Unit III

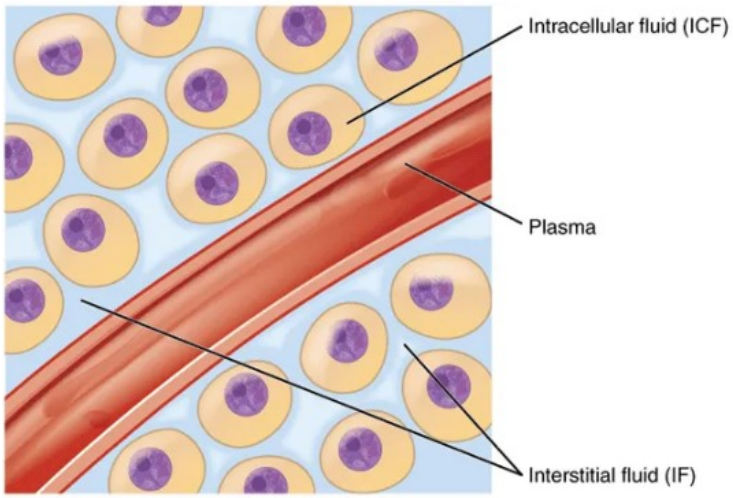
BODY FLUIDS AND BLOOD

A body fluid refers to any fluid produced by a living organism. In humans, the body fluid can be classified into two major types according to the location in the body:

Extracellular fluid (ECF)

The body fluid located outside the cell or cells of an organism. It makes up about 26% of the total body water composition in humans. Interstitial fluid, intravascular fluid, lymph, and transcellular fluid make up the extracellular fluid.

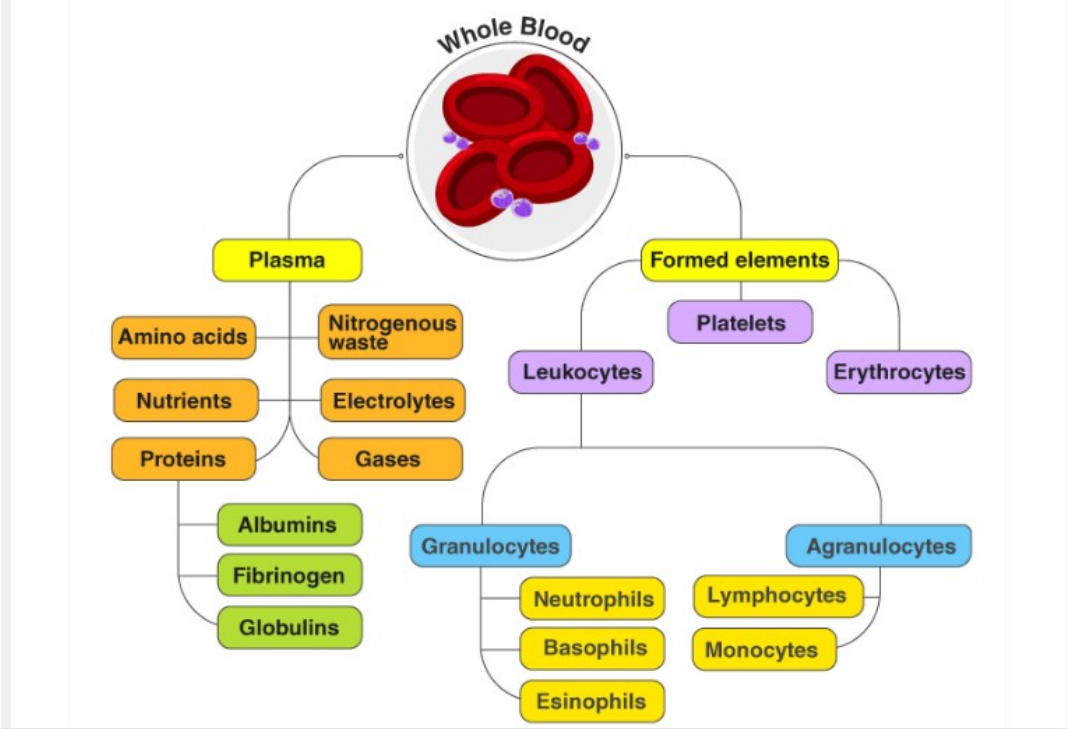
Intracellular fluid (ICF)– the body fluid located within the cell or all cells of an organism. In humans, the intracellular fluid makes up 67% of the total body water composition. It is composed of water, dissolved ions, and other molecules.



BLOOD

Blood is a vital, red fluid tissue that acts as the body's transport system, delivering oxygen, nutrients, hormones, and cells to tissues while removing waste products like carbon dioxide, all circulated by the heart through arteries and veins.

COMPOSITION OF BLOOD



Plasma

Blood plasma is a mixture of proteins, enzymes, nutrients, wastes, hormones and gases.

Proteins

These are the most abundant substance in plasma by weight and play a part in a variety of roles including clotting, defense and transport. Collectively, they serve several functions:

1. They are an important reserve supply of amino acids for cell nutrition.
2. Plasma proteins also serve as carriers for other molecules.
3. The plasma proteins interact in specific ways to cause the blood to coagulate,

4. Plasma proteins govern the distribution of water between the blood and tissue fluid by producing what is known as a colloid osmotic pressure.

There are three major categories of plasma proteins

- **Albumins**, which are the smallest and most abundant plasma proteins.
- **Globulins**, which can be subdivided into three classes from smallest to largest in molecular weight into alpha, beta and gamma globulins.
- **Fibrinogen**, which is a soluble precursor of a sticky protein called fibrin, which forms the framework of blood clot.

Amino acids

These are formed from the breakdown of tissue proteins or from the digestion of digested proteins.

Nitrogenous waste

Being toxic end products of the breakdown of substances in the body, these are usually cleared from the bloodstream and are excreted by the kidneys at a rate that balances their production.

Nutrients

Those absorbed by the digestive tract are transported in the blood plasma. These include glucose, amino acids, fats, cholesterol, phospholipids, vitamins and minerals.

