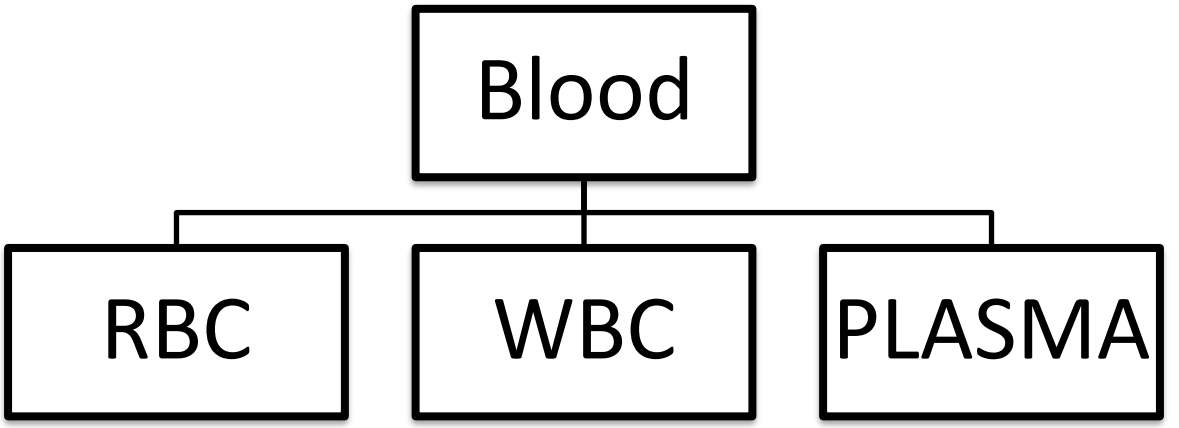
Blood



RBC (Red Blood Cells)

- Red blood cells, also known as erythrocytes, are specialized cells in the circulatory system that are responsible for transporting oxygen from the lungs to the body's tissues and removing carbon dioxide from the tissues and carrying it back to the lungs to be exhaled.
- Red blood cells are unique in their structure and function.
- They are small, biconcave discs that lack a nucleus and most other organelles, allowing them to have more room to carry hemoglobin, a protein that binds to oxygen and gives the cells their characteristic red color.
- Red blood cells are produced in the bone marrow and have a lifespan of about 120 days.
- After their lifespan, they are removed from circulation and broken down in the spleen and liver.
- Red blood cells are crucial for maintaining proper oxygen levels in the body.
- Throughout their lifespan, which is typically about 120 days
- RBCs are constantly produced and replaced in the bone marrow to maintain a stable population in the bloodstream.
- The rate of RBC production is tightly regulated by the body's oxygen needs.
- RBCs are essential for transporting oxygen from the lungs to tissues throughout the body and carrying carbon dioxide (a waste product of metabolism) from tissues back to the lungs for exhalation.
- Their formation and regulation are crucial for maintaining proper oxygenation and overall health.

Formation of RBC

- Red blood cells (RBCs), also known as erythrocytes, are formed through a process called erythropoiesis.

- Erythropoiesis primarily occurs in the bone marrow, specifically in the red bone marrow found in the cavities of certain bones, such as the sternum, ribs, vertebrae, and pelvic bones.

The formation of RBCs is regulated and involves several stages:

1. **Hematopoietic Stem Cells (HSCs):**
   Erythropoiesis begins with hematopoietic stem cells, which are pluripotent cells capable of differentiating into various blood cell types, including RBCs.
   These stem cells are located in the bone marrow.
2. **Proerythroblast Stage:**
   Under the influence of the hormone erythropoietin (EPO), produced primarily by the kidneys in response to low oxygen levels in the blood, hematopoietic stem cells differentiate into proerythroblasts.
   These cells are committed to becoming RBCs.
3. **Erythroblast Stages:**
   Proerythroblasts progress through several stages of development, becoming normoblasts and then reticulocytes.
   During these stages, the cells accumulate hemoglobin (a protein that carries oxygen) and lose their nuclei and most organelles to become more specialized for oxygen transport.
4. **Reticulocytes:**
   Reticulocytes are immature RBCs that still contain some residual organelles but lack a nucleus.
   They are released into the bloodstream from the bone marrow. In circulation, reticulocytes mature into fully functional RBCs within a day or two.
5. **Mature Red Blood Cells:**
   The final stage of erythropoiesis is the maturation of reticulocytes into mature RBCs.
   During this process, any remaining organelles are removed, and the cell takes on its characteristic biconcave shape, which maximizes its surface area for oxygen exchange.

