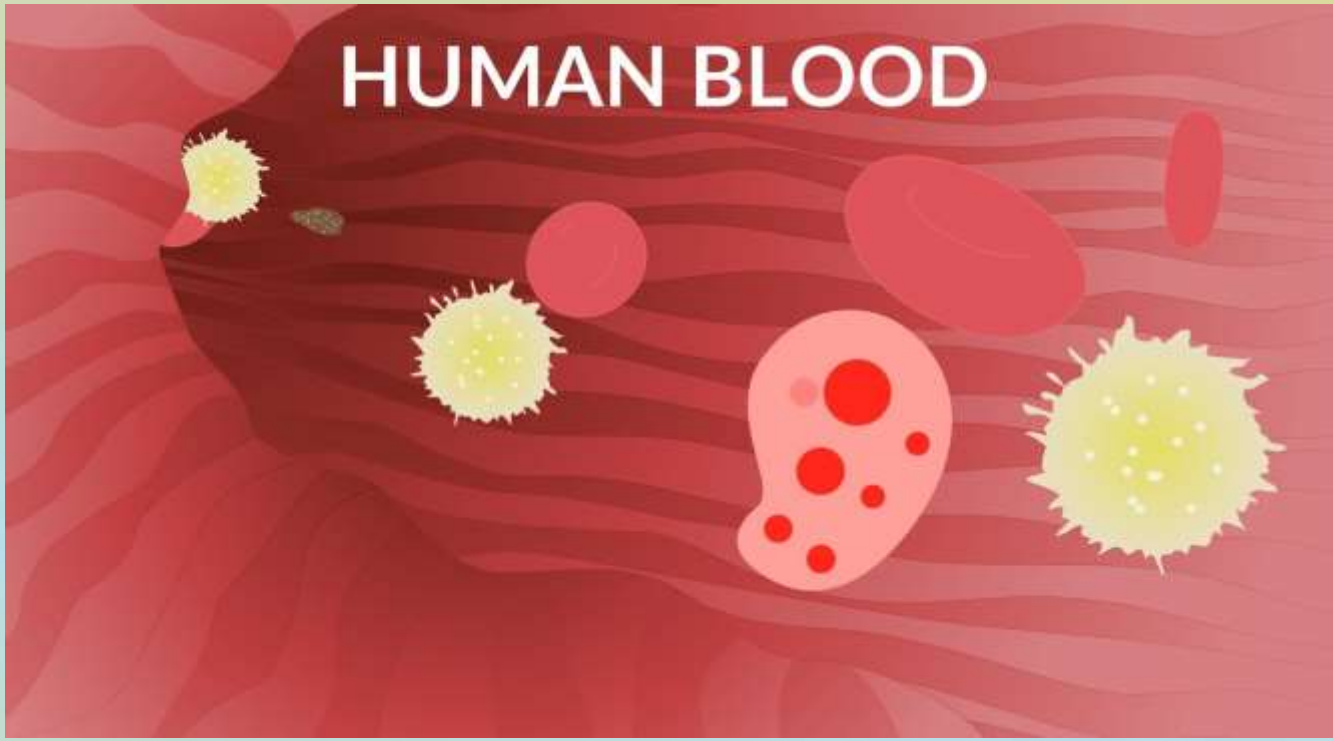
Blood



Mr. Ashley Fernandis.
Clinical Instructor
MES College of Nursing, Ghanekhunt-Lote.

Blood

Blood is one of the most important components of life.

Blood is a fluid connective tissue that consists of plasma, blood cells and platelets. It circulates throughout our body delivering oxygen and nutrients to various cells and tissues.

