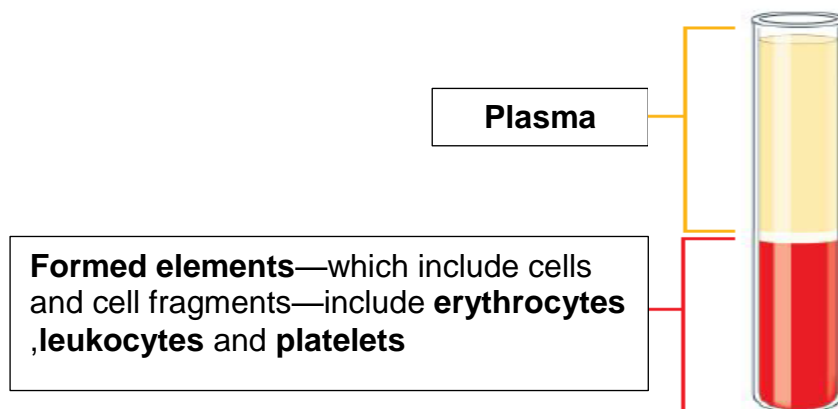


## Blood

Blood is a type of connective tissue that consists of cells surrounded by a liquid matrix. The total blood volume in the average adult is about 5 liters. Blood makes up about 8% of total body weight. Blood performs many functions essential to life and often can reveal much about our state of health.

- 1.its main function is to serve as a transport medium.
- 2.Blood delivers oxygen and removes waste products from the body's cells.
3. it delivers nutrients, hormones, enzymes, and many other critical substances to points throughout the body.
4. it plays multiple roles in protecting the body against infection.
- 5.it helps stabilize the body's acid-base balance.
6. it also helps regulate body temperature.

When a sample of blood is spun down in a centrifuge, its two main components become apparent.



### *Plasma*

Plasma is a pale yellow fluid that consists of about 92% water and 8% substances such as proteins, ions, nutrients, gases, and waste products. Plasma proteins include albumin, globulins, and fibrinogen. When the protein which produces clots (fibrinogen) is removed from plasma the remaining fluid is called blood serum.

**Note:** An important property of blood—determined by the combination of plasma and blood cells—is viscosity. Basically, viscosity refers to how thick or sticky a fluid is. Whole blood is normally five times as thick as water, mainly due to the presence of RBCs. If the number of RBCs drops, blood becomes “thinner,” or less viscous, causing it to flow too rapidly. Too many RBCs increase viscosity, making blood flow sluggish. Left untreated, either condition can cause cardiovascular problems.

## ***Blood cells***

About 95% of the volume of the blood cells consists of red blood cells (RBCs) or erythrocytes. The remaining 5% of the volume consists of white blood cells (WBCs), or leukocytes and cell fragments called platelets, or thrombocytes. Erythrocytes are 700 times more numerous than leukocytes and 17 times more numerous than thrombocytes.

The process of blood cell production is called hematopoiesis. In the fetus, hematopoiesis occurs in several tissues such as the liver, thymus gland, spleen, lymph nodes, and red bone marrow. After birth, hematopoiesis is confined primarily to red bone marrow, but some leukocytes are produced in lymphatic tissues. All the formed elements of blood are derived from a single population of cells called stem cells or hemocytoblasts. These stem cells differentiate to give rise to different cell lines. Each line ends with the formation of a particular type of blood cells.

Normal erythrocytes are disk-shaped cells with edges that are thicker than the center of the cell. During their development, erythrocytes lose their nuclei and most of their organelles. Consequently, they are unable to divide. The main component of an erythrocyte is the pigmented protein hemoglobin, which accounts for about one third of the cell's volume and responsible for its red color.

The primary functions of erythrocytes are to transport oxygen from the lungs to the various tissues of the body and to assist the transport of carbon dioxide from the tissues to the lungs. Oxygen transport is accomplished by hemoglobin, which consists of four protein chains and four heme groups. Erythrocytes live for about 120 days in males and 110 days in females. Old, damaged, or defective erythrocytes are removed from the blood by macrophages located in the spleen and liver. Hemoglobin is broken down, iron and amino acids are reused, and heme becomes bilirubin that is secreted in bile.

