Chapter 10 - Blood
Blood is a fluid tissue that transports chemicals and many different kinds of cells

- Blood performs vital pickup and delivery services

- It also provides much of the protection necessary to withstand foreign "invaders"

The average person has 4-6 liters of blood and it normally accounts for 7 to 9% of total weight
Blood is made up of 55% plasma and 45% formed elements

1.) **Plasma** is the liquid part of blood

Plasma is mainly made up of water but a small portion is proteins, nutrients, hormones, and gases

**Plasma proteins** are the proteins in the plasma that thicken the blood, contain antibodies and cause the blood to clot

**Serum** is the plasma minus the clotting factors
2.) **Formed elements** are the cells and cell fragments in the blood.

There are three main types of formed elements:

a.) Red blood cells

b.) White blood cells

c.) Platelets
A.) **Red Blood Cells**

Look like circles with an area caved in on each side and the mature RBC's do not have a nucleus!

The shape is critical for the RBC's to carry oxygen and carbon dioxide (lots of surface area! how much??)

---

How many red blood cells do you suppose would be in a drop of blood? 1 mm$^3$
What is the function of RBCs?

A.) They carry carbon dioxide away from cells to the lungs where it is exhaled

B.) Carry oxygen from the lungs to the cells

- **Hemoglobin** is a red pigment in RBCs that bind with oxygen
**Anemia** is a condition caused by an inability of the blood to carry sufficient oxygen to the body cells.

Can result from either inadequate numbers of RBCs or a deficiency of hemoglobin.
Iron is a critical component of hemoglobin. Improper diets may not provide enough iron for the body to manufacture enough hemoglobin.

One sign of being anemic is being tired all the time.
**Hematocrit** is a common lab test to find the volume of RBC's in a sample.

- This is done by spinning blood in a centrifuge.

- The heavier stuff will settle to the bottom:
  - RBC's at bottom
  - **Buffy coat** in the middle (WBC and platelets)

- Plasma at the top
B.) White Blood Cells

WBCs defend the body from microorganisms that have invaded the tissues or bloodstream

WBCs are also called **leukocytes**
1.) Neutrophils (First responders)

2.) Monocytes

Both of these types of WBCs engulf microbes through a process called phagocytosis

**Phagocytosis** is the process of ingesting and digesting particles inside of a cell

Therefore neutrophils and monocytes are also called phagocytes
3.) B-lymphocytes

4.) T-lymphocytes

Both of these produce antibodies that inhibit microbes

Collectively called **lymphocytes**
5.) **Eosinophils** use phagocytosis to protect the body against parasites and irritants that cause allergies

6.) **Basophils** also function in allergic reactions

   - Also secrete a chemical called **heparin** which prevents the clotting of blood as it flows through the blood vessels
There are many diseases of the WBCs

1.) **Leukopenia** refers to an abnormally low WBC count (less than 5000 WBC/mm$^3$ of blood)
   
i.e. AIDS (Aquired immunodeficiency syndrome)

2.) **Leukocytosis** refers to abnormally high WBC count (more than 10,000 WBC/mm$^3$ of blood)
   
i.e. **Leukemia** which is "blood cancer"
   
   - The extra WBCs created do not function properly
C.) Platelets

Platelets are the essential parts of blood clotting.

A clot plugs up a torn or cut vessel.

Two proteins thrombin and fibrinogen combine to form a fibrous gel called fibrin.

There are many other steps involved...one of them being correct blood calcium level.
Clots sometimes form in unbroken blood vessels of the heart, brain, lungs or other organs and can cause sudden death by shutting off blood supply.

These clots can induce strokes and heart attacks.
An unwanted clot that stays in place where it was formed is called a **thrombus** and the condition is called **thrombosis**.

If part of this clot dislodges and circulates through the blood stream it is called an **embolus** and the condition is called an **embolism**.

![Diagram of blood clot (thrombus) and embolus traveling through vein.](image)
Blood Types

Blood type is identified by certain self-antigens located in the membranes of RBCs

**Antigen** - a substance that can activate the immune system to produce antibodies

**Antibodies** - a substance made by the body in response to stimulation by an antigen
When an antigen and antibody come into contact they **agglutinate** or clump together.

Usually antigens are found on the cell walls of invading bacteria, which stimulates your immune system thanks to the antibodies in your blood.
There are four different types of blood

1.) Type A

2.) Type B

3.) Type AB

4.) Type O
Suppose you have type A blood

This means you have the type A antigens in your red blood cells membranes

Because you were born with this blood, your body does not react with it. i.e. your body does not form anti-A antibodies

For an unknown reason, type A blood naturally contains anti-B antibodies
This is important to know for blood transfusions.

If you have type A blood and receive type B blood, what will happen?

Your B antibodies will react with the antigens on the B blood, causing them to agglutinate (clump).
Type O blood has no antigens at all

Therefore it can be given to anyone and people with type O blood are called **universal donors**

Type AB blood has both A and B antigens, so they can receive blood from anyone and are called **universal recipients**
Rh factor is another antigen on RBCs

Rh-positive means your blood has the antigen

Rh-negative means your blood does not have the antigen
Rh factor is important in pregnancies

If Rh-negative mother has a child with Rh-positive father and the baby happens to inherit the Rh positive gene....

When the child is being delivered the babies blood can mix with the mothers blood....

This causes the mothers body to produce antibodies for the Rh factor
If the mother later carries another Rh-positive fetus her new Rh antibodies will react with the baby's Rh-positive antigens. This causes a disease called *erythroblastosis fetalis* which often leads to death of the fetus.