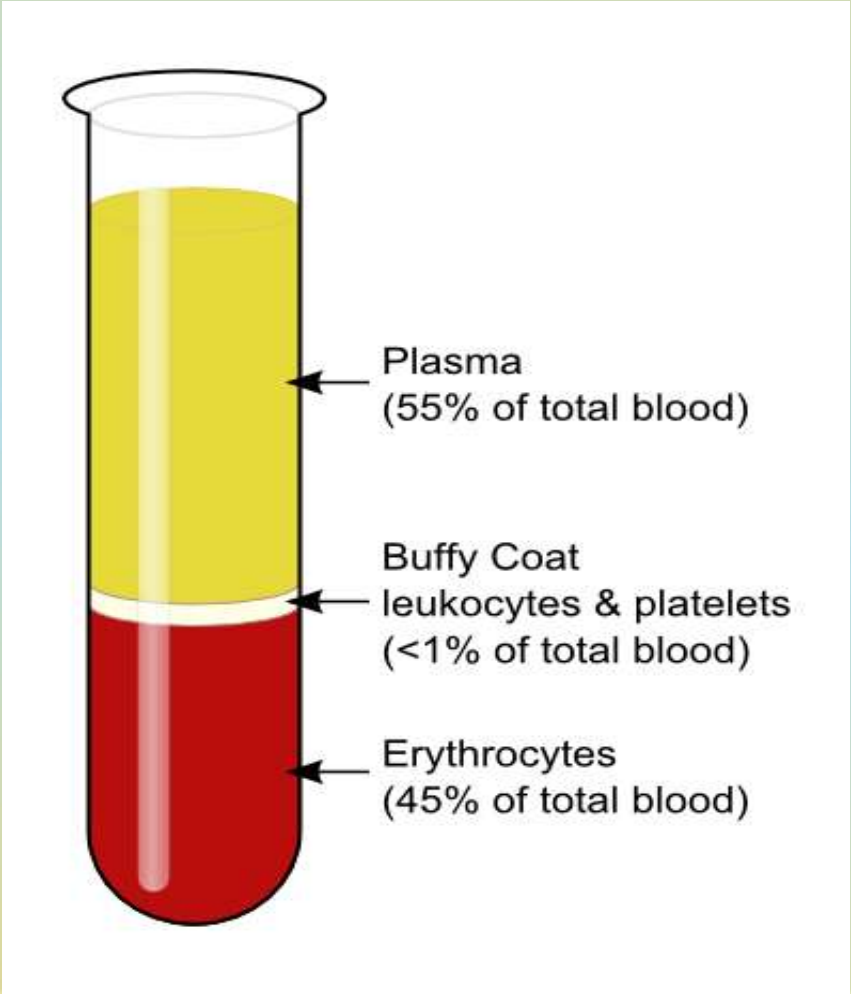
It makes up 8% of our body weight. An average adult possesses around 5-6 liters of blood.

It circulates constantly around the body, propelled by the pumping action of the heart. It transports:

- oxygen
- nutrients
- hormones
- heat
- antibodies and cells of the immune system
- clotting factors
- wastes.

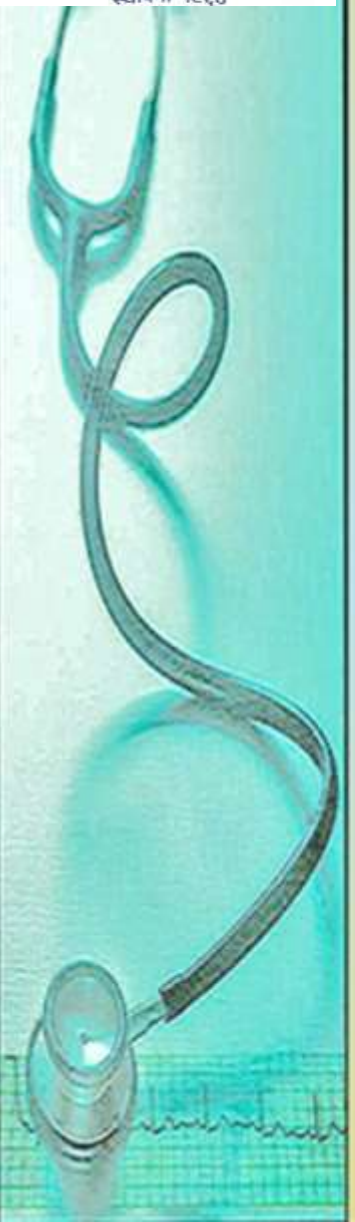
Components Of Blood

There are many cellular structures in the composition of blood. When a sample of blood is spun in a centrifuge machine, they separate into the following constituents: Plasma, buffy coat and erythrocytes.



