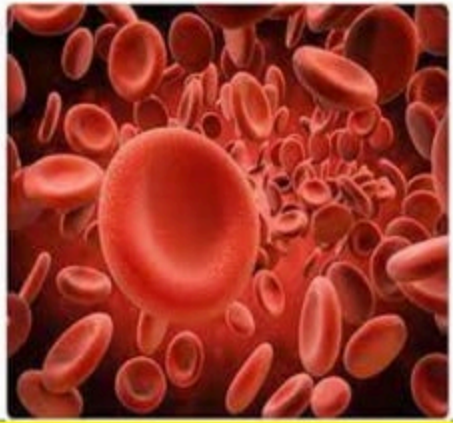
BLOOD

REPRESENTED BY

MD MEHBUB ALAM



CONTENT IN DETAIL

- Definition of blood and haematology
- Functions and properties of blood
- Blood plasma and formed elements
- Haemopoietin
- Red blood cells and erythropoiesis
- White blood cells and platelets
- Mechanism of homeostasis
- Pathway of blood clotting
- Blood groups

INTRODUCTION OF BLOOD

- Blood is a specialized fluid connective tissue which contains of plasma and corpuscles (RBC, WBC and platelets).
- The liquid component of blood is called plasma. It a mixture of water, sugar, fat, protein and salt.
- Blood is the primary transport medium that is responsible for continuously supply oxygen and nutrients to the active cells of the body.

DEFINITION OF BLOOD AND HEMATOLOGY

- **Blood:-**A liquid connective tissue composed of plasma and corpuscles.
- **Haematology:-**The branch of science that deals with the study of **blood, tissue** and **blood disorders.**

PROPERTIES OF BLOOD

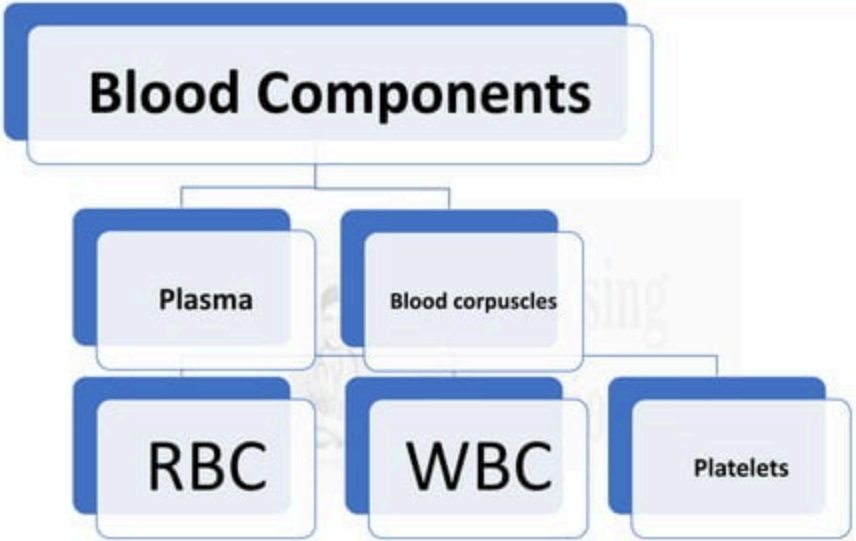
- Colour – Scarlet red
- Volume – 5-6 litres
- Reaction and pH – lightly alkaline and ph-7.4
- Specific gravity – 1.052-1.061
- Viscosity – 5 time more viscous than water.

