**What is blood?**

**Blood**, by definition, is a fluid connective tissue that moves through the vessels of the circulatory system. In humans, it includes plasma (the liquid portion), blood cells (which come in both red and white varieties), and cell fragments called platelets.

* **Plasma** is the main component of blood and consists mostly of water, with proteins, ions, nutrients, and wastes mixed in.
* **Red blood cells** are responsible for carrying oxygen and carbon dioxide.
* **Platelets** are responsible for blood clotting.
* **White blood cells** are part of the immune system and function in immune response.

Cells and platelets make up about 45% of human blood, while plasma makes up the other 55%.

**Plasma**

The liquid state of blood can be contributed to plasma as it makes up  ~55% of blood. It is pale yellow in colour when separated by centrifugation.

The plasma is about 90 percent water, with the remaining 10 percent made up of ions, proteins, nutrients, wastes, and dissolved gases. The ions, proteins, and other molecules found in plasma are important for maintaining blood pH and osmotic balance, with albumin (the main protein in human plasma) playing a particularly important role.

Some of the molecules found in the plasma have more specialized functions. For example, hormones act as long-distance signals, antibodies recognize and neutralize pathogens, and clotting factors promote blood clot formation at the site of wounds. (Plasma that’s been stripped of its clotting factors is called **serum**.) Lipids, such as cholesterol, are also carried in plasma, but must travel with escort proteins because they don’t dissolve in water.

**Components of Blood Plasma**

Blood plasma has several protein components. Proteins in blood plasma are:

* Serum globulin
* Serum albumin
* Fibrinogen

The serum contains only globulin and albumin. Fibrinogen is absent in serum because it is converted into fibrin during blood clotting.

**Red blood cells**

Red blood cells, or **erythrocytes**, are specialized cells that circulate through the body and deliver oxygen to tissues. In humans, red blood cells are small and biconcave (thinnest in the center, just 7 - 8 μm in size), and do not contain mitochondria or a nucleus when mature.

These characteristics allow red blood cells to effectively perform their task of oxygen transport. Small size and biconcave shape increase the surface area-to-volume ratio, improving gas exchange, while lack of a nucleus makes additional space for **hemoglobin**, a key protein used in oxygen transport. Lack of mitochondria keeps red blood cells from using any of the oxygen they’re carrying, maximizing the amount delivered to tissues of the body.

In the lungs, red blood cells take up oxygen, and as they circulate through the rest the body, they release the oxygen to the surrounding tissues. Red blood cells also play an important role in transport of carbon dioxide, a waste product, from the tissues back to the lungs. Some of the carbon dioxide binds directly to hemoglobin, and red blood cells also carry an enzyme that converts carbon dioxide into bicarbonate. The bicarbonate dissolves in plasma and is transported to the lungs, where it's converted back into carbon dioxide and released.

Red blood cells have an average life span of 120 days. Old or damaged red blood cells are broken down in the liver and spleen, and new ones are produced in the bone marrow. Red blood cell production is controlled by the hormone **erythropoietin**, which is released by the kidneys in response to low oxygen levels.

**Platelets and clotting**

Platelets, also called **thrombocytes**, are cell fragments involved in blood clotting. They are produced when large cells called **megakaryocytes** break into pieces, each one making 2000 - 3000 platelets as it comes apart. Platelets are roughly disc-shaped and small, about 2 - 4 μm in diameter.

When the lining of a blood vessel is damaged (for instance, if you cut your finger deeply enough for it to bleed), platelets are attracted to the wound site, where they form a sticky plug. The platelets release signals, which not only attract other platelets and make them become sticky, but also activate a signaling cascade that ultimately converts fibrinogen, a water-soluble protein present in blood plasma, into **fibrin** (a non-water soluble protein). The fibrin forms threads that reinforce the platelet plug, making a clot that prevents further loss of blood.

Platelets (Thrombocytes)

* Thrombocytes are specialized blood cells produced from bone marrow.
* Platelets come into play when there is bleeding or haemorrhage.
* They help in clotting and coagulation of blood. Platelets help in coagulation during a cut or wound.

**White blood cells**

White blood cells, also called **leukocytes**, are much less common than red blood cells and make up less than 1 percent of the cells in blood. Their role is also very different from that of red blood cells: they are primarily involved in immune responses, recognizing and neutralizing invaders such as bacteria and viruses.

White blood cells are larger than red blood cells, and unlike red blood cells, they have a normal nucleus and mitochondria. White blood cells come in five major types, and these are divided into two different groups, named for their appearance under a microscope.