Blood plasma makes up approximately 55% of whole blood and is itself made up of the following components:

- Water
- Electrolytes or ions such as sodium, potassium, magnesium, calcium
- Plasma proteins such as albumin, fibrinogen and globulins
- Nutrients
- Waste products
- Respiratory gases
- Hormones



The other 45% of whole blood is made up of formed elements or cells. There are three types of blood cells in the human body.

Names and functions of blood cells.

Blood cell	**Function**
Erythrocytes (RBC)	Transport respiratory gases
Leukocytes (WBC)	Immune defense
Thrombocytes (Platelets)	Blood clotting

Physical Characteristics of Whole Blood

pH: 7.35-7.45 (slightly alkaline)

Viscosity: about 5 times as viscous as water

Temperature: about 38 degrees Celsius

Volume: approximately 8% of body weight (i.e. approximately 5 liters of blood in an average sized 60 kg person)

Functions of Blood

1. Blood Is Fluid Connective Tissue

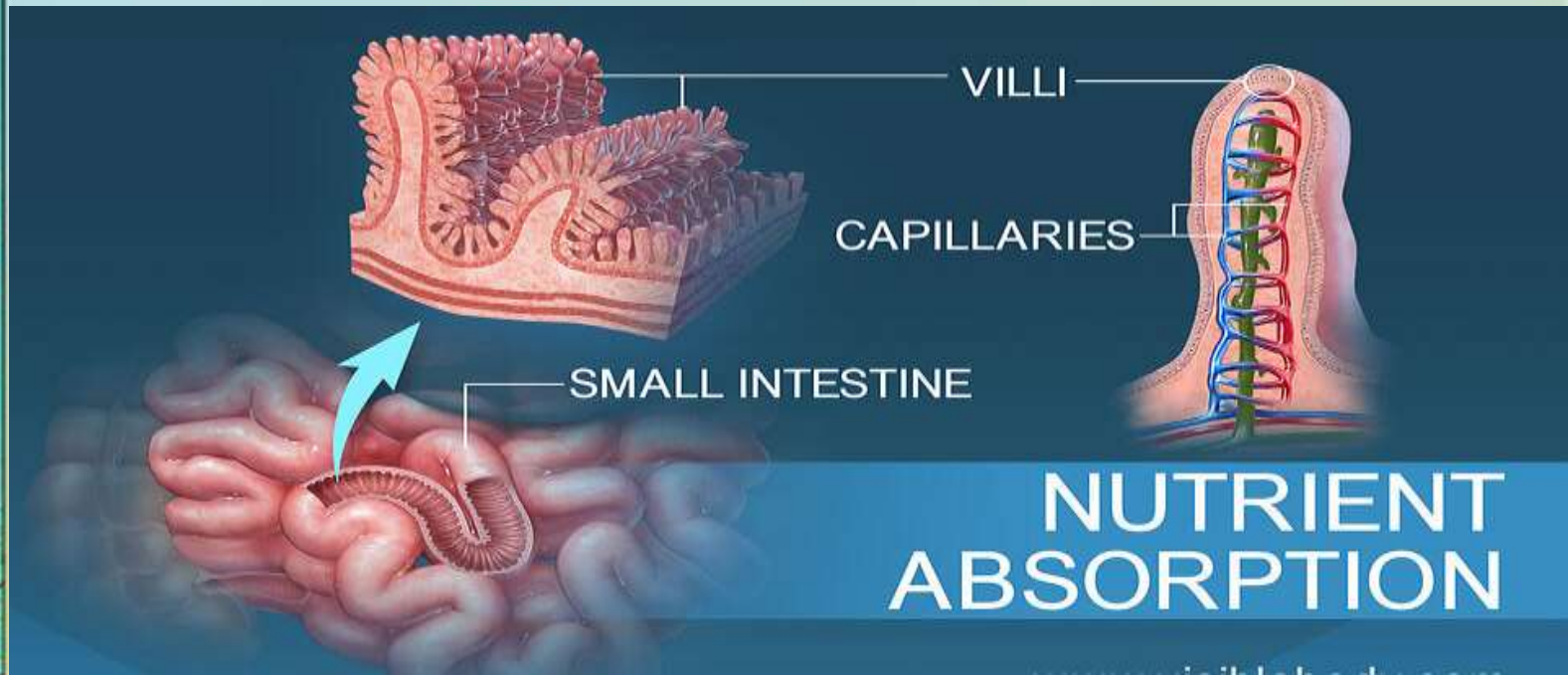
Blood is composed of 55% plasma and 45% “formed elements,” including red blood cells, white blood cells, and platelets.