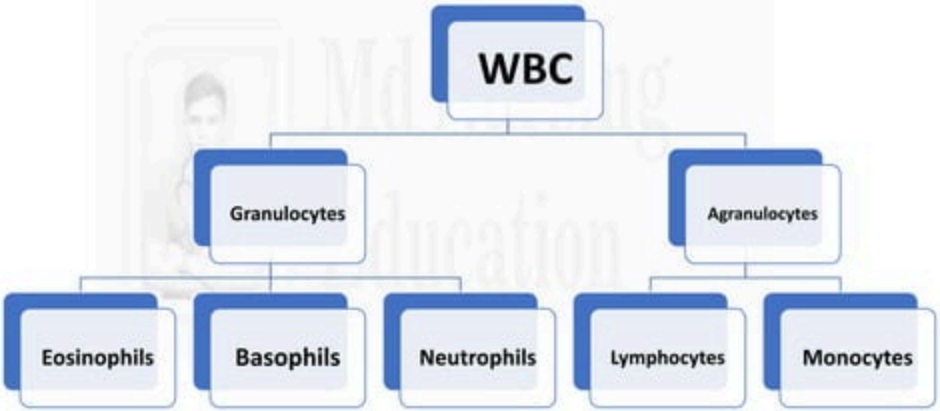
FUNCTIONS OF BLOOD

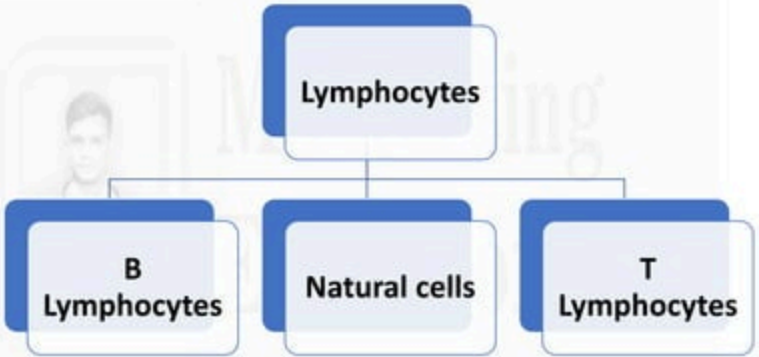
❑Transport medium:-

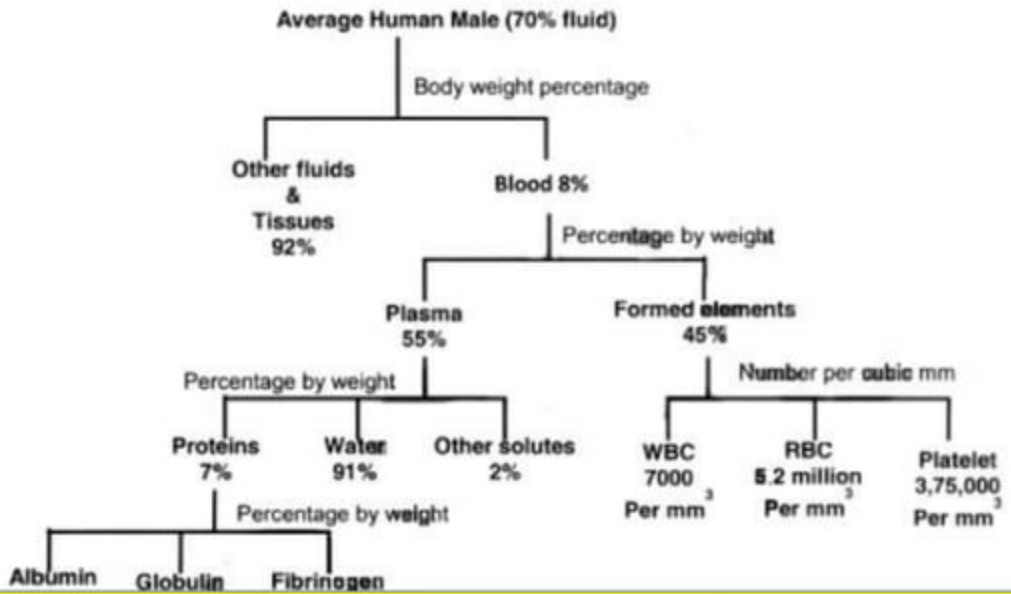
1. Oxygen, nutrients and waste material
2. Hormones to there target tissue
3. Protective antibodies to the site of infection

- Protection against infection
- Regulation of pH
- Maintenance of body temperature
- Clot formation









RED BLOOD CELLS

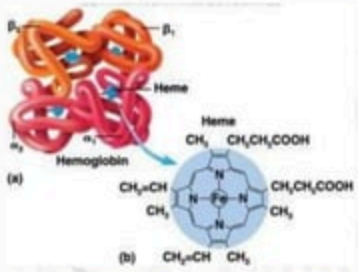
- It is also known as erythrocytes.
- RBC are present in large amount in the blood (41%).
- Vitamins B12 (cobalamin) vitamin B9 (folic acid) both are required for RBC synthesis.
- Formation of RBC is known as erythropoiesis.
- Life span of RBC is 90 – 120 days.
- Death of RBC in Spleen and liver.
- Spleen also known as graveyard of RBC.
- Colour – red.
- Lack of RBC can cause Anaemia (jaundice).

- Biconcave disc shaped
- Male :-5.4 M/mcL (million RBC per microliter)
- Female:-4.8 M/mcL
- Have no nuclei
- Production occurs in the bone marrow

1. Erythropoiesis
2. Controlled by erythropoietin

- Contains Haemoglobin (280M/RBCs)
- ***Functions:-****Transport of oxygen from lungs to tissue and carbon dioxide from tissue to lungs.*

