The Hematologic System

- Blood is classified as connective tissue. It is made up of plasma and formed elements.
  - The formed elements of blood are made up of platelets and red and white blood cells.

46 % -63 % of plasma is made up of water.

- Hematopoiesis is the formation of formed elements in the blood. This process happens in the bone marrow. The bone marrow is in the spongy tissue in the middle of the bones. There are cells in the bone marrow called pluripotent stem cells.
  - These cells are undifferentiated and have the ability to become whatever the hormones want them to become.
- RBCs (red blood cells) are what give blood its red color. RBCs make up 43 % of blood volume. In each drop of blood there are 4-6 million RBCs. This is why the blood is viscous (thick).
- RBCs are not true cells because they don't have a nucleus and they lack essential organelles. They cannot be repaired and can't go through mitosis because they lack the necessary tools. Once they are damaged, they get filtered out and removed.

The reason why the RBCs are red is because they contain a red protein called hemoglobin.

The little red dot on an RBC is an iron atom, and that is where the oxygen binds.

  - RBCs look like a biconcave disk because they have a dip in the middle where the nucleus and organelles should be. This gives the cell more surface area so that the gas exchange can happen quickly.
- These are easy to stack and have extreme flexibility. The reason they can stack is because it makes it easier for them to go through the circulatory system. Sometimes RBCs have to bend in half when going through a blood vessel.
- The purpose of RBCs is transportation of oxygen. They pick up oxygen in our lungs and deliver it to all our cells, tissues, and organs in the body. They use hemoglobin to do this because it can carry oxygen.

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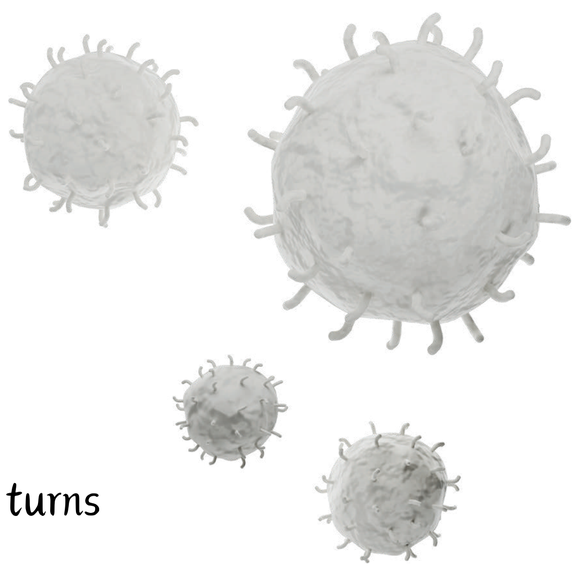
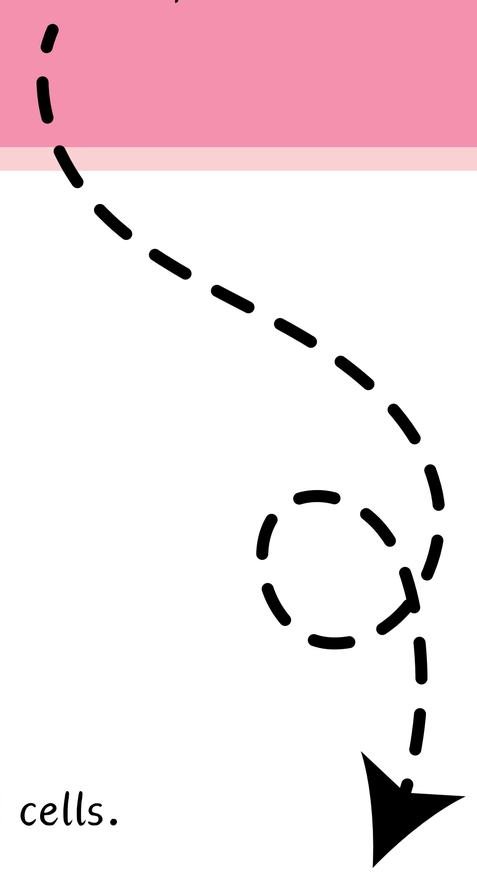
- WBCs (white blood cells) function to protect the body.
  - There are fewer of these than the RBCs because they are more specialized and aren't needed in extremely high numbers.
  - These are colorless cells with no hemoglobin.
  - They contain nuclei and organelles, unlike RBCs.
- WBCs are amoeboid, as they sometimes have certain characteristics of amoeba but are not amoeba themselves. They move with fingerlike projections that pull them closer to the object they are targeting. They specifically use adhesion molecules to pull themselves along because adhesion molecules are attracted to the chemical compounds released by the cells that are calling for help.
- An amoeba is an organism that moves around the body by extending fingerlike projections that stick onto walls, floors, or other objects.



- Erythropoietin is the hormone that turns pluripotent stem cells into red blood cells.
- Thrombopoietin makes platelets out of pluripotent stem cells.
- Cytokines and thymus hormones convert pluripotent stem cells into white blood cells.
- Hemoglobin is a red protein responsible for transporting oxygen in the blood of vertebrates.