Composition of Heamoglobin

- ✓ Hemoglobin is a protein molecule found in red blood cells that is responsible for carrying oxygen from the lungs to the body's tissues and organs.
- ✓ Hemoglobin is composed of four protein subunits, each of which contains a heme group.
- ✓ The heme group consists of an iron ion surrounded by a porphyrin ring, which is responsible for binding to oxygen.
- ✓ There are several different types of hemoglobin found in humans
  1. Hemoglobin A (HbA): This is the most common type of hemoglobin found in adults and is composed of two alpha globin chains and two beta globin chains.
  2. Hemoglobin A2 (HbA2): This type of hemoglobin is composed of two alpha globin chains and two delta globin chains. HbA2 typically makes up only a small percentage of total hemoglobin in the blood.

3. Fetal Hemoglobin (HbF): This type of hemoglobin is present in developing fetuses and is composed of two alpha globin chains and two gamma globin chains. HbF production declines shortly after birth and is replaced by the production of HbA.
4. Hemoglobin S (HbS): This is an abnormal form of hemoglobin that is produced in people with sickle cell disease. HbS is composed of two alpha globin chains and two abnormal beta globin chains that cause red blood cells to become misshapen and break down more easily.
5. Hemoglobin C (HbC): This is an abnormal form of hemoglobin that is produced in people with hemoglobin C disease. HbC is composed of two alpha globin chains and two abnormal beta globin chains that can cause mild anemia.
6. Hemoglobin E (HbE): This is an abnormal form of hemoglobin that is produced in people with hemoglobin E disease. HbE is composed of two alpha globin chains and two abnormal beta globin chains that can cause mild to moderate anemia.

BLOOD PLASMA

- Blood plasma is the yellowish, liquid component of blood that makes up approximately 55% of total blood volume.
- It is a vital part of the circulatory system and serves several essential functions in the body.
- Blood plasma is a pale, straw-colored fluid that is mostly composed of water but also contains various proteins, electrolytes, hormones, waste products, and nutrients.
- Blood plasma is separated from the formed elements of blood (red blood cells, white blood cells, and platelets) through a process called centrifugation.
- This separation allows healthcare professionals to collect and analyze plasma for diagnostic purposes, such as assessing blood chemistry, detecting diseases, and monitoring organ function.
- Plasma transfusions are also used to treat certain medical conditions, especially those involving clotting disorders or severe burns.

Components of blood plasma

1. **Water**
   - Water makes up the majority (about 90-92%) of blood plasma. It serves as the solvent for the various solutes suspended or dissolved in plasma.
2. **Electrolytes**
   - Blood plasma contains ions such as sodium, potassium, calcium, magnesium, chloride, and bicarbonate.
   - These electrolytes help maintain the body's pH balance, nerve function, muscle contraction, and fluid balance.
3. **Nutrients**
   - Plasma transports nutrients like glucose, amino acids, fatty acids, vitamins, and minerals to various cells and tissues, providing the necessary energy and building blocks for bodily functions.
4. **Waste Products**

- Plasma also carries waste products generated by metabolism, including urea, creatinine, and bilirubin, to be eliminated from the body through the kidneys and other excretory organs.