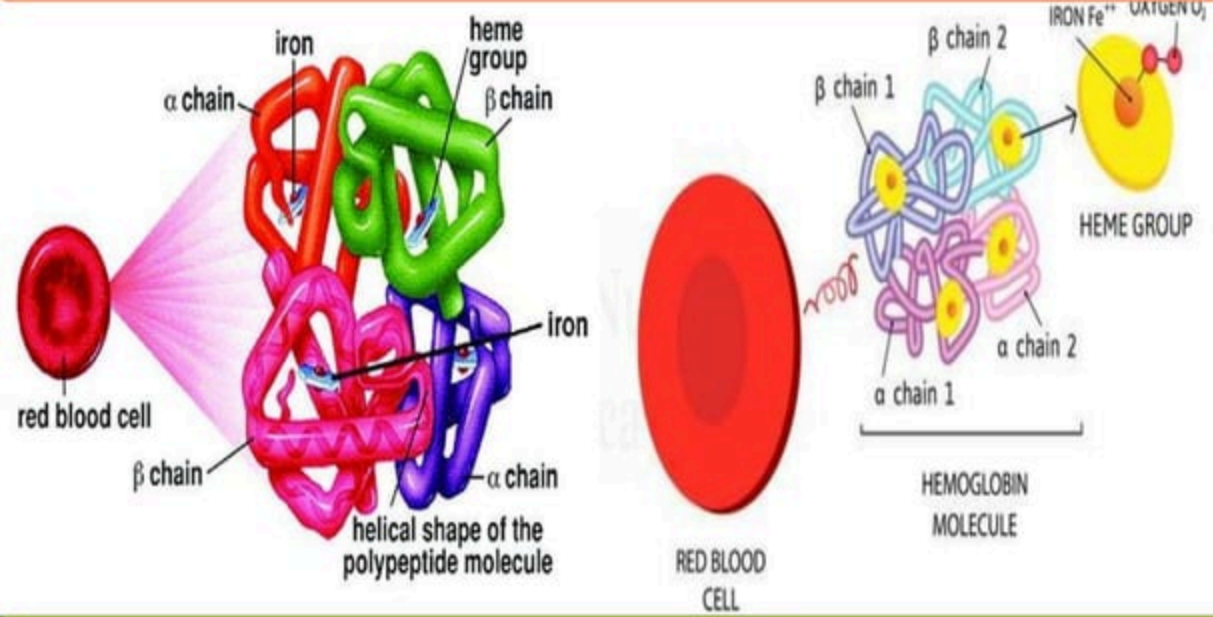
HAEMOGLOBIN

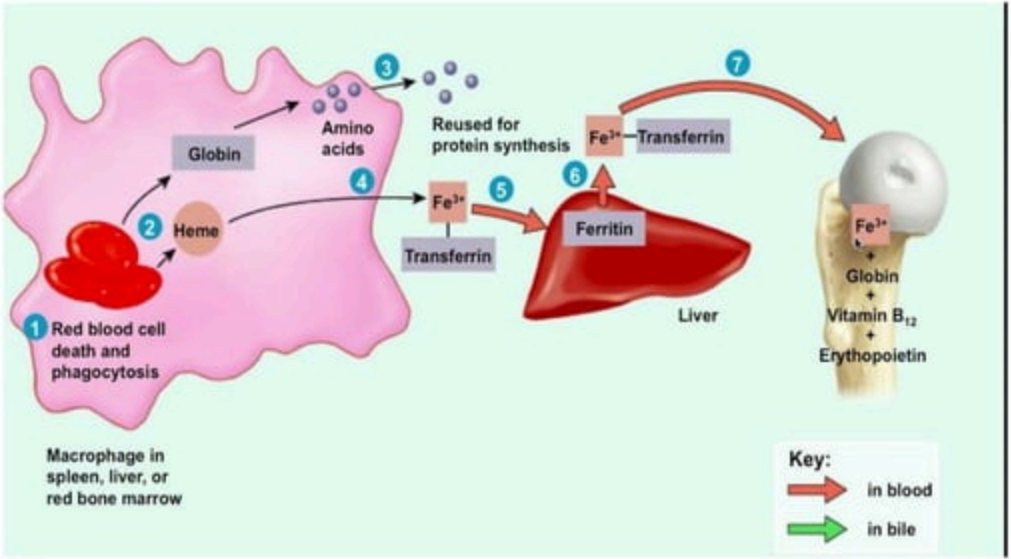


- Consists of:
  - 4 globin molecules:
    colourless protein (96%).
  - 4 heme molecules (4%):
    Transport of oxygen
    iron is required for oxygen transport

Normal values:

- Female :11.6 to 15gm/dl
- Male: 13.2 to 16.6gm/dl
- Infant:-14 to 20 gm/dl





FORMATION AND DESTRUCTION OF RBC

- After 120 days RBC will ruptured or damaged.
- Without a nucleus and other organelles RBCs can't synthesize new components to replace damaged once.
- Ruptured RBCs removed from circulation and destroyed by macrophages in the spleen and liver, and breakdown products are recycled.
- Globin is breakdown into amino acids which can be reused to synthesize other proteins.

FORMATION AND DESTRUCTION OF RBC

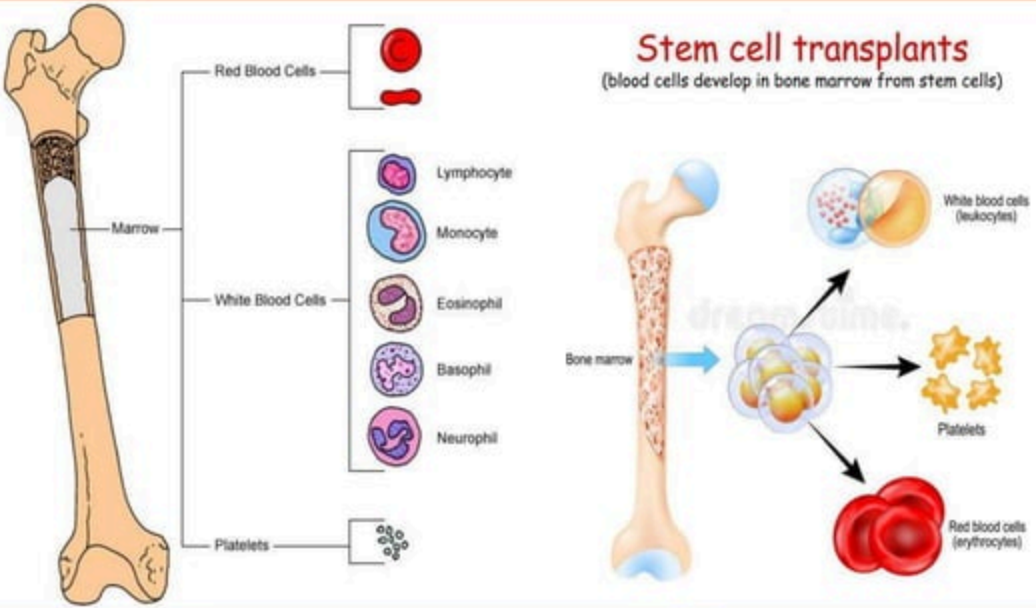
- Iron is removed in the form of Fe3, which associates with the plasma protein transferrin.
- In muscles fibres liver cells and macrophages of the spleen and liver Fe3 detaches from transferrin and attaches to an iron storage protein called ferritin.
- Upon release from a storage site or absorption from the gastrointestinal tract, Fe3 reattaches to transferrin.
- The fe3-transferrin complex is then carried to red bone marrow, where RBC precursor cells use it in Haemoglobin synthesis.
- Erythropoiesis in red bone marrow results in the production of red blood cells, which enter the circulation.

FORMATION AND DISTRIBUTION OF RBCs

- When iron is removed from heme , the non iron protein of heme is converted to biliverdin, a green pigment and then into bilirubin a yellow orange pigment.
- Bilirubin enters the blood and is transported to the liver.
- Within the liver bilirubin is released by liver cells into bile which pass into the small intestine and then into the large intestine.
- In the large intestine

BONE MARROW

- It the cellulovascular tissue occupying the Medullary cavities and the cancellous space of the bone.
- Active bone marrow in the adult is estimated at from 3.5-6% of body weight.
- The volume of bone marrow is 70 ml at birth and 4000 ml in the adult.
- Red bone marrow (active) and yellow bone marrow (inactive).
- In adults red bone marrow is present in the axial skeleton (skull, pelvis, ribs, sternum, vertebrae, and proximal ends of femur and humerus.
- In newborn hematopoiesis is going on out side the bone marrow, i.e., in the liver, spleen and lymph nodes, it is called extra Medullary Hematopoiesis.

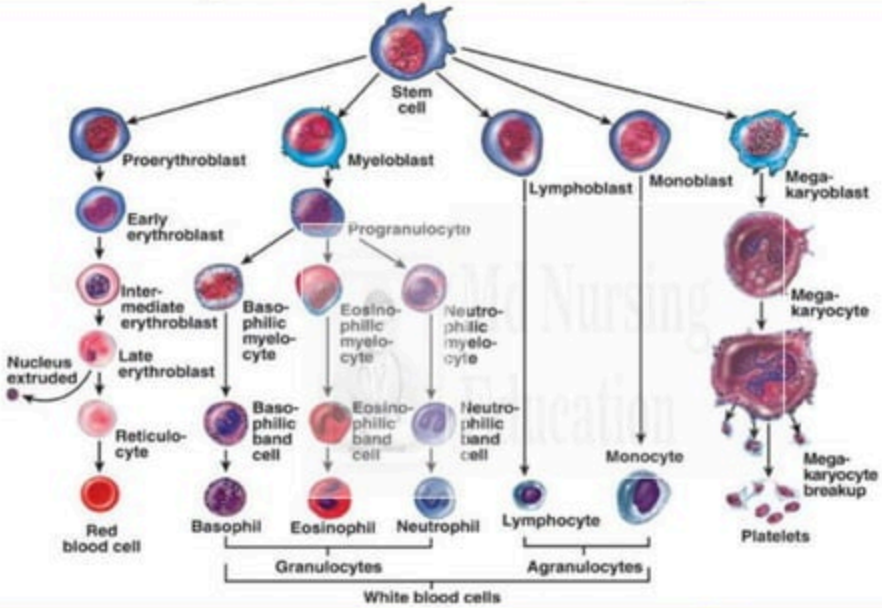


Stem cell transplants

(blood cells develop in bone marrow from stem cells)