2. Blood Provides the Body's Cells with Oxygen and Removes Carbon Dioxide

Blood absorbs oxygen from air in the lungs. It transports the oxygen to cells throughout the body, and it removes waste carbon dioxide from the cells. In the lungs, the carbon dioxide moves from the blood to the air and is exhaled.

3. Blood Transports Nutrients and Hormones

Blood plays a large role in digestion and endocrine system functions. Digested nutrients are absorbed into the bloodstream through capillaries in the villi that line the small intestine.



4. Blood Regulates Body Temperature

Blood absorbs and distributes heat throughout the body. It helps to maintain homeostasis through the release or conservation of warmth.

5. Platelets Clot Blood at Sites of Injury

When a blood vessel tears, platelets and plasma proteins work together to stop blood loss. Platelets, also called **thrombocytes**, clump and form a plug in the damaged area.

6. Blood Brings Waste Products to the Kidneys and Liver

Blood flows into the kidneys through the renal arteries and out through the renal veins.

7. Red Blood Cells Are the Most Numerous Living Cells in Blood

Blood is 55% plasma and 45% formed elements. Red blood cells, also called **erythrocytes,** make up most of that 45%.

8. White Blood Cells Protect the Body from Pathogens

White blood cells, also called **leukocytes**, are the disease-fighting components of blood.

Formation of blood cells

All of the cells found in the blood come from bone marrow.

Within the bone marrow, all blood cells originate from a single type of unspecialized cell called a **stem cell.** When a stem cell divides, it first becomes an **immature red blood cell, white blood cell, or platelet-producing cell.**

- The rate of blood cell production is controlled by the body's needs.
- Normal blood cells last for a limited time (ranging from a few hours to a few days for white blood cells, to about 7 - 10 days for platelets, to about 120 days for red blood cells) and must be replaced constantly.
- Certain conditions may trigger additional production of blood cells.
- When the oxygen content of body tissues is low or the number of red blood cells decreases, the kidneys produce and release erythropoietin, a hormone that stimulates the bone marrow to produce more red blood cells.
- The bone marrow produces and releases more white blood cells in response to infections. It produces and releases more platelets in response to bleeding.

Erythropoiesis:

Erythropoiesis is the process of formation of the matured RBCs from the stem cells.

The site for erythropoiesis is the spleen and the liver in the foetus while it is the bone marrow in the adults.

Red blood cells

(Erythrocytes)

RBCs are biconcave cells without nucleus in humans; also known as erythrocytes. RBCs contain the iron-rich protein called haemoglobin; give blood its red colour.

- Roughly 0.5 billion RBC contain in the single blood drop.
- For each 600 RBC, there are about 40 platelets and one WBC (white blood cell).

Their main function is to transport oxygen from and to various tissues and organs.

It also extracts the carbon-dioxide to be replenished in the lungs from multiple organs and tissues.

Leucocytes

Leucocytes are white blood cells or WBCs. They take part in immune responses.

