small compared with red blood cells, but it increases during illness.



Properties:

Contain a nucleus.

Count in men: 9000 cells/mm³

Count in women: 7000 cells/mm³

Life span: 7 days

Platelets

Function:

Help in blood clotting. They also stick to germs and slow their movement, making them easier for phagocytic cells to engulf.



Properties:

Small plate-like bodies.

No nucleus.

Count: 150,000–400,000 platelets/mm³

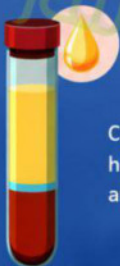
Life span: 5 days

Plasma

It is a yellow fluid that forms 55% of blood.

Function:

Carries digested food, medicine, hormones, salts, vitamins, and wastes.



Composition:

It consists of 90% water and 10% dissolved substances, including proteins that regulate the amount of water in the blood, proteins involved in immunity, and proteins that help form blood clots.

Notes

- ▶ Red blood cells are made of proteins containing iron called hemoglobin, which combines chemically with oxygen to carry it to body cells. It can also carry some carbon dioxide, but most carbon dioxide is carried by plasma.
- ▶ There are three groups of proteins that give plasma its yellow color:
 - ▶ Albumin: regulates the amount of water in the blood.
 - ▶ Gamma globulins: help white blood cells resist disease.
 - ▶ Fibrinogen: plays a role in blood clotting.
- ▶ The spleen is called the graveyard of cells, where worn-out and damaged blood cells are found until they are broken down.

Blood Flow in the Body

Pulmonary Circulation

Right ventricle - pulmonary artery - lungs - pulmonary veins - left atrium

The right ventricle pumps deoxygenated blood through the pulmonary artery to the lungs, where gas exchange occurs. The blood gives CO_2 to the lungs and takes O_2 , then returns through the pulmonary veins to the left atrium of the heart.

Systemic Circulation

Left ventricle - aorta - body - vena cava - right atrium

The left ventricle pumps oxygenated blood carrying nutrients through the aorta to the upper and lower parts of the body. Exchange of oxygen, nutrients, carbon dioxide, and wastes occurs between blood and body cells. Then deoxygenated blood returns through the superior and inferior vena cava to the right atrium, which sends the blood to the right ventricle to begin pulmonary circulation.

Important Note:

Capillaries carry blood to all body cells.



Types of Blood Pressure

- ◀ Contraction of the heart causes blood pressure to rise to its highest level (systolic pressure).
- ◀ Relaxation of the heart causes blood pressure to fall to its lowest level (diastolic pressure).
- ◀ The normal blood pressure reading in a healthy person is 120/80.
- ◀ That means 120 systolic and 80 diastolic.

Diseases of the Circulatory System

- ◀ **Atherosclerosis:**
Blockage of arteries due to fatty deposits or a blood clot.
- ◀ **Heart attack:**
Occurs when blood does not reach the heart muscle, causing damage to the heart muscle.
- ◀ **Stroke:**
Occurs when oxygenated blood does not reach the brain because of blood clots. This may lead to rupture of blood vessels, internal bleeding, and damage to parts of the brain.

Blood Groups

O	AB	B	A	Blood Group
None	Antigen AB	Antigen B	Antigen A	Antigen
anti-A, anti-B	None	anti-A	anti-B	Antibody
A, B, AB, O	AB	B, AB	A, AB	Donates blood to
O	A, B, AB, O	B, O	A, O	Receives blood from

◀ Rh Factor:

- ◀ A marker, or antigen, found on the surface of red blood cells.
- ▶ Human blood is therefore divided into Rh positive (has the antigen) and Rh negative (does not have the antigen).

Dangerous Cases

- ◀ Transfusing blood from an Rh+ person (has the antigen) to an Rh- person (does not have the antigen) causes clumping of red blood cells, because the Rh- person forms antibodies against the Rh+ cells.
- ◀ Also, if fetal Rh+ blood mixes with the blood of an Rh- mother, the mother forms antibodies against the Rh factor. These antibodies may cross the placenta in another pregnancy and destroy the fetus's red blood cells if the fetus is Rh positive.

Prevention: Give the mother an injection that prevents the production of antibodies against the Rh+ factor.

Mechanism of Blood Clotting

- ◀ When blood vessels are cut or torn, blood quickly clots to protect the body. Platelets form a protein substance called thromboplastin, which stops the action of heparin so the blood can clot.
- ◀ In the presence of calcium ions, thromboplastin converts prothrombin (a protein secreted by the liver with the help of vitamin K) into thrombin.
- ◀ Thrombin is an active enzyme that converts fibrinogen (a soluble protein in plasma) into an insoluble protein in the form of threads called fibrin, which stops bleeding.

The following is a simple diagram of blood clot formation

- ▶ Platelets + damaged cells - clotting factors in blood - thromboplastin
- ▶ Prothrombin - thromboplastin + Ca + clotting factors - thrombin
- ▶ Fibrinogen - thrombin - fibrin



Preventing blood clotting



Note:



Heparin secreted by the liver prevents the conversion of prothrombin into thrombin, thus preventing blood clotting.