HEMATOPOIESIS

- The process of formation of blood cells, i.e. RBC, WBC and platelets is called hematopoiesis and the sites where it occurs are known as hematopoietic tissue or organ (bone marrow, liver and spleen).
- The cells responsible for hematopoiesis are first seen in yolk sac of embryo in third week of embryonic development and these cells are known as hematopoietic stem cells.

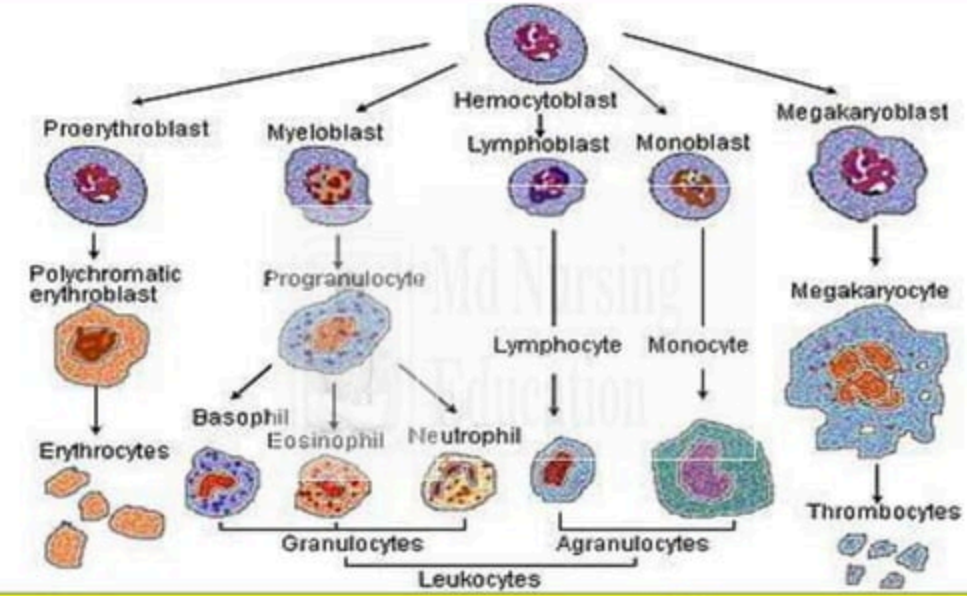


HEMATOPOIESIS

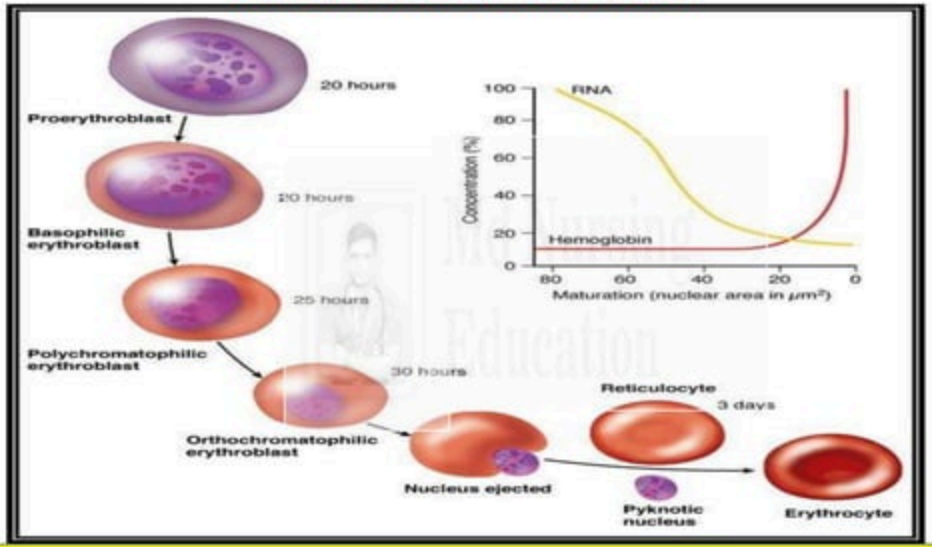
- Hematopoiesis is completed through five process:
  1. Erythropoiesis
  2. Lymphopoiesis
  3. Granulopoiesis
  4. Monopolises
  5. Thrombopoiesis

ERYTHROPOIESIS

- It is a process by which erythrocytes are producing.
- The process is triggered by erythropoietin, which is a kidney hormone and is released during hypoxia.
- Erythroblast present in cytoplasm has a large nucleus with blue cytoplasm and differentiates to become progressively smaller size.



DEVELOPMENT OF RBCs



WHITE BLOOD CELLS

- Range :- 5000 to 10000/mm3 of blood
- Produced by leucopoiesis in red bone marrow, contain nuclei.
- Functions:-

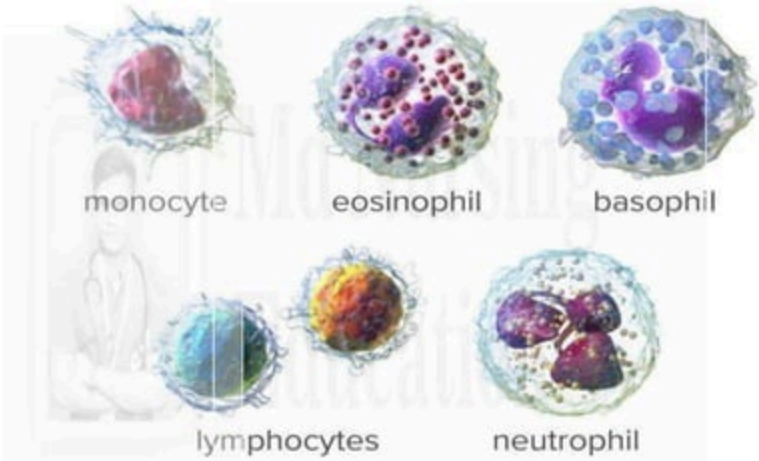
-Defence against pathogens

-Removal of toxins, wastes and damaged cells.