**Note:** *How much oxygen the blood can carry depends on the quantity of red blood cells and hemoglobin it contains. That's why some of the most commonly performed blood tests measure hematocrit, hemoglobin concentration, and RBC count. Normal values vary between men and women, as shown below:*

- *Hematocrit:* Female: 37%–48%; Male: 45%–52%
- *Hemoglobin:* Female: 12–16 g/dl; Male: 13–18 g/dl
- *RBC count:* Female: 4.2–5.4 million/mcL; Male: 4.6–6.2 million/mcL

**Note:** *Sickle cell disease is an inherited blood disorder involving hemoglobin. Affected RBCs are stiff rather than flexible; as they try to squeeze into narrow blood vessels, they can't fold over like a normal RBC. Instead, their shape becomes distorted: the cells elongate and the ends point, making them look somewhat like a sickle (which is where the disease gets its name). These distorted cells are also sticky, causing them to clump together.*

## Life Cycle of Red Blood Cells

Red blood cells circulate for about 120 days before they die, break up, and are consumed by phagocytic cells in the spleen and the liver. In fact, 2.5 million RBCs are destroyed every second. While this is only a fraction of the trillions of RBCs in the body, the body must constantly produce new RBCs to maintain homeostasis. The process of producing new erythrocytes—called **erythropoiesis**—is maintained through a negative feedback loop.

1. As damaged RBCs are removed from circulation, oxygen levels fall.
2. The kidneys detect the declining levels of oxygen and respond by secreting a hormone called erythropoietin (EPO).
3. EPO stimulates the red bone marrow to begin the process of creating new erythrocytes.
4. An immature form of an erythrocyte, called a reticulocyte, is released into circulation.
5. After one to two days, the reticulocyte becomes a mature erythrocyte.
6. As the number of RBCs increases, oxygen levels rise. Less EPO is produced and RBC production declines.

## Breakdown of Red Blood Cells

As an RBC ages, its membrane weakens, becoming fragile. As it passes through the narrow capillaries in the spleen, it begins to break down.

Macrophages in the liver and spleen ingest and destroy old RBCs. In the process, hemoglobin is broken down into its two components of globin and heme.

Globin is further broken down into amino acids. The amino acids are used for energy or to create new proteins.

Heme is broken down into iron and bilirubin. Iron is transported to the bone marrow, where it's used to create new hemoglobin.

Bilirubin is excreted into the intestines as part of bile. Bile in the intestines gives feces its brown color. Another pigment resulting from the breakdown of hemoglobin (called urochrome) gives urine its yellow color.

*When the destruction of RBCs becomes excessive (hemolysis), the body can't readily assimilate the increased amounts of bilirubin being produced. Instead of being excreted into the intestines, the excess bilirubin enters the tissues, causing the skin and sclera to take on a yellowish hue. This condition is called jaundice.*

*Jaundice may also result from conditions such as liver disease or bile duct obstruction that interfere with the flow of bile into the intestines. Newborns, too, often develop jaundice shortly after birth (a condition called physiological jaundice). This occurs as their immature livers begin the task of clearing bilirubin from the blood.*

## **Anemia is a deficiency of RBCs or hemoglobin.**

Sometimes anemia occurs because of a loss of RBCs, such as from a hemorrhage, or when too many RBCs are being destroyed (**hemolytic anemia**).

More commonly, anemia results from an insufficient supply of iron in the diet. Because iron is a key component of hemoglobin, an insufficient supply of this nutrient leads to **iron-deficiency anemia**.

(Another nutritional anemia—*pernicious anemia*—results from a lack of vitamin B12. In this instance, the anemia typically occurs because the body can't assimilate the vitamin due to a lack of a chemical produced in the stomach called *intrinsic factor*.)

Another cause of anemia is an insufficient supply of the hormone erythropoietin (EPO). Without EPO, red bone marrow isn't stimulated to create new erythrocytes, which explains why anemia usually accompanies kidney disease.

Without enough RBCs or hemoglobin, the oxygen-carrying capacity of blood is diminished, causing fatigue, pallor, and, possibly, shortness of breath. Blood viscosity is also reduced, resulting in a faster heart rate and lower blood pressure.

