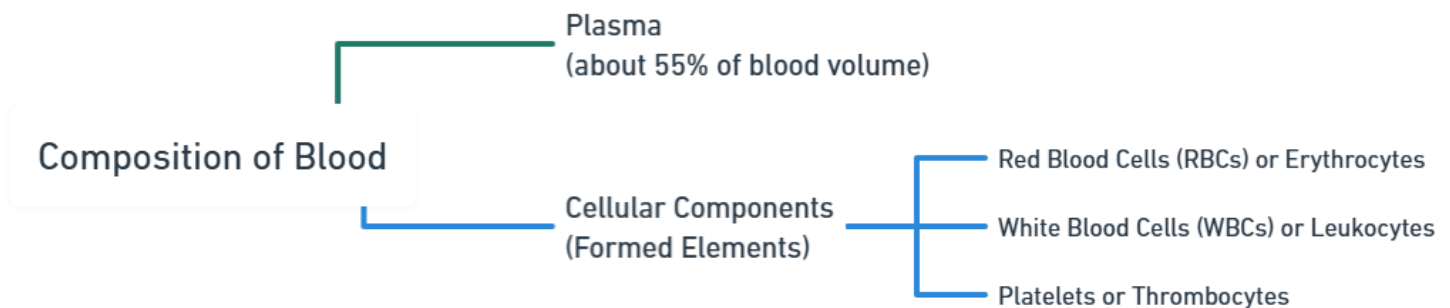


Haemopoietic system

Blood: composition and functions

- Blood is a specialized connective tissue consisting of cells suspended in a liquid matrix called plasma.
- Blood is composed of various cellular components, including red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes), suspended in plasma.
- The red blood cells are responsible for oxygen transport, while white blood cells are involved in immune responses. Platelets aid in clotting.



Composition of Blood

1. Plasma (about 55% of blood volume)

- Plasma is the liquid portion of blood, primarily made of water (about 90%) and contains dissolved proteins, glucose, mineral ions, hormones, and other substances.

- **Functions:**

- **Transport Medium:** Carries nutrients, waste products, and hormones throughout the body.
- **Regulation:** Helps regulate body temperature and maintain the acid-base balance.

2. Cellular Components (Formed Elements)

- The cellular components, or formed elements, include red blood cells (RBCs), white blood cells (WBCs), and platelets.

Each has specific roles:

A. Red Blood Cells (RBCs) or Erythrocytes

- The most abundant blood cells, responsible for oxygen transport.

- **Functions:**

- **Oxygen Transport:** RBCs transport oxygen from the lungs to body tissues and remove carbon dioxide, a waste product of cellular metabolism.

- **Haemoglobin:** RBCs contain haemoglobin, an oxygen-binding protein that gives them their red color.
- **Acid-Base Balance:** RBCs help maintain the blood's pH balance.

B. White Blood Cells (WBCs) or Leukocytes

- Nucleated cells crucial for the immune system, protecting the body against infections and diseases.

- **Types and Functions:**

- I. **Neutrophils:** The most abundant WBCs, which phagocytize (engulf and destroy) bacteria and foreign particles.
- II. **Lymphocytes:** Produce antibodies and regulate immune responses; include:
 - **B-cells:** Produce antibodies.
 - **T-cells:** Directly attack infected cells and regulate immune responses.
 - **Natural Killer (NK) Cells:** Kill abnormal cells, such as cancerous or virus-infected cells.
- III. **Monocytes:** Transform into macrophages that phagocytize pathogens, dead cells, and debris.
- IV. **Eosinophils:** Combat parasitic infections and participate in allergic reactions.
- V. **Basophils:** Release histamine during allergic reactions and contribute to inflammation.

C. Platelets or Thrombocytes

- Small cell fragments critical for blood clotting and wound healing.

- **Functions:**

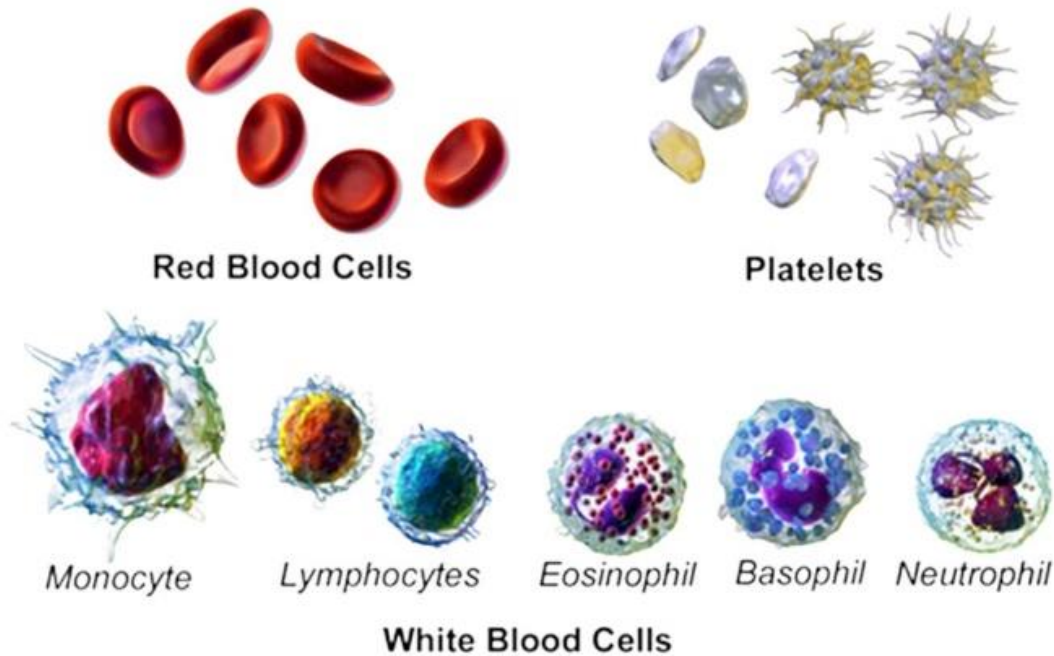
- **Clot Formation:** Platelets clump together at injury sites to form a plug, preventing excessive blood loss.
- **Wound Healing:** Release growth factors that promote tissue repair and regeneration.