One cool thing about WBCs is that they can travel outside of the circulatory system. They can migrate out of the vessels through diapedesis.



Diapedesis is when white blood cells leave capillaries and other blood vessels to fight infections or be in contact with an injury.

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- Vasodilation is the widening of blood vessels. This is done by relaxing the vessel walls.
- Inflammation is a response to harmful stimuli.
    - This is part of the immune system.
- Megakaryocytes are polypoid cells that are found in the bone marrow.
    - These are responsible for making platelets.
- Thrombin is one of the key players in blood clotting and the hemostasis process.
    - It is a procoagulant and anticoagulant.

Because it can act as both, it is the main regulator.

Instead of engulfing bacteria, antibodies bind to the specific invading molecules and block the parts of the cell that bind to the body's cells. (Antibodies are specific to each virus or bacteria.)

- T cells come from your thymus gland.
    - These are a type of white blood cell that protect the body from infection.
- B cells are the white blood cells that make antibodies.

- Granulocytes are immune system cells that get their name because of their dark-staining granules. These cells are larger than RBCs and function as phagocytes.
    - Since they are immune system cells, they eat bacteria or harmful viruses.
    - Anytime they come across something that looks suspicious, they engulf it and eat it up.
    - These are also involved in allergic reactions. If they think something is bad, they will go after it, even if the suspect is not pathogenic.
- Agranulocytes are different than granulocytes. These often lack membrane-bound organelles.

The A in front of the word means that the cell is missing something.

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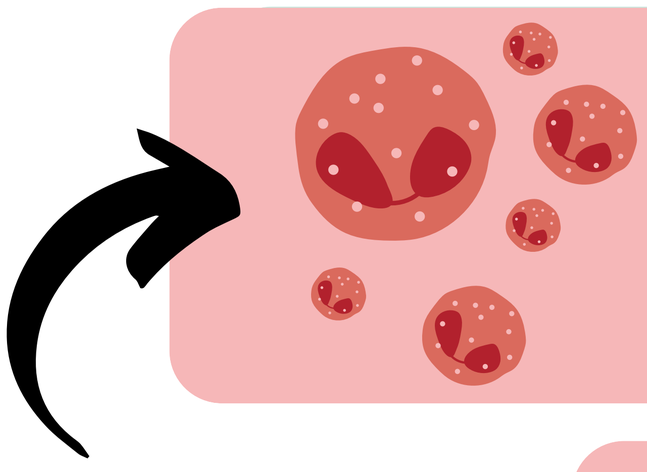
Granulocytes

Neutrophils make up the majority of the immune system cells. These cells have 2-5 lobes. They do have a nucleus, but it is not round, it is segmented. The granules of the neutrophils contain lots of digestive enzymes. They also ingest fungi, viruses, and bacteria.

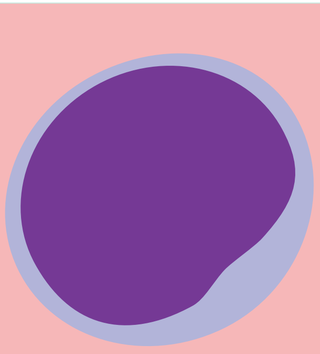


You can see the little stringlike attachment between the lobes through a microscope.

Eosinophils have nuclei with two lobes that are linked by a thin fragment. These cells look red under a microscope because it is the only color that will stain them. Instead of engulfing the bacteria and viruses, these cells work by secreting toxic compounds that attack parasitic worms.

Basophils are the rarest leukocytes. If you looked through a microscope, you would be able to see two lobes stained blue. These granules contain histamine, which causes vasodilation during inflammation.

Agranulocytes



Lymphocytes make up 20 % -25 % of all leukocytes. These help mediate adaptive immunity. These cells are made up of T cells, B cells, and natural killer cells. None of these are phagocytes. Instead of going out to eat other cells, they are in charge of making antibodies.

Monocytes make up 3 % -8 % of leukocytes. They are phagocytes. They differentiate into macrophages, which can be either fixed or wandering. Their nuclei are kidney bean shaped and take up most of the cell.

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- Platelets are just cell fragments that form clots to prevent and stop bleeding. They make up quite a few formed elements in blood.
    - Megakaryocytes can reproduce as many as 4,000 platelets.
- Hemostasis is the process by which the platelets plug the injury and stop the bleeding.

The vascular phase is when the blood vessels nearest to the cut constrict to decrease blood flow. Although the pressure is increased, there isn't as much blood coming out because the vessel is smaller.

The second stage of hemostasis is the platelet plug. This is when the platelets form a matrix around the opening and seal the cut. This is only a temporary arrangement, but because of how tightly bound the platelets are, they don't let blood pass.

The last step of hemostasis is coagulation. This is when a fibrin mesh is built behind the temporary platelet plug to repair the skin. The platelets, fibrin mesh, RBCs, and white blood cells that were at the site form the scab that comes off of your skin.

The scab typically remains on the skin till the skin is fully healed.

- White blood cells protect the body against viruses, bacteria, and other pathogens that can enter the bloodstream through injuries or other means. The white blood cells rush to the site of injury so that they can engulf and ingest these dangerous particles. White blood cells are key figures in keeping infection away.