Gases

Some oxygen and carbon dioxide are transported by plasma. Plasma also contains a substantial amount of dissolved nitrogen.

Electrolytes

The most abundant of these are sodium ions, which account for more of the blood's osmolarity than any other solute.

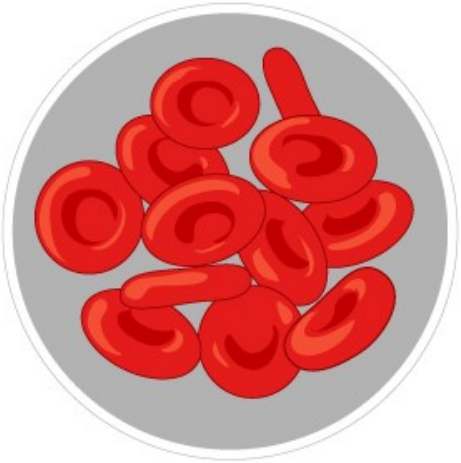
FORMED ELEMENTS

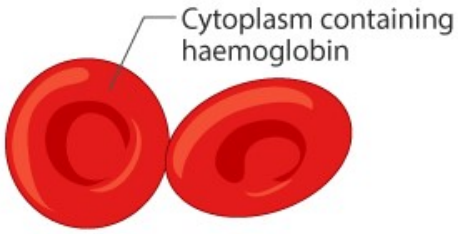
Types of Blood Cells

(A) Red blood cells (Erythrocytes)

- RBCs are the biconcave cells and without nucleus in humans; also known as erythrocytes.

- RBCs contain the iron-rich protein called **haemoglobin** which gives blood its red colour.
- RBCs are the most copious blood cell produced in bone marrows.
- It's main function is to transport oxygen from and to various tissues and organs.
- Life span is 120 days.
- Number: in male -> 4.7-6.1 million/µL, in female -> 4.2-5.2 million/ µL
- Diameter: ~2 µm at the periphery, ~1 µm at the center





(B) White blood cells (Leucocytes)

- Leucocytes are the colourless blood cells.
- They are colourless because it is devoid of haemoglobin.
- They are further classified as granulocytes and agranulocytes.
- WBCs mainly contribute to immunity and defence mechanism.
- Total WBC count: 4,000–11,000 cells/mm³ of blood (Normal)

Types of White Blood Cells

There are five different types of White blood cells and are classified mainly based on the presence and absence of granules.

- Granulocytes
- Agranulocytes

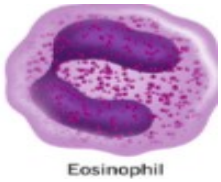
Granulocytes

They are leukocytes, with the presence of granules in their cytoplasm.

The granulated cells include-

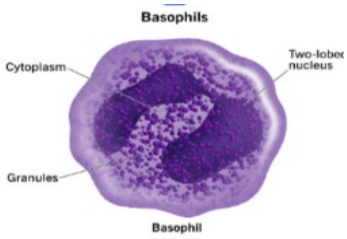
- Eosinophil/Acidophills,
- Basophil,
- Neutrophil.

Eosinophils (2-3%)



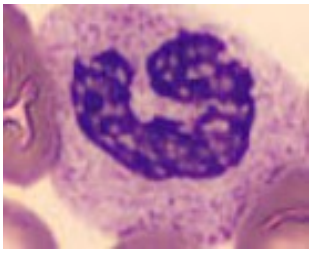
1. pink-orange color because of their affinity for the acidic dye eosin.
2. Have bilobbed nucleus.
3. Responsible for combating infections
4. Small granulocyte.
5. These cells are present in high concentrations in the digestive tract.

Basophils (0.5-1%)



1. Stained by basic dyes stains dark blue/purple .
2. These are the least common of the granulocytes, ranging from 0.5 to 1 per cent of WBCs.
3. They contain large cytoplasmic granules, which plays a vital role in mounting a non-specific immune response to pathogens. allergic reactions by releasing histamine and dilates the blood vessels.
4. Also release heparin (Anticoagulant)
5. Release seretonin (vasoconstrictor)

Neutrophils (60-65%)



1. They are predominant cells, which are present in pus.
2. Around 60 to 65 per cent of WBCs are neutrophils with a diameter of 10 to 12 micrometres.
3. The nucleus is 2 to 5 lobed (polymorphic) and cytoplasm has very fine granules.

4. Neutrophil helps in the destruction of bacteria with lysosomes, and it acts as a strong oxidant.
5. Neutrophils are stained only using neutral dyes. May be acidic or basic.

Agranulocytes

They are leukocytes, with the absence of granules in their cytoplasm. Agranulocytes are further classified into monocytes and lymphocytes.

Monocytes(3-8%)

- These cells usually have a large bilobed nucleus, with a diameter of 12 to 20 micrometres.
- Nucleus half-moon shaped or kidney-shaped.
- They are the garbage trucks of the immune system.
- The most important functions of monocytes are to migrate into tissues and clean up dead cells, protect against the bloodborne pathogens and they move very quickly to the sites of infections in the tissues.
- These white blood cells have a single bean-shaped nucleus, hence referred to as Monocytes.

Lymphocytes (20-25%)

- They play a vital role in producing antibodies.
- Their size ranges from 8 to 10 micrometres.
- They are commonly known as natural killer cells.
- They play an important role in body defense.
- These white blood cells are colourless cells formed in lymphoid tissue, hence referred to as lymphocytes.
- There are two main types of lymphocytes – **B lymphocytes and T lymphocytes**.
- These cells are very important in the immune systems and are responsible for humoral and cell-mediated immunity.

(C) Platelets (Thrombocytes)

- Thrombocytes are specialized blood cells produced from bone marrow.
- Platelets come into play when there is bleeding or hemorrhage.
- They help in clotting and coagulation of blood. Platelets help in coagulation during a cut or wound.
- These white blood cells have the ability to be stained when exposed to basic dyes, hence referred to as basophil.
- These cells are best known for their role in asthma and their result in the inflammation and broncho-constriction in the airways.
- They secrete serotonin, histamine and heparin.