- Types:-

1. Granulocytes :-75% of total WBC
   - -Neutrophils
   - -Eosinophils
   - -Basophils
2. Agranulocytes:- 25% of total WBC
   - -Lymphocytes
   - -Monocytes

White Blood Cells



Leucocytosis and leukopenia

- Leucocytosis:-High white blood cells count is called leucocytosis.
- Low white blood cells count is called as leukopenia.

Neutrophils

- It is 60 to 70% of total WBCs
- Granules do not stain with dyes
- Diameter :-10-12 µm
- Nucleus:- usually 2-4 lobes

Functions:-

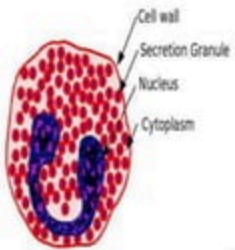
- neutrophils are phagocytic towards bacteria(1neutrophil can phagocytize 5-20 bacteria).

EOSINOPHILS

- 2-4% of total WBCs
- Granules stained by red acidic dyes
- Diameter 10-12 µm
- Nucleus:-usually 2 lobes

Functions:-

- Involved in allergic reactions and parasitic infections.
- They destroyed the antigen-antibody complexes and restrict the process of inflation.



Eosinophil

BASOPHILS

- 0.5 – 1% of total WBC's
- Granules stained with basic purple blue colour
- Diameter: 8-10µm
- Nucleus: irregular and usually 2 lobes
- Granules contain heparin and histamine

Functions:-

- At the site of infection basophils convert into mast cells
- Basophils and mast cells release histamine, bradykinin and serotonin.

LYMPHOCYTES

- 20-25% of total WBCs.
- Depending upon the site of production and their actions, divided into T,B cells and natural killer cells.
- Nucleus :-Will be round shaped
- Functions:-play important role in immunity.

MONOCYTES

- 3-8% of total WBCs
- Diameter 12-20 µm
- Monocytes are converted into macrophages of the tissues.
- Functions:-phagocytosis

THROMBOCYTES

- Range 250,000-500,000/mm3 of blood
- No nuclei
- Diameter :-2-4 µm
- Life span:-10-12 days
- Functions:-involved in blood clotting

BLOOD GROUP

BLOOD GROUP

- It is determined by the presence of:-
- Antigens (Agglutinogen) present on the surface of RBCs.
- Antibodies (Agglutinins) presence of blood plasma.
- Antibody can bind to RBC antigens, resulting in agglutination (clumping) or haemolysis of RBCs.
- 2 types of blood groups:

  -ABO and Rh factor

ABO BLOOD GROUPING SYSTEM

- Landsteiner (1900)
- According to ABO blood grouping system :-

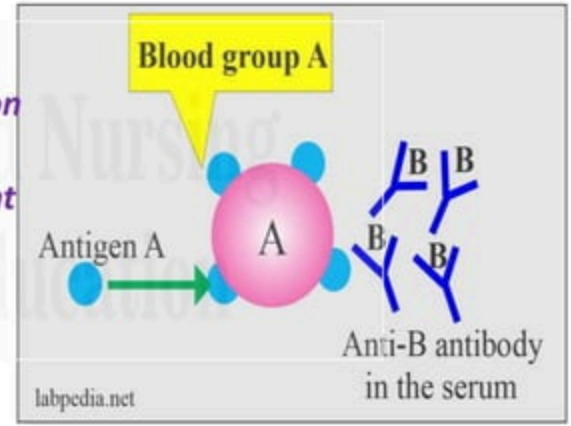
  4 types of blood groups:

1. Blood group –A
2. Blood group –B
3. Blood group –AB
4. Blood group -O

ABO BLOOD GROUP

Blood group -A

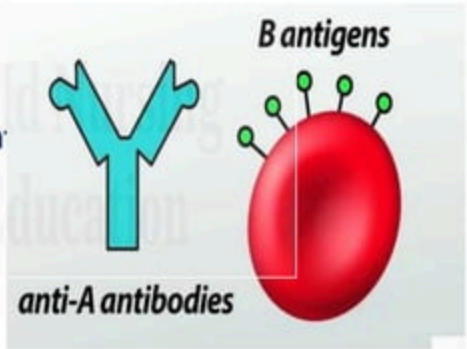
- *A antigen will present on the surface of RBCs.*
- *B antibodies will present in the plasm.*



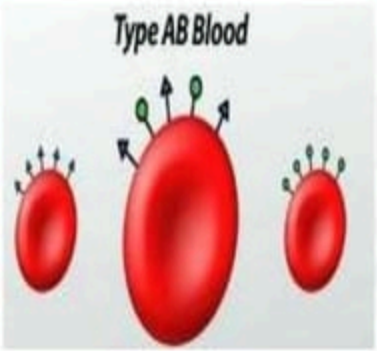
ABO BLOOD GROUP

Blood group -B

- B antigens will be on the surface of the RBCs.
- A antibodies will be present in the plasma.



ABO BLOOD GROUP



Blood group AB:-

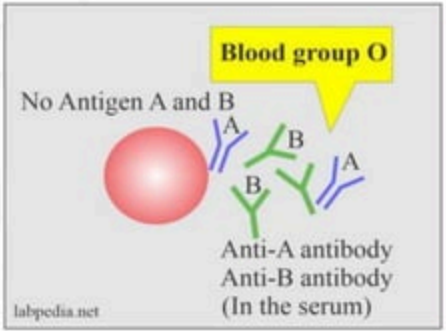
- A and B antigens on the surface of RBCs no AB antibodies are present in plasma.

- Blood group O:-
- Neither A or B antigens on surface of RBCs.
- Both A and B antibodies are present in plasma.