The important characteristics

- They are colourless.
- They are produced in the bone marrow from stem cells.
- They do not contain haemoglobin.
- They are less in number compared to red blood cells.
- They play a vital role in fighting against infection.
- **Leukopenia** is a condition wherein the WBC count is low. In **leukocytosis**, WBC count increases.
- **Leukaemia** is a type of blood cancer, wherein WBCs multiply rapidly within the bone marrow.

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.

1) **Granulocytes** - producing an immune response, which is non-specific to a particular pathogen. They are leukocytes, with the presence of granules in their cytoplasm.

i) Eosinophils

- They are the cells of leukocytes, which are present in the immune system.
- These cells are responsible for combating infections in parasites of vertebrates and for controlling mechanisms associated with allergy and asthma.

ii) Basophils

- They are the least common of the granulocytes, ranging from 0.5 to 1 per cent of WBCs.
- They contain large cytoplasmic granules, which play a vital role in mounting a non-specific immune response to pathogens.

iii) Neutrophils

- Neutrophils are the most abundant type of WBCs.
- They are phagocytic (**surrounds and destroys foreign substances, such as bacteria and removes dead cells**.) in nature.
- They engulf pathogens and destroy them.

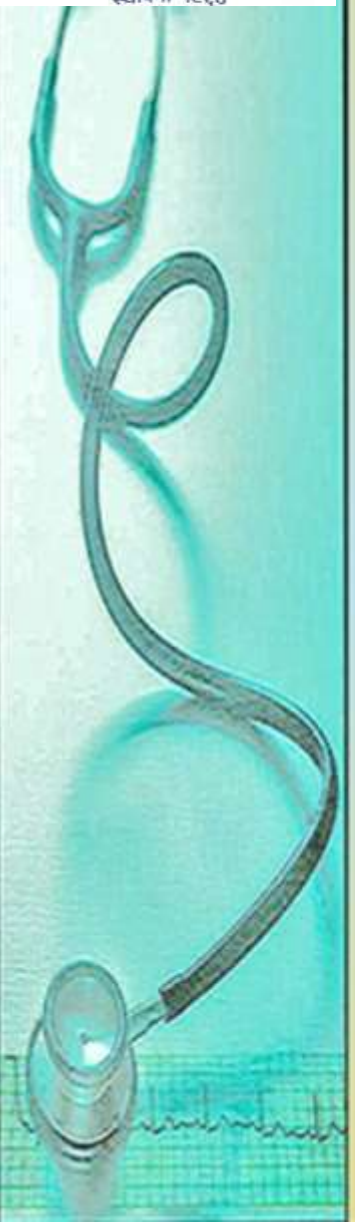
2) Agranulocytes - They are leukocytes, with the absence or lack granules in their cytoplasm.

i) Lymphocytes

- They play a vital role in producing antibodies.
- They are commonly known as natural killer cells.
- They play an important role in body defence.
- These white blood cells are colourless cells formed in lymphoid tissue, hence referred to as lymphocytes.
- These cells are very important in the immune systems.

ii) Monocytes

- They are the largest WBCs.
- They provide the first line of defence against infection.
- They act as a scavenger and remove dead cells and damaged components of the blood.



Platelets (Thrombocytes)

- Thrombocytes are specialized blood cells produced from bone marrow.
- Platelets come into play when there is bleeding or haemorrhage.
- They help in clotting and coagulation of blood.
- Platelets help in coagulation during a cut or wound.

Clotting mechanism of blood

Blood Coagulation

Blood coagulation or clotting is an important phenomenon to prevent excess loss of blood in case of injury or trauma.

The expected range for clotting time is **4-10 mins**.

The normal clotting time in a person is between **8-15 minutes.**

Hemostasis

"Hemostasis is a physiological defensive reaction to an injury or a cut that seals the blood vessels and thus helps in healing."

1. Vasoconstriction

When platelets come into contact with a damaged blood vessel, their surface becomes sticky and they adhere to the damaged wall.

2. Platelet plug formation

The sticky platelets clump together and release other substances, including adenosine diphosphate (ADP), which attract more platelets to the site.