FUNCTIONS OF BLOOD

Blood is responsible for the following body functions:

1. **Fluid Connective Tissue**

   Blood is a fluid connective tissue composed of 55% plasma and 45% formed elements including WBCs, RBCs, and platelets. Since these living cells are suspended in plasma, blood is known as a fluid connective tissue and not just fluid.

2. **Provides oxygen to the cells**

   Blood absorbs oxygen from the lungs and transports it to different cells of the body. The waste carbon dioxide moves from the blood to the lungs and exhaled.

3. **Transports Hormone and Nutrients**

   The digested nutrients such as glucose, vitamins, minerals, and proteins are absorbed into the blood through the capillaries in the villi lining the small intestine.

4. The hormones secreted by the endocrine glands are also transported by the blood to different organs and tissues.

5. **Homeostasis**

   Blood helps to maintain the internal body **temperature** by absorbing or releasing heat.

6. **Blood Clotting at Site of Injury**

   The platelets help in the clotting of blood at the site of injury. Platelets along with the fibrin form clot at the wound site

7. **Transport of waste to the Kidney and Liver.**

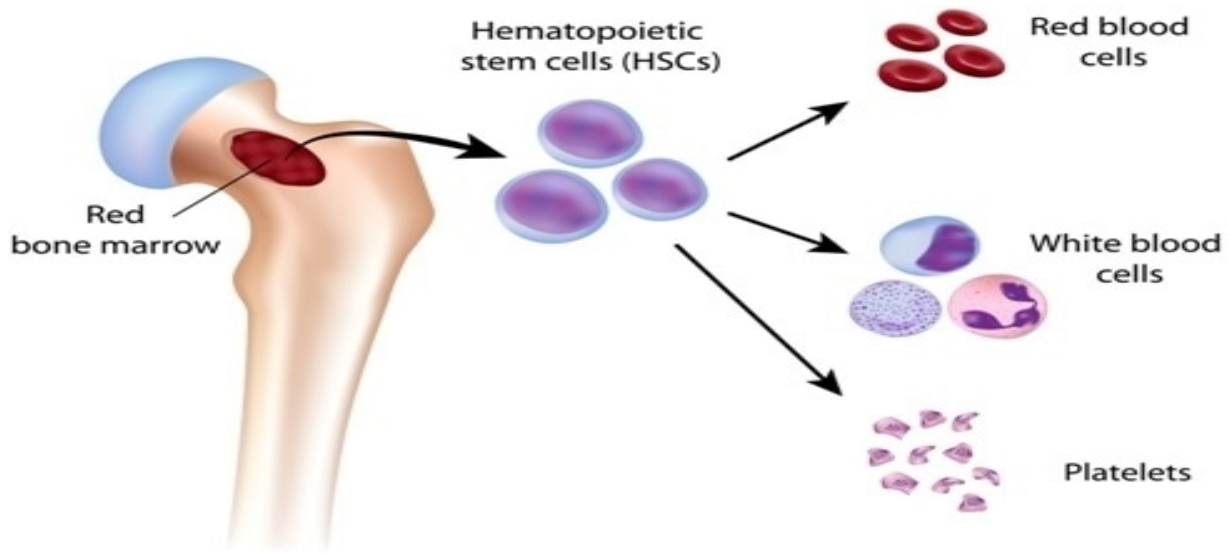
Blood enters the kidney where it is filtered to remove nitrogenous waste out of the blood plasma. The toxins from the blood are also removed by the liver.

8. **Protection of body against pathogens**

   The White Blood Cells fight against infections. They multiply rapidly during the infections.

HEMATOPOIESIS PROCESS

Hematopoiesis is the continuous, regulated process of renewal, proliferation, differentiation, and maturation of all blood cell lines



ERYTHROPOIESIS

Erythropoiesis is the process of the origin, development, and maturation of erythrocytes.

1. Erythrocytes are red blood cells that are an essential constituent cell of blood.
2. It contains a vital pigment called hemoglobin that transports oxygen to all the cells in the body and brings carbon dioxide from the cells to the lungs for purification.
3. The formation of these red blood cells is called erythropoiesis.

4. This process consists of the **development**, **differentiation**, and **maturation of erythrocytes** from the primitive stem cells.
5. These primitive cells are **pluripotent** stem cells that can form into any type of blood cell, and myeloid stem cells that can form the erythroid progenitor cells.
6. The primary sites of erythropoiesis in adults are red bone marrow in the axial skeleton (skull, vertebrae, sternum) and proximal ends of the long bones (humerus, tibia, femur).
7. There are various stages of erythropoiesis that start with the stem cells that form the Burst Forming Units- erythrocytes (BFU-E) and Colony-Forming Units- erythrocytes (CFU-E).
8. All of them go through a series of cell formation to ultimately create the mature erythrocyte.

SITE OF ERYTHROPOIESIS

IN FETAL LIFE

In fetal life, erythropoiesis occurs in three stages:

1. Mesoblastic Stage

During the first two months of intrauterine life, the RBCs are produced from **mesenchyme of the yolk sac**.

2. Hepatic Stage

From the third month of intrauterine life, **liver** is the main organ that produces RBCs. **Spleen and lymphoid organs** are also involved in erythropoiesis.

3. Myeloid Stage

During the last three months of intrauterine life, the RBCs are produced from **red bone marrow and liver**.

STAGES OF ERYTHROPOIESIS

Various stages between CFU-E (Colony forming units-Erythrocyte) cells and matured RBC are

1. Proerythroblast
2. Early normoblast
3. Intermediate normoblast
4. Late normoblast
5. Reticulocyte

6. Matured erythrocyte

1. Proerythroblast (Megaloblast)

a) Proerythroblast or megaloblast is the first cell derived from CFU-E.
b) It is very large in size with a diameter of about **20 µm**.
c) Its nucleus is large and occupies the cell almost completely.
d) The nucleus has two or more nucleoli and a reticular network.
e) Proerythroblast does not contain hemoglobin.

