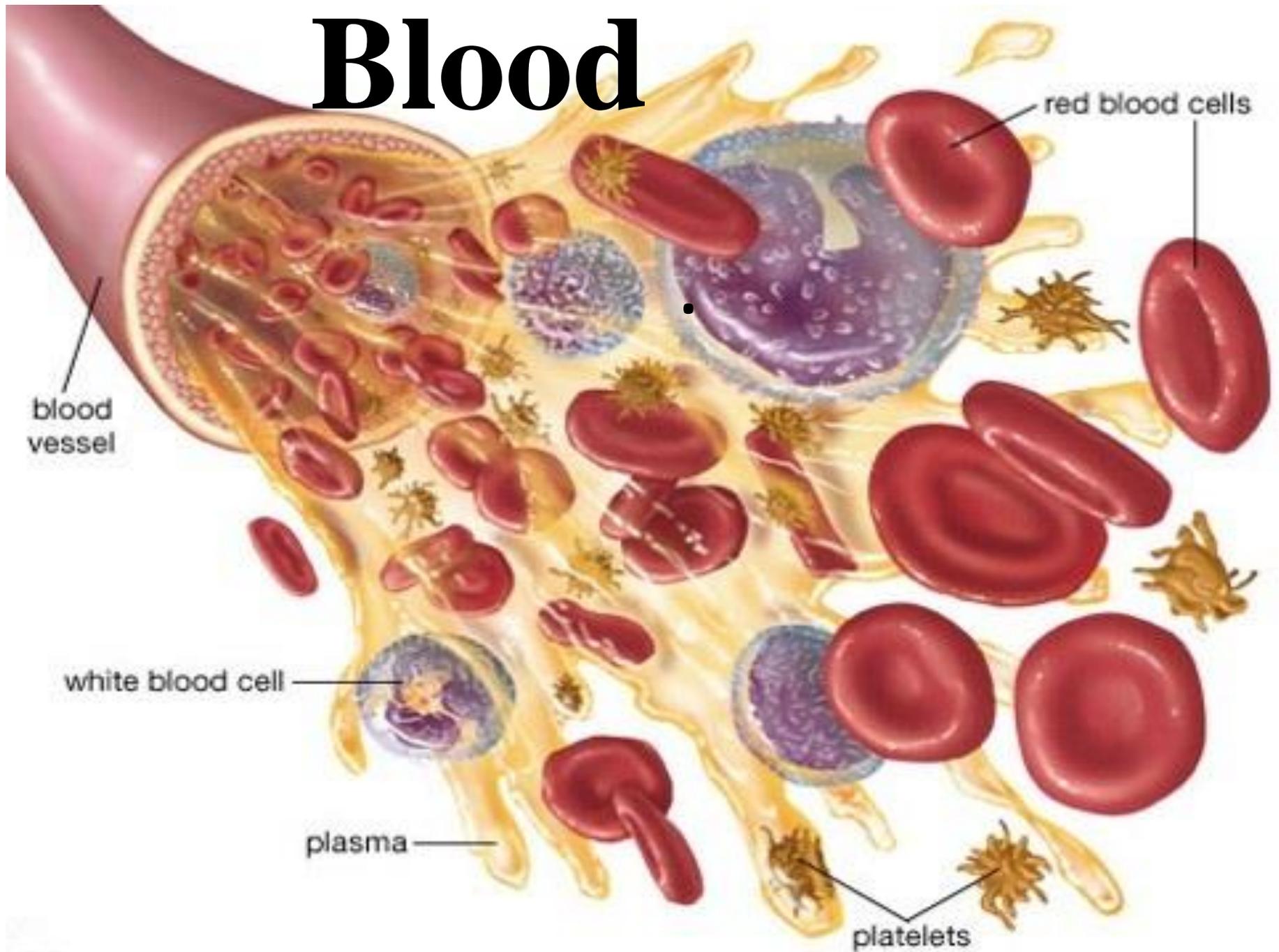
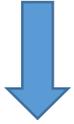


Blood



Connective Tissue



C.T. proper

- Loose C.T.
- Adipose C.T.
- Reticular C.T.
- Dense C.T.
- Elastic C.T.
- Muroid C.T.



Modified C.T.