3. Coagulation (blood clotting)

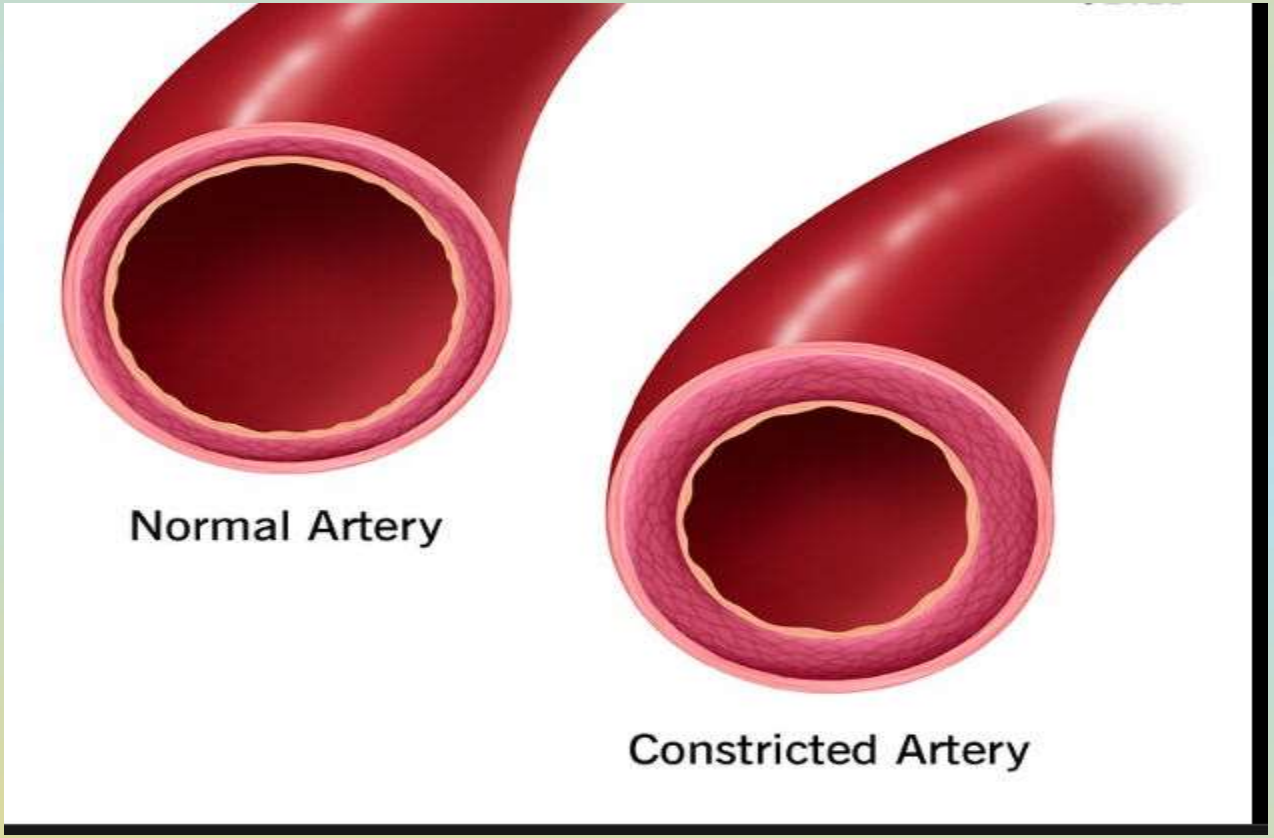
This is a complex process that also involves a positive feedback system and only a few stages are included here.