2. Early Normoblast

a) The early normoblast is slightly smaller than proerythroblast with a diameter of about **15 µm**.
b) In the nucleus, the **nucleoli disappear**.
c) Condensation of chromatin network occurs.
d) The cytoplasm is basophilic in nature.
e) It is also called **basophilic erythroblast**.
f) This cell develops into the next stage called **intermediate normoblast**.

3. Intermediate Normoblast

a) Cell is smaller than the early normoblast with a diameter of **10–12 µm**.
b) The nucleus is still present, but chromatin network shows further condensation.
c) **Hemoglobin starts appearing**.

4. Late Normoblast

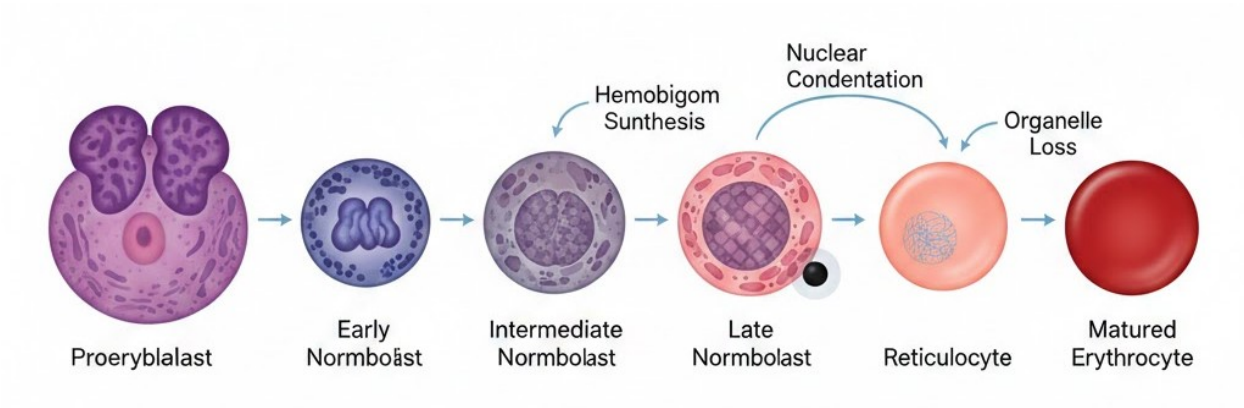
a) Diameter of the cell decreases further to about **8–10 µm**.
b) Nucleus becomes very small with highly condensed chromatin network and is known as **ink-spot nucleus**.
c) Quantity of hemoglobin increases.
d) The nucleus disintegrates and disappears.
e) The process by which nucleus disappears is called **pyknosis**.

5. Reticulocyte

a) Reticulocyte is otherwise known as **immature RBC**.
b) It is slightly larger than matured RBC.
c) Cytoplasm contains a reticular network (reticulum) formed by remnants of disintegrated organelles.
d) Due to the reticular network, the cell is called reticulocyte.
e) The reticulum stains with **supravital stain**.
f) In newborn babies, reticulocyte count is **2%–6% of RBCs** (2–6 reticulocytes per 100 RBCs).

6. Matured Erythrocyte

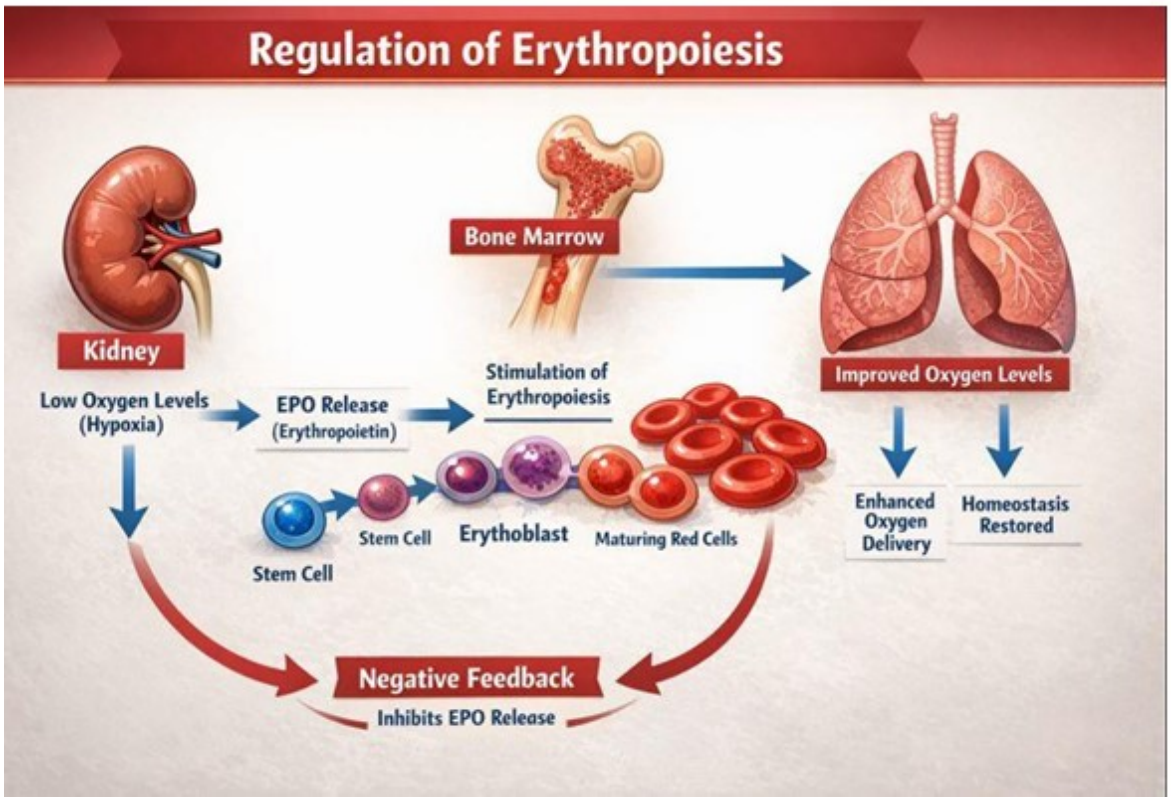
a) Reticular network disappears and the cell becomes matured RBC with **biconcave shape**.
b) Cell size decreases to **7.2 µm** in diameter.
c) Matured RBC contains hemoglobin but **lacks nucleus**.