* One group, the **granulocytes**, includes neutrophils, eosinophils, and basophils, all of which have granules in their cytoplasm when stained and viewed on a microscope.
* The other group, the **agranulocytes**, includes monocytes and lymphocytes, which do not have granules in the cytoplasm.

## Types of White Blood Cells

There are five different types of White blood cells and are classified mainly based on the presence and absence of granules.

* Granulocytes
* Agranulocytes

### Granulocytes

They are leukocytes, with the presence of granules in their cytoplasm. The granulated cells include- eosinophil, basophil, and neutrophil.

#### Eosinophils

* They are the cells of leukocytes, which are present in the immune system.
* These cells are responsible for combating infections in parasites of vertebrates and for controlling mechanisms associated with allergy.
* Eosinophil cells are small granulocyte, which are produced in the bone marrow and makes 2 to 3 per cent of whole WBCs. These cells are present in high concentrations in the digestive tract.

#### Basophils

* They are the least common of the granulocytes, ranging from 0.5 to 1 per cent of WBCs.
* They contain large cytoplasmic granules, which play a vital role in mounting a non-specific immune response to pathogens, and allergic reactions by releasing histamine and dilating the blood vessels.
* These white blood cells have the ability to be stained when exposed to basic dyes, hence referred to as basophil.
* These cells are best known for their role in asthma and their result in inflammation and bronchoconstriction in the airways.
* They secrete serotonin, histamine and heparin.

#### Neutrophils

* They are normally found in the bloodstream.
* They are predominant cells, which are present in pus.
* Around 60 to 65 per cent of WBCs are neutrophils with a diameter of 10 to 12 micrometres.
* The nucleus is 2 to 5 lobed and the cytoplasm has very fine granules.
* Neutrophil helps in the destruction of bacteria with lysosomes, and it acts as a strong oxidant.
* Neutrophils are stained only using neutral dyes. Hence, they are called so.
* Neutrophils are also the first cells of the immune system to respond to an invader such as a bacteria or a virus.
* The lifespan of these WBCs extends for up to eight hours and is produced every day in the bone marrow.

### Agranulocytes

They are leukocytes, with the absence of granules in their cytoplasm. Agranulocytes are further classified into monocytes and lymphocytes.

#### Monocytes

* These cells usually have a large bilobed nucleus, with a diameter of 12 to 20 micrometres.
* Largest of all WBC’s in the body
* The nucleus is generally half-moon shaped or kidney-shaped and it occupies 6 to 8 per cent of WBCs.
* They are the garbage trucks of the immune system.
* The most important functions of monocytes are to migrate into tissues and clean up dead cells, protect against bloodborne pathogens and move very quickly to the sites of infections in the [tissues](https://byjus.com/biology/tissues/).
* These white blood cells have a single bean-shaped nucleus, hence referred to as Monocytes.

#### Lymphocytes

* They play a vital role in producing antibodies.
* Their size ranges from 8 to 10 micrometres.
* They are commonly known as natural killer cells.
* They play an important role in body defence.
* These white blood cells are colourless cells formed in lymphoid tissue, hence referred to as lymphocytes.
* There are two main types of lymphocytes – B lymphocytes and T lymphocytes.
* These cells are very important in the immune systems and are responsible for humoral and cell-mediated immunity.

**Functions of Blood**

Blood is a specialized body fluid. Blood has many different functions, including:

1. Fluid Connective Tissue

Blood is a fluid connective tissue composed of 55% plasma and 45% formed elements including WBCs, RBCs, and platelets. Since these living cells are suspended in plasma, blood is known as a fluid connective tissue and not just fluid.

1. Provides oxygen to the cells

Blood absorbs oxygen from the lungs and transports it to different cells of the body. The waste carbon dioxide moves from the blood to the lungs and is exhaled.

1. Transports Hormones and Nutrients

The digested nutrients such as glucose, vitamins, minerals, and proteins are absorbed into the blood through the capillaries in the villi lining the small intestine.

The hormones secreted by the endocrine glands are also transported by the blood to different organs and tissues.

1. Homeostasis

Blood helps to maintain the internal body temperature by absorbing or releasing heat.

1. Blood Clotting at Site of Injury

The platelets help in the clotting of blood at the site of injury. Platelets along with the fibrin form clot at the wound site

1. Transport of waste to the Kidney and Liver

Blood enters the kidney where it is filtered to remove nitrogenous waste out of the blood plasma. The toxins from the blood are also removed by the liver.

1. Protection of the body against pathogens

The White Blood Cells fight against infections. They multiply rapidly during infections.



