Components of blood

The different components that make up blood. Plasma, white blood cells, red blood cells, platelets.

Introduction

If you prick your finger or scrape your knee, you'll see some droplets of blood form. Just by eye, these droplets may seem to be made of uniform red liquid, similar to food colouring or paint. However, if you were to look under a microscope, you would see that your blood is actually a mixture of liquid and cells. And if you could zoom in even further, you would see that there are also many macromolecules (such as proteins) and ions (such as sodium) floating in the liquid. All of these components are important to the roles blood plays in the body.

What is blood?

Blood, by definition, is a fluid that moves through the vessels of a 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.

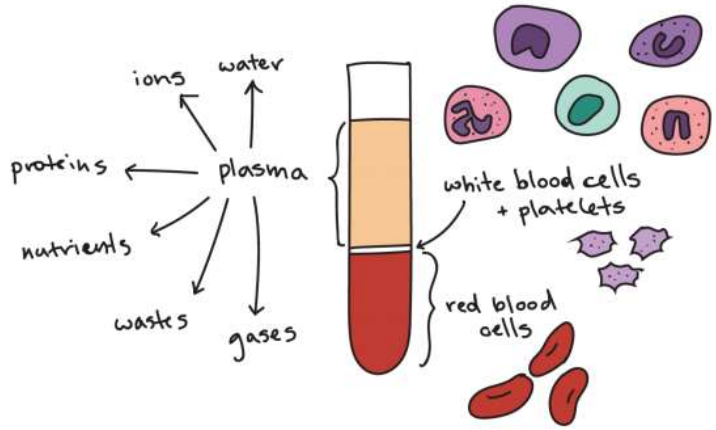
Platelets are responsible for blood clotting.
White blood cells are part of the immune system and function in immune response.

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

percent. The diagram below shows red blood cells, white blood cells of different types (large, purple cells), and platelets.

Plasma

Plasma, the liquid component of blood, can be isolated by spinning a tube of whole blood at high speeds in a centrifuge. The denser cells and platelets move to the bottom of the tube, forming red and white layers, while the plasma remains at the top, forming a yellow layer.



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.

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 centre, just 7 8 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 haemoglobin, 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.

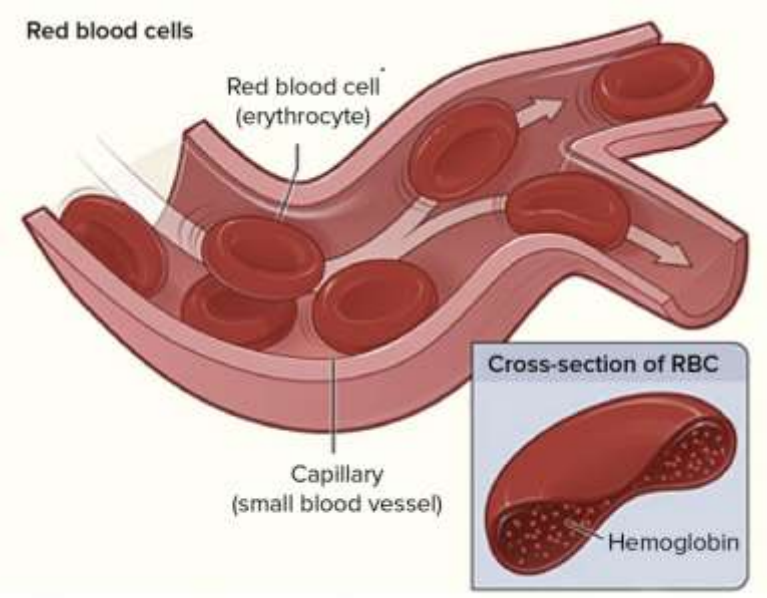


Image modified from "Modified sickle cell," by NHLBI (public domain).

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 haemoglobin, 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. This negative feedback loop ensures that the number of red blood cells in the body remains relatively constant over time.