5. **Hormones**
   - Hormones, produced by endocrine glands, are transported throughout the body via the bloodstream.
   - Plasma serves as a carrier for hormones, helping to regulate various physiological processes.
6. **Gases**
   - Small amounts of oxygen, carbon dioxide, and nitrogen are dissolved in plasma and play essential roles in respiration and gas exchange.

Plasma Proteins

- Blood plasma contains a variety of proteins, including albumin, globulins, and fibrinogen.
- These proteins play crucial roles in maintaining blood volume, regulating osmotic pressure, transporting substances like hormones and lipids, and aiding in blood clotting.

1. **Albumin**
   - The most abundant plasma protein, albumin, helps maintain the osmotic pressure of the blood, which is important for fluid balance between blood vessels and tissues.
   - It also transports various substances, including fatty acids and drugs.
2. **Globulins**
   - These proteins include antibodies (immunoglobulins) that play a key role in the immune system's defense against infections.
   - They also transport certain hormones and other substances.
3. **Fibrinogens**
   - Fibrinogen is involved in blood clotting.
   - When activated, it forms fibrin threads that help create blood clots to stop bleeding.

Functions of blood plasma:

1. **Transport of substances**

- Plasma acts as a transport medium, carrying various substances throughout the body.
- This includes Nutrients, Hormones, Waste Products, Maintaining Blood Volume, Blood Clotting, Acid-Base balance, Temperature regulation, Gas exchange, Maintenance of electrolyte balance, Osmatic regulation, Clotting factors.

1. **Nutrients:** Plasma transports nutrients such as glucose, amino acids, fatty acids, vitamins, and minerals from the digestive system and storage sites to cells where they are needed for energy production and cellular functions.
2. **Hormones:** Hormones produced by endocrine glands are carried in the bloodstream within plasma. These hormones regulate various physiological processes, including metabolism, growth, and reproduction.
3. **Waste Products:** Plasma carries metabolic waste products, including urea, creatinine, and bilirubin, from cells to excretory organs (e.g., kidneys and liver) for elimination from the body.

4. **Maintaining Blood Volume:** Plasma contains proteins, primarily albumin, which help maintain blood volume and blood pressure by exerting osmotic pressure. This prevents excessive loss of fluid from the bloodstream into the surrounding tissues.
5. **Blood Clotting:** Plasma contains fibrinogen, a protein that plays a crucial role in blood clotting (coagulation). When an injury occurs, fibrinogen is converted to fibrin, forming a mesh-like structure that traps blood cells to stop bleeding.
6. **Immune Response:** Plasma contains globulins, including immunoglobulins or antibodies, which are vital components of the immune system. These proteins help defend the body against infections by recognizing and neutralizing pathogens (e.g., bacteria and viruses).
7. **Acid-Base Balance:** Plasma helps regulate the body's acid-base balance (pH) by carrying bicarbonate ions and other buffering systems. This ensures that the blood remains within the narrow pH range necessary for proper physiological function.
8. **Temperature Regulation:** Plasma plays a role in thermoregulation by transporting heat throughout the body. Blood circulation helps distribute heat generated by metabolic processes to maintain body temperature.
9. **Gas Exchange:** Plasma contains dissolved gases, including oxygen (O2) and carbon dioxide (CO2). These gases are transported to and from tissues and the lungs, facilitating the exchange of gases necessary for respiration and maintaining oxygen levels in the body.
10. **Maintenance of Electrolyte Balance:** Plasma contains various electrolytes (ions), such as sodium, potassium, calcium, and chloride. These electrolytes help regulate nerve impulses, muscle contractions, and the balance of fluids within and outside of cells.
11. **Osmotic Regulation:** Plasma osmolarity, controlled by the concentration of solutes, influences the movement of water between blood vessels and tissues. This osmotic regulation is essential for maintaining tissue hydration and preventing edema (excessive fluid accumulation).
12. **Coagulation Factors:** Plasma contains clotting factors (coagulation factors), which are essential for the formation and regulation of blood clots in response to injury. These factors include various proteins that interact to achieve hemostasis.