REGULATION OF ERYTHROPOISIS

1. **Stimulus (Hypoxia):** low level of oxygen in tissue due to blood loss, high altitude or lungs disease trigger this process.
2. **Detection and hormone release:** Kidney cell detect hypoxia and release Erythropoietin (EPO)
3. **Bone Marrow Activation**: EPO travelles to bone marrow and bind to receptor on Haematopoitic stem cell.
4. **Stem Cell Differentiation:** Hematopoietic Stem Cells (HSCs) differentiate into Common myeloid Progenator (CMP) then it convert to Megakaryocyte erythroid progenitor (MEP) and finally into early erythroid precursor.

5. **EPO Action:** EPO stimulates MEPs, causing them to become the first identifiable red cell precursors, **Proerythroblasts**, which start hemoglobin production and divide rapidly.
6. **Erythropoisis:** which involve the process of hemoglobin accumulation.
7. **Feedback loop completion:** increased RBCs improve the oxygen delivery which resolve the initial hypoxia, which further reduce the EPO release and regulation process completed

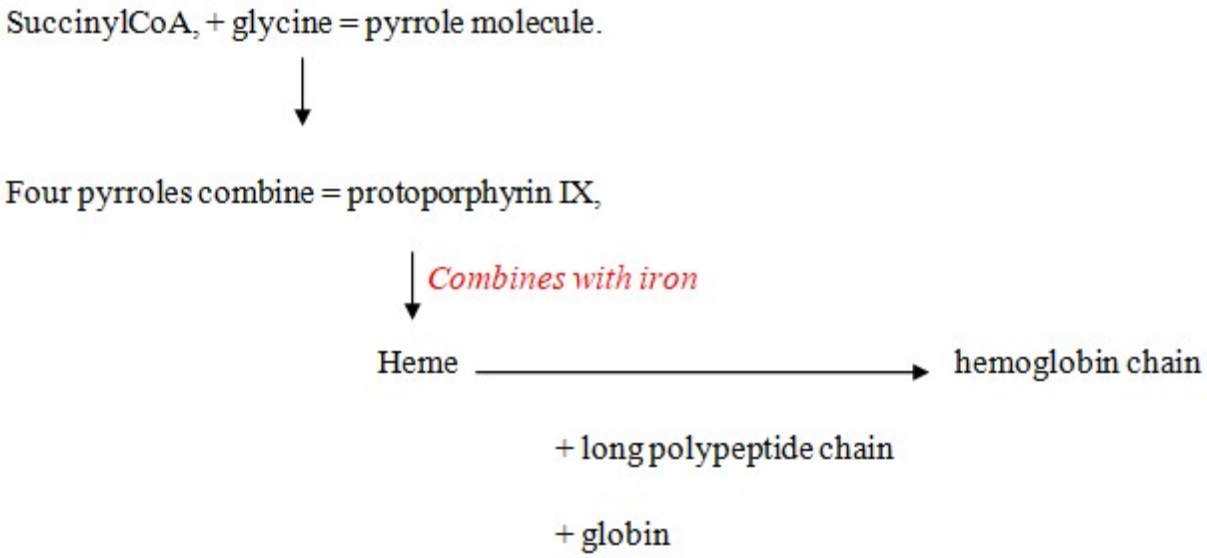


HEMOGLOBIN

Hemoglobin (Hb) is an iron-rich protein in red blood cells that carries oxygen from the lungs to the body's tissues and returns carbon dioxide to the lungs, giving blood its red color.

Hemoglobin The major function of red blood cells is to transport hemoglobin, which in turn carries oxygen from the lungs to the tissues. Hemoglobin, the protein that makes red blood cells red, binds easily and reversibly with oxygen, and most oxygen carried in blood is bound to hemoglobin.

BASIC CHEMICAL STEPS IN THE FORMATION OF HEMOGLOBIN

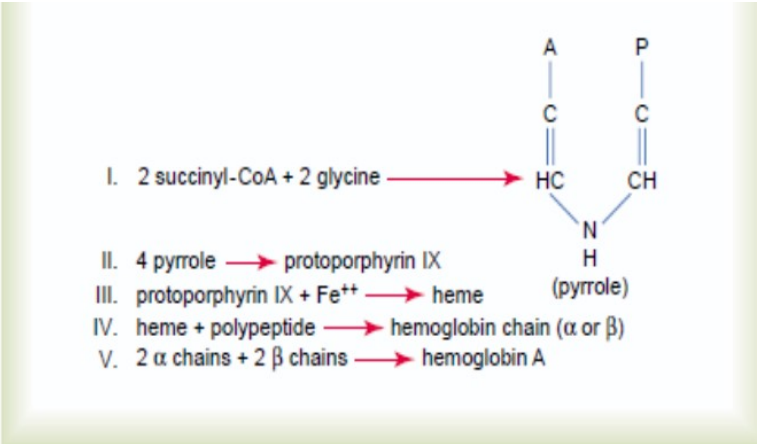


The different types of chains are designated alpha chains, beta chains, gamma chains, and delta chains.

Normal values for hemoglobin are

13–18 grams per 100 milliliters of blood (g/100 ml) in adult males,

12–16 g/100 ml in adult females.



TYPES OF HEMOGLOBIN

1. Hemoglobin A: is a combination of two alpha chains and two of beta chains, it is the most common form of hemoglobin (95-98%) in the adult human being.

2. Hemoglobin A2: is a combination of two alpha chains and two of delta chains, it represents 2-3% of hemoglobin in the adult human being.

3. Hemoglobin F (fetus Hb): is a combination of two alpha chains and two of gamma chains, also it found in newborns blood of about 1% of their hemoglobin.