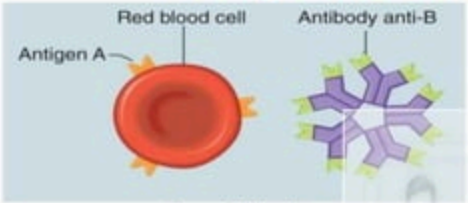
ABO BLOOD GROUP

Blood group-O

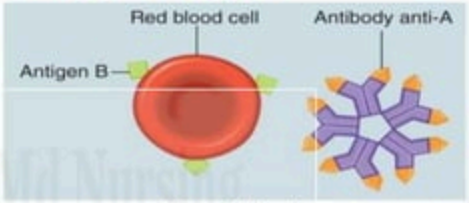
- A and B antigens will be absent on the surface of RBCs.
- Antibody A and B will be present in the plasma.



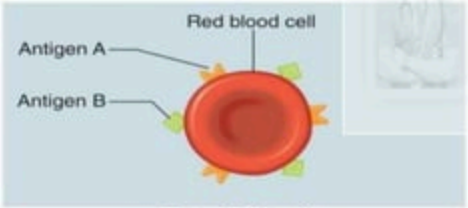
Antigens and antibodies of ABO types



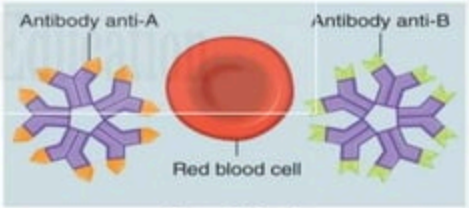
Type A blood



Type B blood

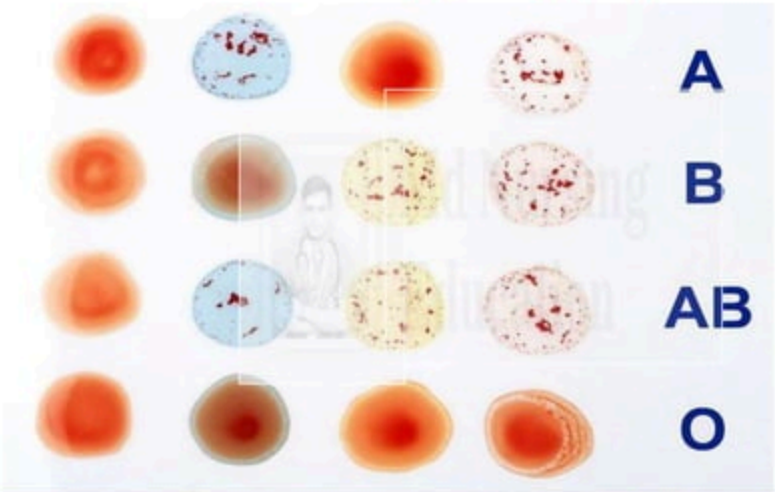


Type AB blood



Type O blood

Determination of blood group



- Blood group 'O' is called "Universal donar" because it has no antigens on RBCs.

- Blood group AB is called "universal receivers" because it has no anti-bodies in plasma.

Rh Blood group

- First studied in Rhesus monkeys.
- Types:-

  -Rh positive: Antigens on the surface of RBCs.

  -Rh negative: Antigens are absent on the surface of RBCs.

- *Hemolytic disease of newborn (HDN)*

  -Mother produces anti-Rh antibodies that cross placenta and cause agglutination and haemolysis of fetal RBCs.

Rh Blood Group

- person with Rh- Blood develops Rh antibodies in the blood if receives blood from Rh+ person.
- There is development of Rh-antibodies, that react with donor's Rh Antigens and agglutinate the blood.
- A person with Rh+ blood can receive blood from a person with Rh blood about any problems.

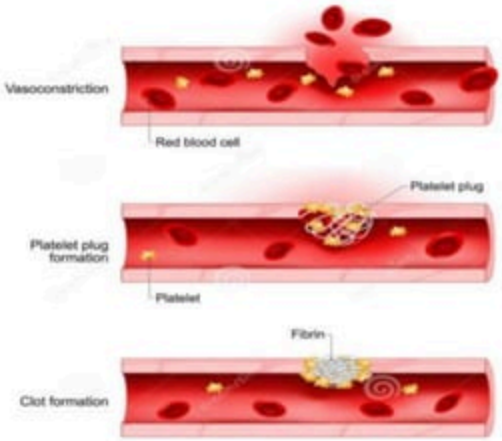
Haemostasis- Stoppage of bleeding

- **When the blood vessels get damaged, platelets plays a vital role in Haemostasis.**
- **3 mechanisms are involved in Haemostasis:**

1. Vascular spasm
2. Blood clotting
3. Platelet plug formation

HEMOSTASIS

- Blood vessels injury
- Vasoconstriction
- Platelet plug formation
- Coagulation



VASCULAR SPASM

- When arteries are damaged, the smooth muscles in the walls of arteries contracts immediately, a reaction is called as vascular spasm.
- The spasm is caused due to release of mediators from the activated platelets.

BLOOD CLOTTING

- Blood clots consists of network of insoluble protein fibres called fibrin in which the formed elements (RBCs, WBCs and platelets) of blood are trapped.
- The process of clot forming called as clotting.

BLOOD CLOTTING FACTORS

1. Fibrinogen
2. Prothrombin
3. Tissue factor
4. Calcium ions
5. Labile factor
6. Absent
7. Stable factor
8. Antihemophilic factor
9. Christmas factor or AHF (B)
10. Stuart factor
11. Plasma thromboplastin
12. Hageman factor or AHF(c)
13. fibrin-stabilizing factor

The extrinsic pathway

- Fewer steps and occurs rapidly within a seconds
- Tissue protein called tissue factor(TF) likes into the blood from cells outside blood vessels and initiates the formation of prothrombinase.
- TF is complex mixture of lipoprotein and phospholipids released from the surface of damaged cells.
- In the presence of calcium ions(ca^2), TF begins a sequence of reactions that activate clotting factor-X .
- Once factor X is activated, it combines with factor V in the presence of Ca^2 to form the enzyme prothrombinase, completing the extrinsic pathway.

THE INTRENSIC PATHWAY

- More capex and occurs more slowly, requires several minutes.
- Its activators are present either in direct contact with blood or contain within the blood.
- Out side tissue damage is not needed.
- If endothelial cells becomes damaged, blood can come in contact with collagen fibres of the blood vessels.
- Trauma to endothelial cells cause damage to platelets, resulting in release of phospholipids by the platelets.