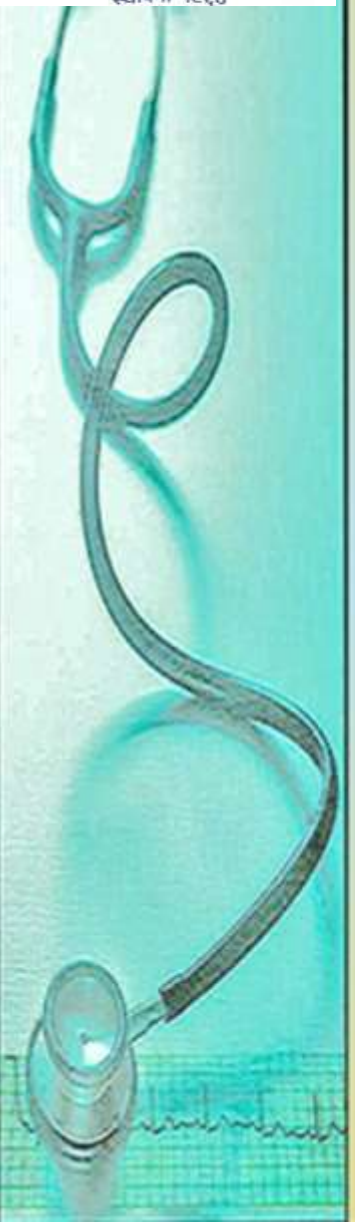
4. Thrombolysis

After the clot has formed, the process of removing it and healing the damaged blood vessel begins. Plasmin breaks down fibrin removing thr clot to allow tissue repair to proceed.

Vasoconstriction

Vasoconstriction is **the narrowing (constriction) of blood vessels by small muscles in their walls**. When blood vessels constrict, blood flow is slowed or blocked. Vasoconstriction may be slight or severe.





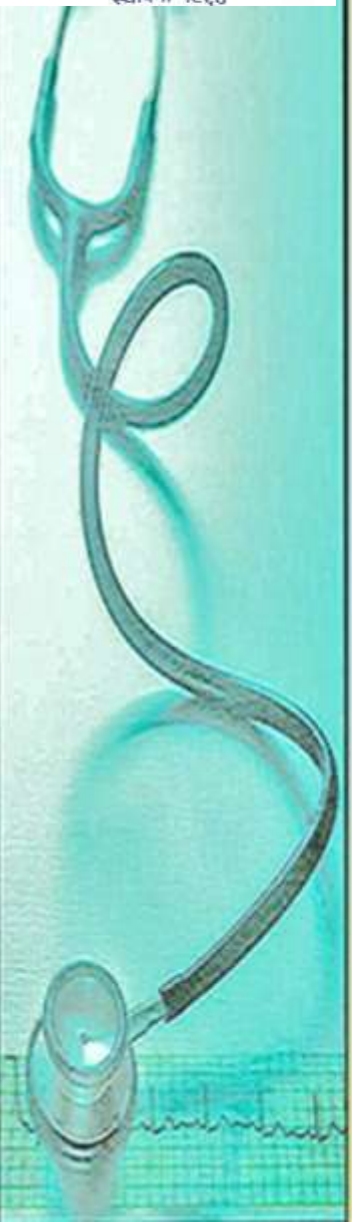
The extrinsic pathway

The extrinsic pathway is activated rapidly (within seconds) following tissue damage and is probably the more important of the two. .

The intrinsic pathway

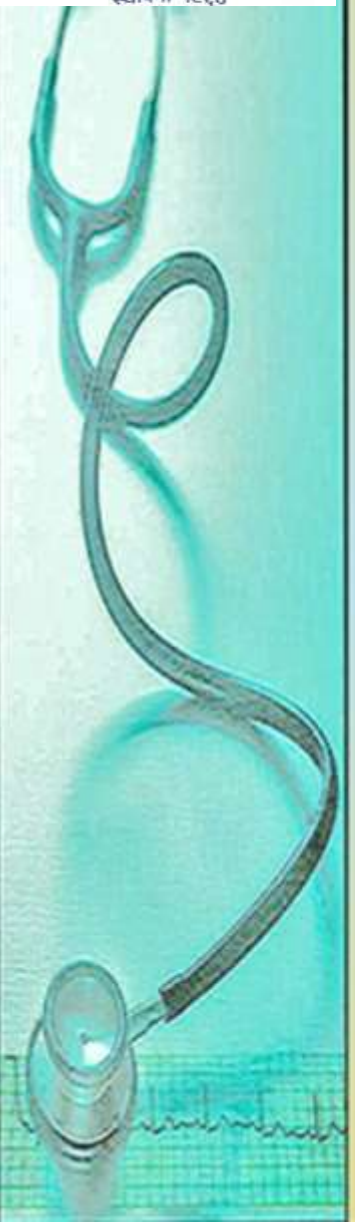
The intrinsic pathway is slower (3-6 minutes) and is triggered when blood comes into contact with damaged blood vessel lining (endothelium).