COAGULATION PROCESS

The coagulation process, or blood clotting, is the body's natural way to stop bleeding (hemostasis) by turning liquid blood into a gel-like clot, involving platelet activation and a cascade of clotting factors (proteins) that form a strong fibrin mesh over an injury to seal the wound and allow for repair, a process with intrinsic, extrinsic, and common pathways

Extrinsic Pathway

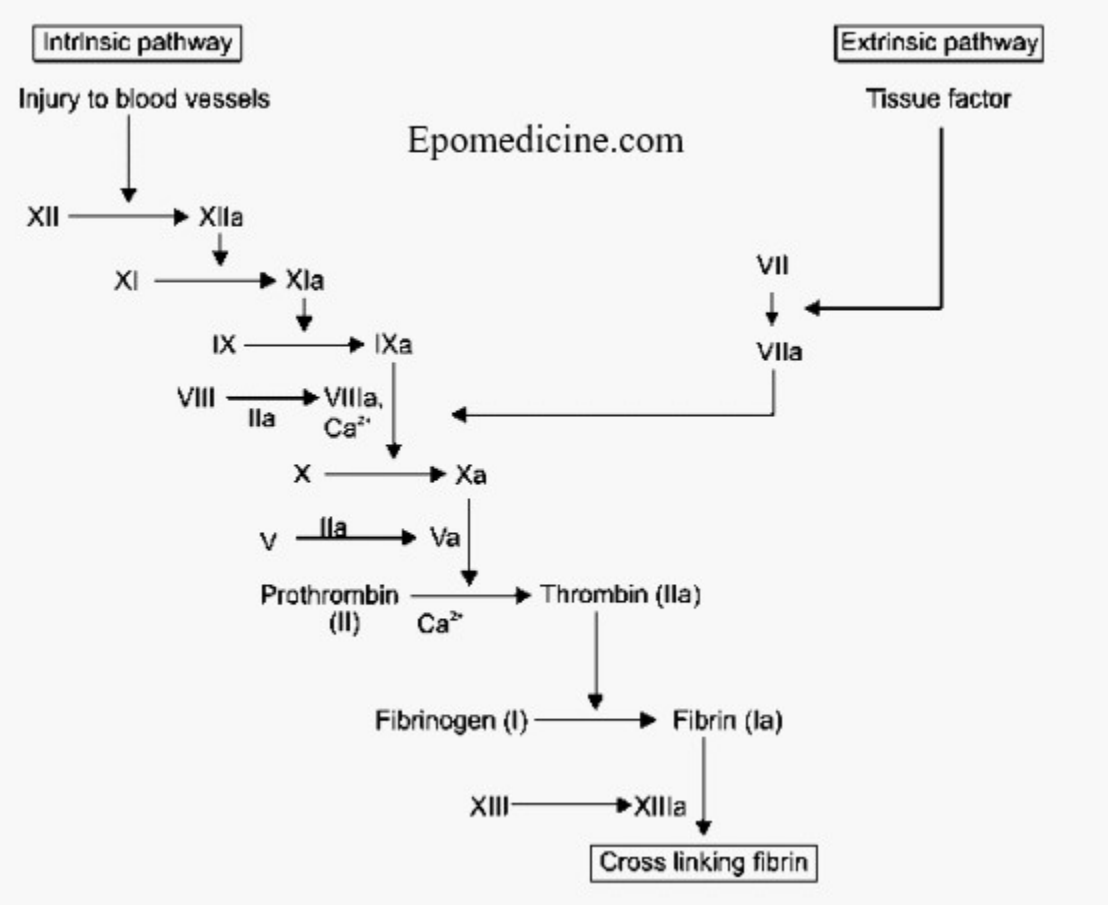
The extrinsic pathway is activated by external trauma that causes blood to escape from the vascular system. This pathway is quicker than the intrinsic pathway. It involves factor VII.

Intrinsic Pathway

The intrinsic pathway is activated by trauma inside the vascular system, and is activated by platelets, exposed endothelium, chemicals, or collagen. This pathway is slower than the extrinsic pathway, but more important. It involves factors XII, XI, IX, VIII.

Common Pathway

Both pathways meet and finish the pathway of clot production in what is known as the common pathway. The common pathway involves factors I, II, V, and X.



CLOTTING FACTORS

1. Factor I: Fibrinogen (First)
2. Factor II: Prothrombin (Person)
3. Factor III: Tissue thromboplastin or Tissue factor (Told)
4. Factor IV: Calcium (Cancer)
5. Factor V: Labile factor (Leads), Proaccelerin
6. Factor VII: Stable factor (Sickness), Proconvertin
7. Factor VIII: Anti-hemophilic factor A (Another)
8. Factor IX: Christmas factor (Chap), Anti-hemophilic factor B
9. Factor X: Stuart power factor (Said), Autoprothrombin III

10. Factor XI: Plasma Thromboplastin Antecedent or PTA (Protein)
11. Factor XII: Hageman factor (High), Glass or contact factor
12. Factor XIII: Fibrin stabilizing factor or Fibrinase (Fat)

(FEB me **PROTEIN CA LABLE STABLE** rahta **HAI** kyuki **CHRISTMUS** me **POWER START** ka **PTA HAGMAN** ko **FIR SE** chala gaya)

BLOOD RELATED DISORDER

ANEMIA

Anemia is defined as a low number of red blood cells. In a routine blood test, anemia is reported as a low hemoglobin.

Anemia Symptoms

The signs of anemia can be so mild that you might not even notice them. At a certain point, as your blood cells decrease, symptoms often develop. Depending on the cause of the anemia, symptoms may include:

- Dizziness, lightheadness, or feeling like you are about to pass out
- Fast or unusual heartbeat
- Headache
- Pain, including in your bones, chest, belly, and joints
- Problems with growth, for children and teens
- Shortness of breath

COMMON TYPES OF ANEMIA

IRON-DEFICIENCY ANEMIA

It is the most common type of anemia. It happens when you do not have enough iron in your body. Iron deficiency is usually due to blood loss but may occasionally be due to poor absorption of iron. Pregnancy and childbirth consume a great deal of iron and thus can result in pregnancy-related anemia. People who have had gastric bypass surgery for weight loss or other reasons may also be iron deficient due to poor absorption.