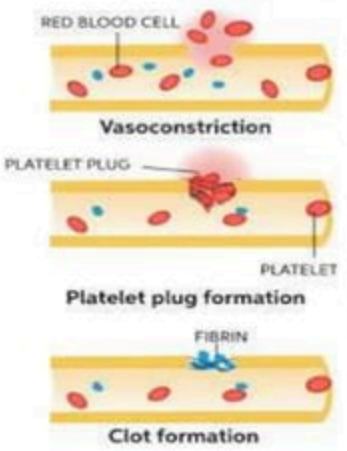
The intrinsic pathways

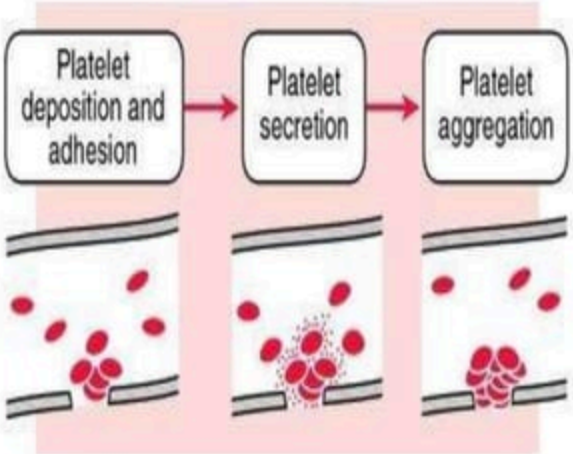
- Contact with collagen fibres activates clotting factor XII, which begins a sequence of reactions that activates clotting factor X.
- Platelet phospholipids and Ca^2 can also participate in the activation of factors X.
- Once factor X is activated, it combines with factor V to form the active enzyme prothrombinase, completing the intrinsic pathway.

THE COMMON PATHWAY

- The formation of prothrombinase starts the beginning of the common pathway
- In the second stage of blood clotting, prothrombinase and Ca^2 catalyze the conversion of prothrombin to thrombin.
- In the third stage thrombin in presence of Ca^2, converts fibrinogen also activates factor XIII (fibrin stabilizing factor) which strengthens and stabilizes the fibrin threads into a stuart clot.

PLATELET PLUG FORMATION





PLATELET PLUG FORMATION

- Inspite of having small size, platelets store lot many chemicals.
- It contains ADP, ATP,Ca^2, serotonin, thromboxane A, a prostaglandin, fibrin-stabilizing factor and platelet-derived growth factor (PDGF).

Platelets plug formation

- Initially, platelets stick to part of a damaged blood vessel, such as collagen fibres of damaged endothelial cells.
- This process is called as platelet adhesion.
- Due to adhesion, the platelets become activated, and their characteristics change dramatically.
- They extend many projections and they being to liberate the contents of their vesicles.
- This phase is called platelet release reaction.

Platelets plug formation

- Liberated ADP and play, a major role of activating nearby platelets.
- Serotonin and thromboxane A^2 functions as vasoconstriction, causing congratulations of vascular smooth muscle, which decrease blood flow through the injured vessels.

Platelets plug formation

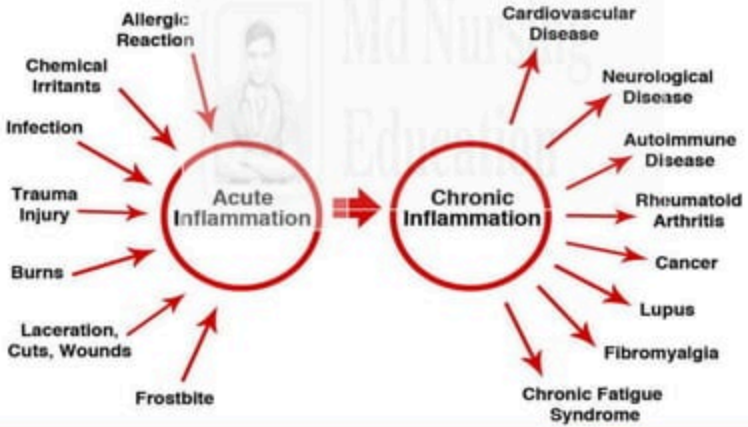
- The release of ADP makes others platelets sticky , and adhere to the originally activated platelets.
- This gathering of platelets is called as platelet aggregation.
- The accumulation and attachment of large numbers of platelets to the site of injury to form a solid mass called as platelet plug.

INFLAMMATION

- Inflammation of the reaction of vascularized living tissue to local injury.
- This reaction results in accumulation of fluid and leukocytes in the extracellular tissue.
- It is a defence mechanism to eliminate or limit the spread of injury or injurious agent.

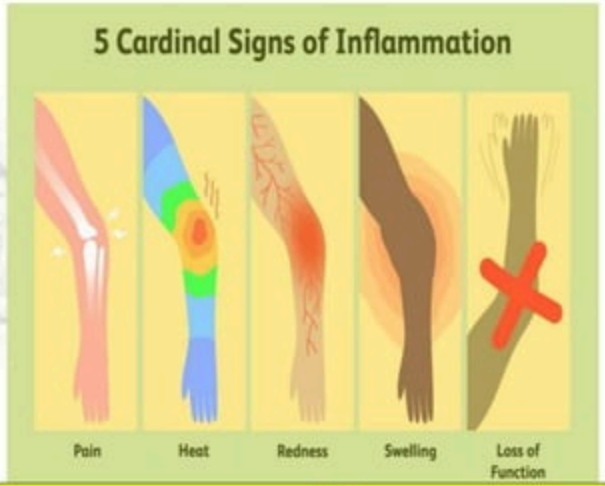
CAUSES

Acute Vs. Chronic Inflammation

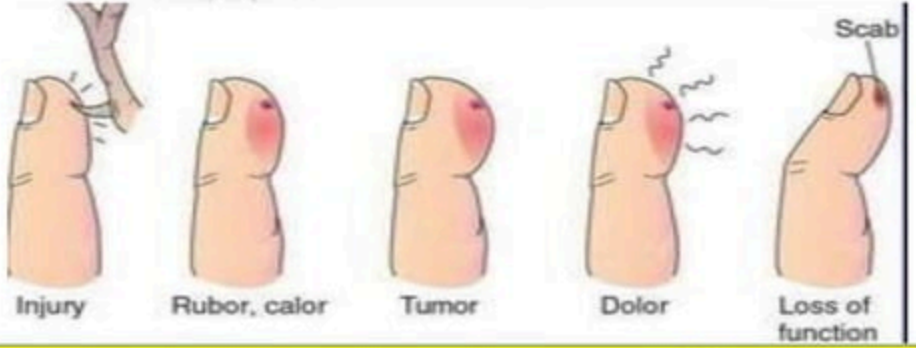


CARDINAL SINGS

- Rubber (redness)
- Tumour (swelling)
- Calor (heat)
- Dolor (pain)
- Loss of functions