Coagulation factors are **proteins in the blood that help control bleeding**. You have several different coagulation factors in your blood. When you get a cut or other injury that causes bleeding, your coagulation factors work together to form a blood clot.



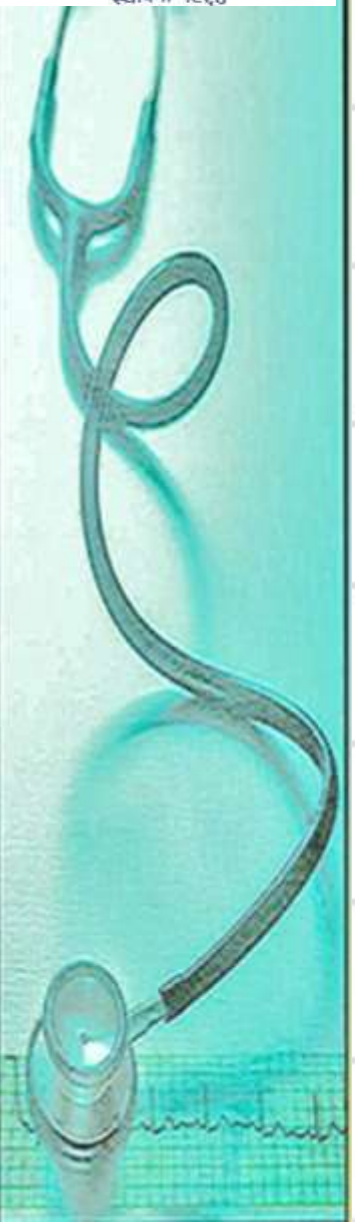
CLOTTING FACTORS

Factor I	Fibrinogen
Factor II	Prothrombin
Factor III	Tissue Thromboplastin
Factor IV	Calcium Ions
Factor V	Labile Factor
Factor VII	Stable Factor
Factor VIII	Antihemophilic Factor
Factor IX	Christmas Factor, or Plasma Thromboplastin Component (PTC)
Factor X	Stuart-Prower Factor
Factor XI	Plasma Thromboplastin Antecedent (PTA)
Factor XII	Hageman Factor
Factor XIII	Fibrin Stabilizing Factor



Karl Landsteiner, an Austrian scientist discovered the ABO blood group system in the year 1900. For this discovery, he was awarded the Nobel Prize.

There are 4 main blood groups (types of blood) – **A, B, AB and O.**



Blood Type	Receive Blood From	Donate Blood To
A+	A+, A-, O+ and O-	A+ and AB+
B+	B+, B-, O+ and O-	B+ and AB+
AB+	All blood types	AB+ only
O+	O+ and O-	O+, A+, B+ and AB+
A-	A- and O-	A+, A-, AB+ and AB-
O-	O- only	All blood types
B-	B- and O-	B+, B-, AB+ and AB-
AB-	AB-, A-, B- and O-	AB+ and AB-

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.

Phagocytic cells – (**A type of immune cell that can surround and kill microorganisms, ingest foreign material, and remove dead cells).**

Composition of the reticuloendothelial system

The composition of the reticuloendothelial system includes **Kupffer cells of the liver, microglia of the brain, alveolar macrophages and bone marrow lymph nodes, and macrophages in the intestine and other tissues**.