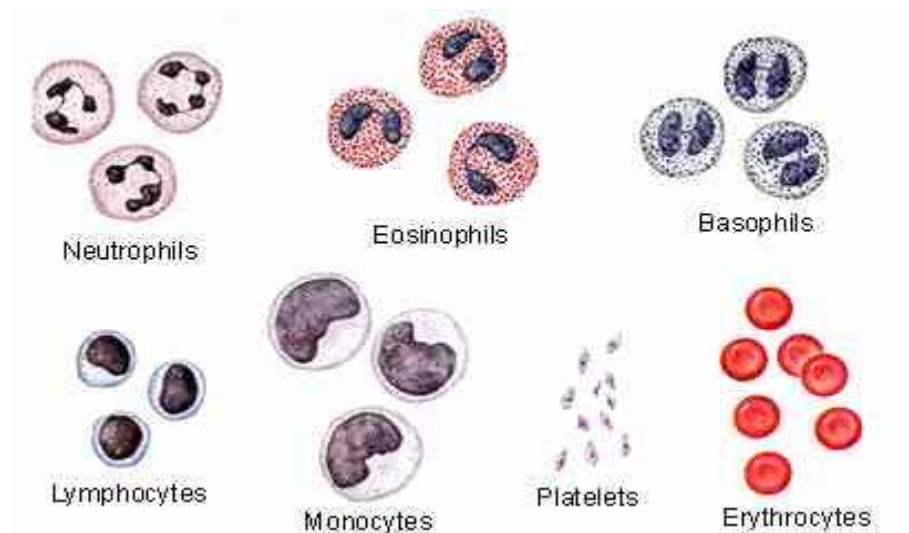
## **Leukocytes**

Leukocytes or white blood cells are spherical cells that are white in color. They are larger than erythrocytes, and they have a nucleus. Leukocytes can leave the blood and move by ameboid movement through the tissues. Leukocytes are named according to their appearance in stained preparations. Those containing large cytoplasmic granules are granulocytes, and those with very small granules that cannot be easily seen with the light microscope are agranulocytes.

There are three kinds of granulocytes. Neutrophils are the most common type of leukocytes. They phagocytize microorganisms and foreign substances. Basophils and eosinophils are involved in regulating the inflammatory response. Basophils release histamine and other chemicals that promote inflammation. Basophils also release heparin, which prevents the formation of clots. Eosinophils release chemicals that reduce inflammation.

There are two kinds of agranulocytes. Lymphocytes play an important role in the body's immune response. Their diverse activities involve the production of antibodies and other chemicals. Monocytes become macrophages after they leave the blood and enter tissues. They ingest bacteria, dead cells, and any other debris within the tissues.

*An abnormally low WBC count (called leukopenia) may result from certain viral illnesses, including AIDS, as well as lead poisoning. An elevated WBC count (called leukocytosis) usually indicates infection or an allergy*



## The blood cells

Thrombocytes or platelets are minute fragments of cells, each consisting of a small amount of cytoplasm surrounded by a cell membrane. Platelets play an important role in hemostasis by preventing blood loss.

## Blood clotting

Blood clotting or coagulation is formation of a clot. When a blood vessel is severely damaged, blood clotting results in the formation of a clot. A clot is a network of thread like protein fibers, called fibrin. The formation of a blood clot depends on a number of proteins found within plasma called clotting factors. There are three steps in the clotting process:-

1. Activation of clotting factors by exposure to connective tissues and chemicals, resulting in the formation of prothrombinase.
2. Conversion of prothrombin to thrombin by prothrombinase.
3. Conversion of fibrinogen to fibrin by thrombin. The fibrin threads form a network, which traps blood cells and platelets to form the clot.

Most of the clotting factors are manufactured in the liver, and many of them require vitamin K for their synthesis. In addition, many of the chemical reactions of clotting require calcium ions and chemical released from platelets. Low levels of vitamin K, Low levels of calcium, low numbers of platelets, or liver dysfunction can seriously impair the blood clotting process.

## Blood groups

In humans, blood is categorized by the ABO blood group system. Blood groups are determined by antigens on the surface of erythrocytes. Type A blood has A antigens, type B

blood has B antigens, type AB blood has A and B antigens, and type O blood does not have A or B antigens.

In addition, in the plasma there are proteins called antibodies. Type A blood has B antibodies, type B blood has A antibodies, type AB blood does not have A or B antibodies, and type O blood has A and B antibodies.

Blood group	Antigen(s) present on the red blood cells	Antibodies present in the serum	Genotype(s)
A	A antigen	Anti-B	AA or AO
B	B antigen	Anti-A	BB or BO
AB	A antigen and B antigen	None	AB
O	None	Anti-A and Anti-B	OO

When the antibodies bind to the antigens, they form molecular bridges that connect the erythrocytes together. As a result, agglutination or clumping of cells occurs. This combination also can initiate reactions that cause hemolysis or rupture of the erythrocytes. It is now known that transfusion reactions are caused by interactions between antigens and antibodies.

A donor is a person who gives blood, and a recipient is a person who receives blood. Usually a donor can give blood to a recipient if they both have the same blood type. Historically, people with type O blood have been called universal donors because they usually can give blood to the other ABO blood types without causing an ABO transfusion reaction. People with type AB blood were called universal recipients because they could receive type A, B, AB, or O blood with little likelihood of a transfusion reaction.

### ***Rh blood group***

Another important blood group is the Rh blood group, so named because it was first studied in the rhesus monkey. People are Rh-positive if they have certain Rh antigen (D antigen) on the surface of erythrocytes, and they are Rh-negative if they don't have this Rh antigen. About 85% of people are Rh-positive and 15% are Rh- negative. The ABO blood type and the Rh blood type usually are designated together in blood transfusion. In addition, Rh incompatibility can pose a major problem in some pregnancies when the mother is Rh-negative, the father is Rh-positive, and the fetus is Rh-positive. The mother produces Rh antibodies cross the placenta and cause agglutination and hemolysis of fetal erythrocytes. This disorder is called hemolytic disease of the newborn (HDN) or erythroblastosis fetals, and it can be fatal to the fetus.