SYMPTOMS

Skin and Mucosal Changes

- Pale skin and pale conjunctiva
- Dry skin
- Brittle or spoon-shaped nails (koilonychia)
- Hair loss

Oral and Gastrointestinal Symptoms

- Sore tongue (glossitis)
- Cracks at the corners of the mouth (angular stomatitis)
- Difficulty in swallowing (Plummer–Vinson syndrome, in severe cases)

Other Symptoms

- Cold hands and feet
- Poor concentration
- Pica (craving for non-food items like clay, ice, or chalk)

TREATMENT

A) Iron Supplementation

Oral Iron Therapy (First Choice)

- Ferrous sulfate
- Ferrous fumarate
- Ferrous gluconate

Dose:

- 100–200 mg elemental iron per day

B) Dietary Management

Increase intake of iron-rich foods:

- Green leafy vegetables
- Pulses and legumes
- Jaggery
- Dates and raisins
- Red meat, liver, eggs

 Vitamin C *enhances iron absorption (citrus fruits, lemon juice)*

Vitamin-deficiency anemia/ Pernicious anemia

It may result from low levels of vitamin B12 or folate (folic acid), usually due to poor dietary intake. Pernicious anemia is a condition in which vitamin B12 cannot be absorbed in the gastrointestinal tract.

Causes

Vitamin B_{12} Deficiency

- Poor dietary intake (strict vegetarian diet)
- Malabsorption disorders
- Pernicious anemia (lack of intrinsic factor)

- Post-gastrectomy
- Chronic alcoholism

Folic Acid Deficiency

- Inadequate diet
- Malnutrition
- Pregnancy
- Chronic alcoholism
- Certain drugs (methotrexate, phenytoin)

General Symptoms

- Fatigue and weakness
- Pallor
- Shortness of breath
- Palpitations

Laboratory Findings

- Low hemoglobin level
- Increased Mean Corpuscular Volume (MCV) → **macrocytic anemia**
- Megaloblastic red blood cells on peripheral smear
- Low serum Vitamin B_{12} or folate levels

Treatment

Vitamin B_{12} Deficiency

- Intramuscular Vitamin B_{12} (cyanocobalamin or hydroxocobalamin)
- Lifelong treatment may be required in pernicious anemia

Folic Acid Deficiency

- Oral folic acid (1–5 mg daily)

Dietary Sources: spinaches

APLASTIC ANEMIA

It is a rare bone marrow failure disorder in which the bone marrow stops making enough blood cells (red blood cells, white blood cells, and platelets).

This occurs as a result of destruction or deficiency of blood-forming stem cells in your bone marrow, in particular when the body's own immune system attacks the stem cells.

However, the few blood cells the marrow does make are normal. Viral infections, ionizing radiation, and exposure to toxic chemicals or drugs can also result in aplastic anemia.

SYMPTOMS

- Fatigue and weakness
- Pallor
- Shortness of breath
- Recurrent infections
- Fever
- Easy bruising

- Petechiae
- Nosebleeds
- Gum bleeding

Treatment

1. Remove the Causative Agent

- Stop exposure to drugs or toxins

2. Supportive Treatment

- Blood transfusions
- Platelet transfusions
- Antibiotics for infections

3. Immunosuppressive Therapy

- Antithymocyte globulin (ATG)
- Cyclosporine
- Corticosteroids

4. Bone Marrow (Stem Cell) Transplant

- Treatment of choice in young patients with severe aplastic anemia and matched donor

Hemolytic anemia

It occurs when red blood cells are broken up in the bloodstream or in the spleen. Hemolytic anemia may be due to mechanical causes (leaky heart valves or aneurysms), infections, autoimmune disorders, or congenital abnormalities in the red blood cell. Inherited abnormalities may affect the hemoglobin or the red blood cell structure or function.

Sickle cell anemia

It is an inherited hemolytic anemia in which the hemoglobin protein is abnormal, causing the red blood cells to be rigid and clog the circulation because they are unable to flow through small blood vessels.

Anemia caused by other diseases - Some diseases can affect the body's ability to make red blood cells. For example, some patients with kidney disease develop anemia because the kidneys are not making enough of the hormone erythropoietin to signal the bone marrow to make new or more red blood cells.

Chemotherapy used to treat various cancers often impairs the body's ability to make new red blood cells, and anemia often results from this treatment.

BLOOD GROUP AND Rh FACTOR

Blood grouping is the classification of blood based on the presence or absence of specific antigens on the surface of red blood cells (RBCs).

a) These antigens are inherited genetically and play a crucial role in blood transfusion, organ transplantation, pregnancy, and forensic medicine.
b) Blood group (ABO) and Rh factor (+/-) are inherited proteins on red blood cells that determine your full blood type (like A+, O-, AB+)
c) Karl Landsteiner, an Austrian scientist made a note of the agglutination and divided the blood types into 4 different groups.

TYPES OF BLOOD GROUP

There are 4 types of blood group – A, B, AB, and O and is mainly based on the antigens and antibodies on red blood cells and in the plasma. Both antigens and antibodies are protein molecules in which antigens are present on the surface of Red Blood Cells and antibodies are present in the plasma which is involved in defending mechanisms.

1. ABO blood Group system

The basis of ABO grouping is of two antigens- Antigen A and Antigen B. The ABO grouping system is classified into four types based on the presence or absence of antigens on the red blood cells surface and plasma antibodies.

Group A – contains antigen A and antibody **b**. he can receive blood from A and O and can donate blood to A and AB.

Group B –contains antigen B and antibody **a**.

- Can receive blood from **B and O**
- Can donate blood to **B and AB**

Group AB –contains both A and B antigen and no antibodies (neither **a** nor **b**).