SIGNS OF INFLAMMATION



TYPES

1. **ACUTE INFLAMMATION**
2. **CHRONIC INFLAMMATION**

- short duration-few minutes to days
- protein exudate
- neutrophils predominate

- days to years
- mainly macrophages and lymphocytes
- Proliferation of blood vessels, fibrosis and tissue necrosis
- fewer neutrophils

Acute and chronic inflammation

Acute inflammation

- It is a short duration of periods such as minutes, hours, or days.
- Its main characteristics:-

1. The exudation of fluid and plasma proteins (oedema).
2. The migration of leukocytes and neutrophils to the site of injury.

Chronic inflammation

- Its for longer duration.
- Its main characteristics:-

1. Associated with lymphocytes and macrophages migration, proliferation of blood vessels, fibrosis and tissue necrosis.

Tissue and cells in inflammation

- The circulating cells:-Neutrophils, monocytes, eosinophils, lymphocytes, basophils and platelets.
- The connective tissue cells:-Mast cells, fibroblasts, macrophages and lymphocytes.
- The extracellular matrix:-fibrous protein(collagen, elastin) and glycoproteins(fibronectin, laminin, collagen) and proteoglycans.

Inflammatory mediators

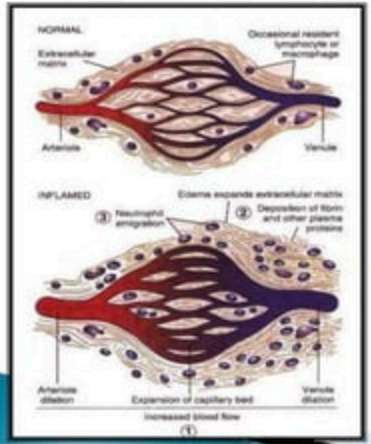
1. Plasma:-

- Complimentary system
- Kinin system
- Clotting system

2. Cells :-

- Histamine
- Serotonin
- Lysosomal enzymes
- Prostaglandins
- Leukotrienes
- Cytokines(IL1, IL6, IL8)
- Platelet activating factor

Mechanism of Inflammation



1. Vaso dilatation
2. Exudation - Edema
3. Emigration of cells
4. Chemotaxis

Vascular changes

1. Change in vascular blood flow:

- Transient vasoconstriction of the arterioles followed by vasoconstriction.
- Vasodilation involves arterioles first then microvascular bed (leading to redness and heat).
- It leads to slowing of blood circulation (blood stasis).

Vascular changes

2. Increase in vascular permeability :

- Vascular permeability:-capacity of the blood vessels wall to allow the entry of small molecules or lymphocytes in and out of the vessels.
- Increase in hydrostatic pressure leading to leakage of fluid to the extravascular space.
- Increase in osmotic pressure leading to leakage of protein-rich fluid.
- The end result is Oedema.

Cellular events

- Decided into five steps:-
- Margination
- Adhesion to endothelium
- Emigration
- Chemotaxis
- Phagocytosis

Cellular events

1. **Migration:-**

- sticking of leucocytes to the endothelial lining of blood vessels (pavementation).

2. **Adhesion:-**

- Mediators of inflammation activates the adhesion molecules on the surface of leukocytes and endothelial cells and facilities their adhesion.
- Adhesion molecules are bacterial toxins, complement fragments, chemotactic peptides and cytokines.

Cellular events

3. Emigration:-

- **Emigration refers to the process by which leucocytes escape from blood vessels to the perivascular tissue.**

4. Chemotaxis:-

- **It is defined as unidirectional migration of leukocyte towards an attractant (chemotactic factors).**

Cellular events

5. Phagocytosis:-

- It is the process of engulfment of pathogens and damaged cells.
- 3 distinct steps:
- Recognition and attachment
- Engulfment
- Killing or degradation

Phagocytosis

1. **Recognition and attachment:-**

- WBCs have specific receptors on the surface.

2. **Engulfment:-**

- The particle is engulfed by pseudopodia and enclosed in membrane bound vesicle called as phagosome.

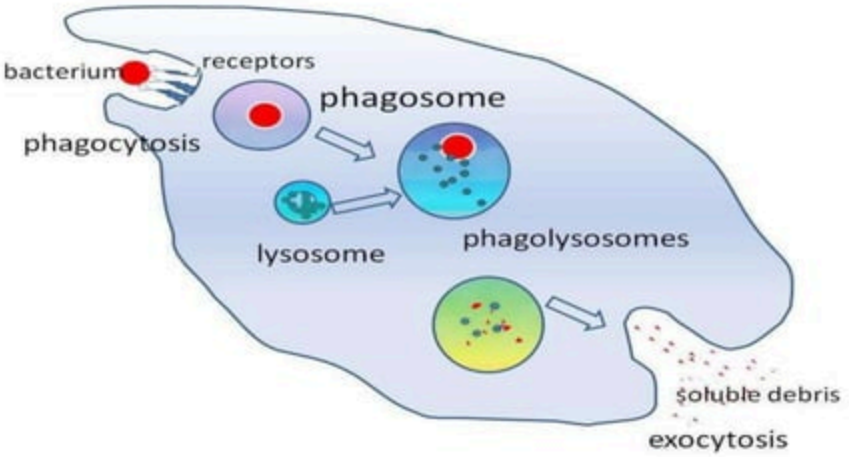
1. **3. Killing and degradation:-**

- Phagosome fuses to lysosome to form phagolysosome .

Killing is facilitated by:

- Oxygen free radicals (oxidative burst).
- Lysosomal enzymes (myeloperoxidase).

PHAGOCYTOSIS



THE END