Platelets and clotting

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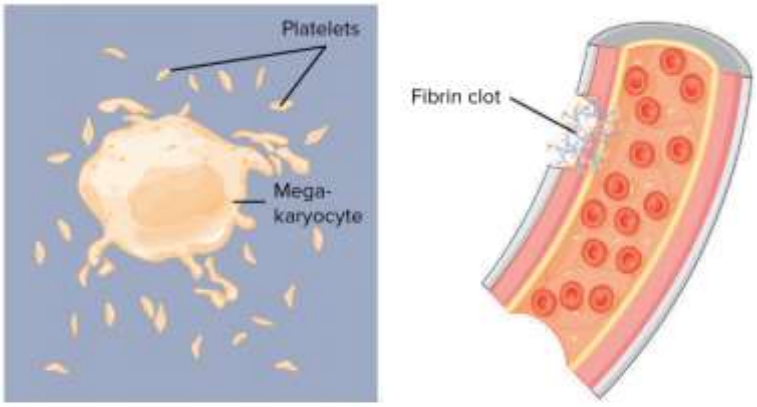
Platelets, also called thrombocytes, are cell fragments involved in blood clotting. They are produced when large cells called megakaryocytes break into pieces, each one making 2000 3000 platelets as it comes apart. Platelets are roughly disc-shaped and small, about 2 4 in diameter.

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 signalling 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.



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White blood cells

White blood cells, also called leukocytes, are much less common than red blood cells and make up less than 1% of the 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, eosinophil's, 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.

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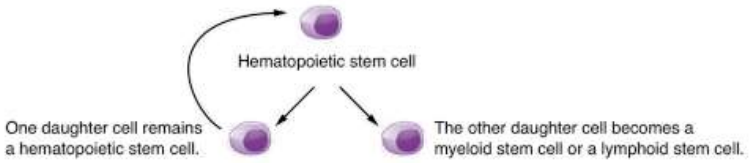
Each type of white blood cell plays a specific role in defence. For example, some white blood cells are involved in engulfing and breaking down pathogens, while others recognize specific microorganisms and launch immune responses against them. Different types of white blood cells have different lifetimes, ranging from hours to years, and new cells are produced primarily in the bone marrow (although some are made or mature in the thymus, lymph nodes, and spleen).

Stem cells and blood cell production

Red blood cells, white blood cells, and platelet producing cells are all descended from a common precursor: a hematopoietic stem cell.

A hallmark of stem cells is that they divide asymmetrically. That is, one daughter cell remains a stem cell of the same type, while the other daughter cell acquires a new identity. For hematopoietic stem cells, which are found in the bone marrow, one daughter cell remains a hematopoietic stem cell, while the other goes on to become a different type of stem cell: either a myeloid stem cell or a lymphoid stem cell.



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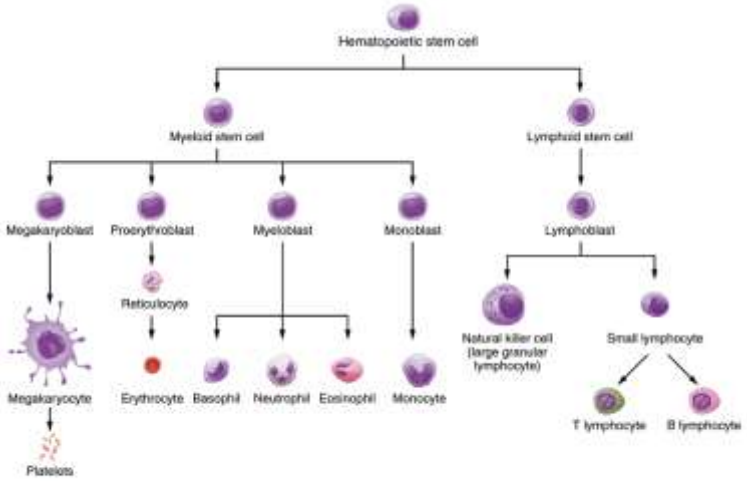
The myeloid stem cells and lymphoid stem cells also divide asymmetrically, with their non-stem cell daughters generating the mature cell types of the blood. Myeloid stem cells give rise to red blood cells, platelets, and some types of white blood cells, while lymphoid stem cells give rise to the types of white blood cells classified as lymphocytes.



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