- It is known as **universal recipient**
- It can receive blood from **A, B, AB, and O**
- It can donate blood only to **AB**

Group O – contains neither A nor B antigen and both antibodies a and b.

a) Known as **universal donor**
b) Can donate blood to **A, B, AB, and O**
c) Can receive blood only from **O**

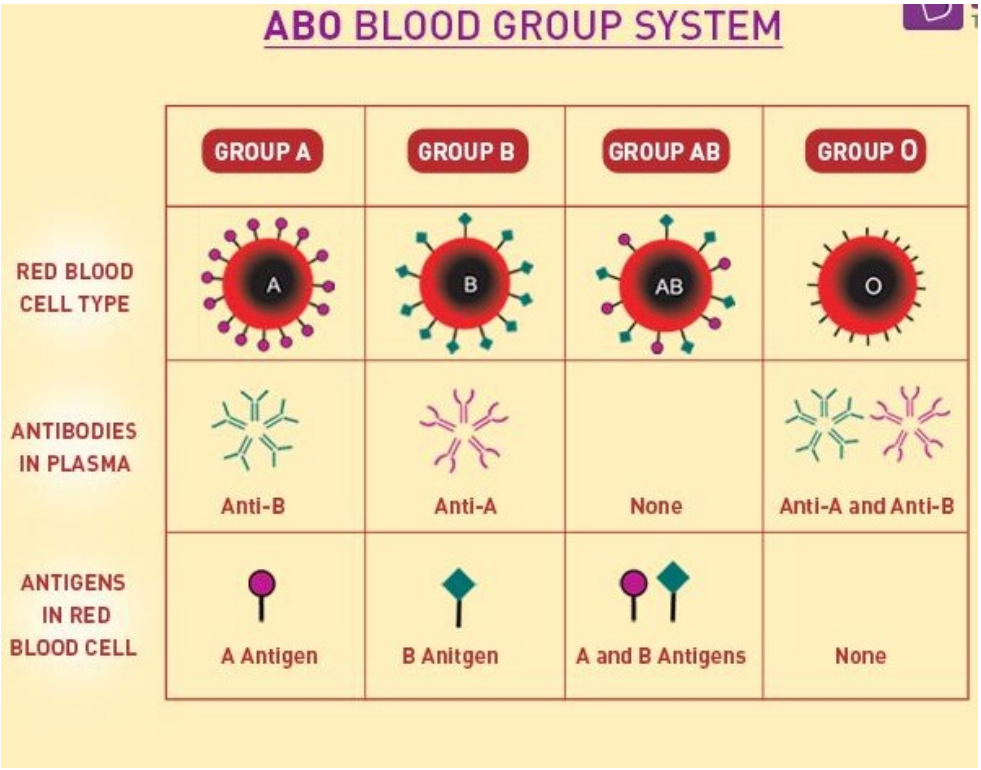
IMPORTANCE OF ABO SYSTEM

The ABO group system is important during blood donation or blood transfusion as mismatching of blood group can lead to clumping of red blood cells with various disorders.

It is important for the blood cells to match while transfusing i.e. donor-recipient compatibility is necessary.

Used in organ transplantation.

For example, a person of blood group A can receive blood either from group A or O as there are no antibodies for A and O in blood group A.



2. Rh Blood Group System

The Rh factor was discovered in **1940 by Landsteiner and Wiener** while experimenting with rhesus monkeys.

In addition to the ABO blood grouping system, the other prominent one is the Rh blood group system. About two-thirds of the population contains the third antigen on the surface of their red blood cells known as ***Rh factor*** or ***Rh antigen***; this decides whether the blood group is positive or negative.

If the Rh factor is present, an individual is ***rhesus positive*** (Rh+ve); if an Rh factor is absent individual is ***rhesus negative*** (Rh-ve) as they produce Rh antibodies.

Therefore, compatibility between donor and individual is crucial in this case as well.

Rh Antibodies

Rh antibodies (anti-D) are **not naturally present**

It is formed only after **exposure** to Rh-positive blood through Blood transfusion or in Pregnancy

Rh Incompatibility

- Rh-negative person receiving Rh-positive blood develops **anti-D antibodies**
- Subsequent exposure causes **hemolysis**

Rh Incompatibility in Pregnancy

This occurs in Rh-negative mother and Rh-positive fetus. During delivery, fetal RBCs enter maternal circulation → mother produces anti-D antibodies.

In subsequent pregnancies the Anti-D antibodies cross placenta and destroy fetal RBCs.

Hemolytic Disease of the Newborn (HDN)

Effects

- Severe anemia
- Jaundice
- Hepatosplenomegaly
- Hydrops fetalis
- Stillbirth in severe cases

Prevention of Rh Incompatibility

Anti-D Immunoglobulin

Given to Rh-negative mother within 72 hours after delivery or after abortion or miscarriage which help to prevents formation of maternal antibodies.

RETICULOENDOTHELIAL SYSTEM

The reticuloendothelial system (RES) is a heterogeneous population of phagocytic cells in systemically fixed tissues that play an important role in the clearance of particles and soluble substances in the circulation and tissues, and forms part of the immune system. Substances that are cleared include immune complexes, bacteria, toxins, and exogenous antigens.

The RES: Consists of the phagocytic cells located in reticular connective tissue, primarily monocytes and macrophages. Since phagocytosis is their primary role, mononuclear phagocytic system has been suggested as an alternative name.

COMPOSITION

The composition of the reticuloendothelial system includes

1. Kupffer cells of the liver
2. Microglia of the brain
3. Alveolar macrophages
4. Bone marrow
5. Lymph nodes
6. Macrophages in the intestine and other tissues

Regulation of the Reticular Endothelial System

The reticuloendothelial system is also under the leading role of the nervous system and is regulated by chemicals in the body fluids. The state of the cerebral cortex has a great influence on the activity of macrophages in the reticular endothelium.

The more the cortex is excited, the more activity in the reticuloendothelial system is inhibited. eg when a person's painful cerebral cortex is in an excited state, the function of the reticuloendothelial system is inhibited.

If the cerebral cortex is in a state of inhibition, such as during sleep or anesthesia, activity on phagocytic cells is enhanced.

The chemical regulation of endocrine and vitamins also has a certain effect on the function of the reticuloendothelial system. eg. Experiments have shown that in the absence of vitamin C or injection of adrenaline, the phagocytic activity of the reticuloendothelial system becomes sluggish, the phagocytic capacity is also weakened, and the production of collagen fibers is also poor.