Functions of blood

1. **Transportation:** Carries oxygen to tissues, removes carbon dioxide, and transports nutrients, hormones, and waste products.
2. **Immune Response:** Contains white blood cells that defend against infections and diseases.
3. **Clotting:** Platelets form clots to prevent excessive bleeding.
4. **Regulation:** Maintains pH balance and electrolyte levels (e.g., sodium, potassium).

5. **Temperature Regulation:** Distributes heat throughout the body.
6. **Hormone Transport:** Delivers hormones from glands to target organs.

Formed Elements of Blood



Hemopoiesis (Haematopoiesis)

- **Hemopoiesis** is the process by which blood cells are produced in the body, primarily occurring in the bone marrow.
- Hematopoietic stem cells (HSCs) differentiate into various blood cell types, including erythrocytes (red blood cells), leukocytes (white blood cells), and thrombocytes (platelets).

1. Erythropoiesis

- Production of erythrocytes (red blood cells) responsible for oxygen transport.
- **Process:**
 - Begins with HSCs differentiating into proerythroblasts.
 - Under the influence of erythropoietin (EPO), proerythroblasts develop through several stages:
 - Proerythroblast → Basophilic erythroblast → Polychromatophilic erythroblast → Orthochromatophilic erythroblast → Reticulocyte.
 - Reticulocytes enter the bloodstream and mature into erythrocytes.

2. Leukopoiesis

- Production of leukocytes (white blood cells) for immune defense.

➤ **Process:**

- HSCs differentiate into myeloid or lymphoid progenitor cells.
- **Myeloid progenitor cells** develop into granulocytes (neutrophils, eosinophils, basophils) and monocytes.
- **Lymphoid progenitor cells** develop into B and T lymphocytes and natural killer (NK) cells.
- Regulated by cytokines and growth factors like GM-CSF, G-CSF, and interleukins.

3. Thrombopoiesis

- Production of thrombocytes (platelets) for blood clotting.

➤ **Process:**

- HSCs differentiate into megakaryocyte progenitor cells.
- Under the influence of thrombopoietin (TPO), these progenitors mature into megakaryocytes.
- Megakaryocytes extend proplatelets into bone marrow blood vessels, which fragment into platelets released into the bloodstream.

Formation of haemoglobin

- **Haemoglobin** is a complex, iron-containing protein in red blood cells (RBCs) that binds and transports oxygen from the lungs to tissues throughout the body.
- Haemoglobin consists of four protein subunits, each containing a heme group with an iron atom at its center.

Steps in Hemoglobin Formation:

1. Synthesis of Globin Chains:

- Haemoglobin in adults (HbA) comprises two alpha (α) chains and two beta (β) chains.
- The α -globin chains are encoded by genes on chromosome 16, while β -globin chains are encoded on chromosome 11.
- These chains are synthesized in the ribosomes of developing red blood cells in the bone marrow.

2. Synthesis of Heme:

- Heme is an organic molecule essential for oxygen binding, with an iron atom at its center.
- Heme synthesis occurs in the mitochondria and cytoplasm of immature red blood cells.

- The process begins with the condensation of succinyl-CoA and glycine to form δ -aminolevulinic acid (ALA) in the mitochondria, followed by a series of transformations in the cytoplasm, leading to the formation of the porphyrin ring and the insertion of an iron atom to complete the heme molecule.

3. Assembly of Hemoglobin:

- The synthesized globin chains bind to the heme groups, forming hemoglobin subunits.
- Two α -globin subunits associate with two β -globin subunits, creating the functional hemoglobin molecule ($\alpha_2\beta_2$).

4. Maturation of Red Blood Cells:

- As red blood cells mature in the bone marrow, they accumulate hemoglobin, lose their nucleus and organelles, and adopt a biconcave shape.
- Mature red blood cells, filled with hemoglobin, are then released into the bloodstream to transport oxygen to tissues and organs.

Mechanisms of coagulation

- Blood clotting, also known as coagulation, is a crucial process that prevents excessive bleeding when a blood vessel is injured.

Here's a detailed overview of how it works:

1. Vascular Spasm

- Immediately after a blood vessel is injured, its walls constrict to reduce blood flow.
- This initial response is known as a vascular spasm.

2. Platelet Plug Formation

- Platelets, a type of blood cell, adhere to the site of injury and to each other, forming a temporary "platelet plug."
- Platelets release chemicals that attract more platelets to the site, reinforcing the plug.

3. Coagulation Cascade

- This step involves a series of complex biochemical reactions involving clotting factors (proteins in blood plasma).
- The cascade is initiated by the exposed tissue at the injury site and proceeds through a series of steps involving these clotting factors.
- The cascade has two pathways—the intrinsic and extrinsic pathways—which converge on a common pathway.
- The cascade is divided into **three pathways: intrinsic, extrinsic, and a common pathway.**



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