Ground substance is modified

- Solid nature** = supporting C.T.
 - **Cartilage** (firm)
 - **Bone** (hard)
- Fluid nature** (plasma)
 - **Blood**

Blood

Modified CT

- ❑ Adult has ~ **5.5 -6 L**
- ❑ Circulate in **CVS**
- ❑ Considered **modified** connective tissue :

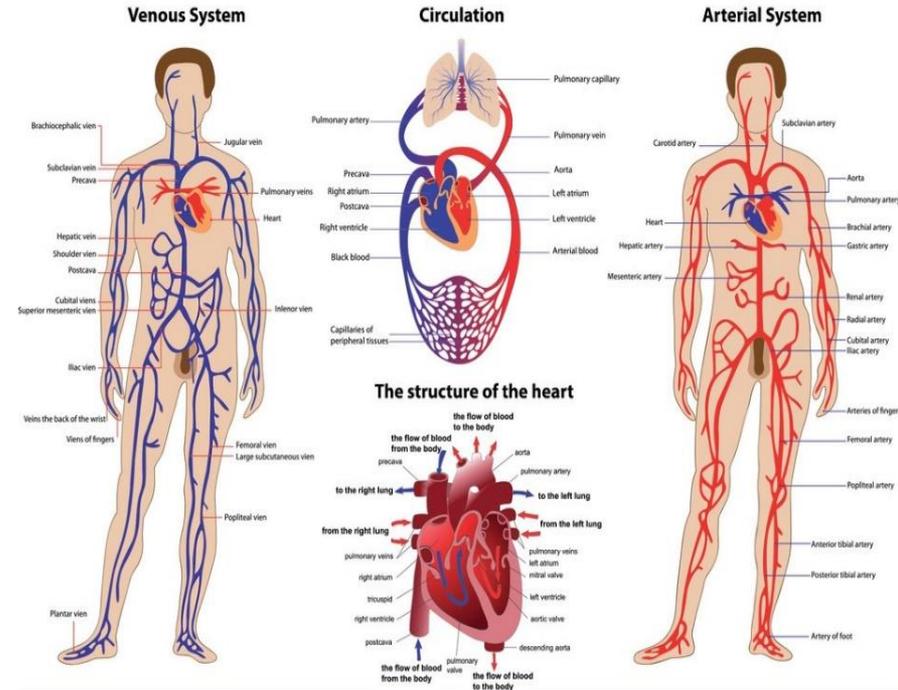
➤ Mesodermal in origin

➤ cells

➤ liquid ground substance (called plasma)

➤ dissolved protein fibers (fibrinogen) → fibrin

CARDIOVASCULAR SYSTEM



BLOOD

Consists of **liquid** and **cellular** components by a machine called a **centrifuge**.

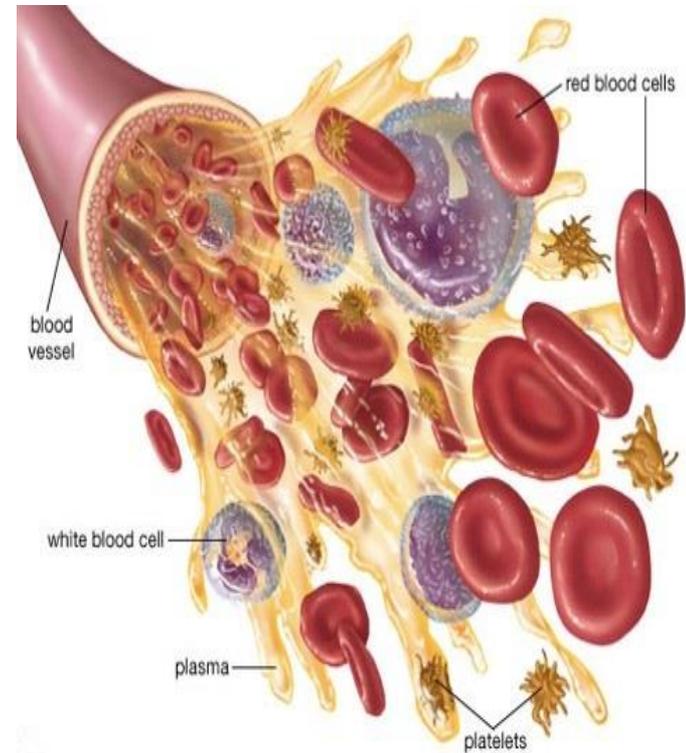
❑ **Plasma: 55%**

❑ **Cells = Formed Blood elements 45%**

- **Originate in the red bone marrow**

- **Blood formation = hematopoiesis**

❑ **No aberrant fibers.**

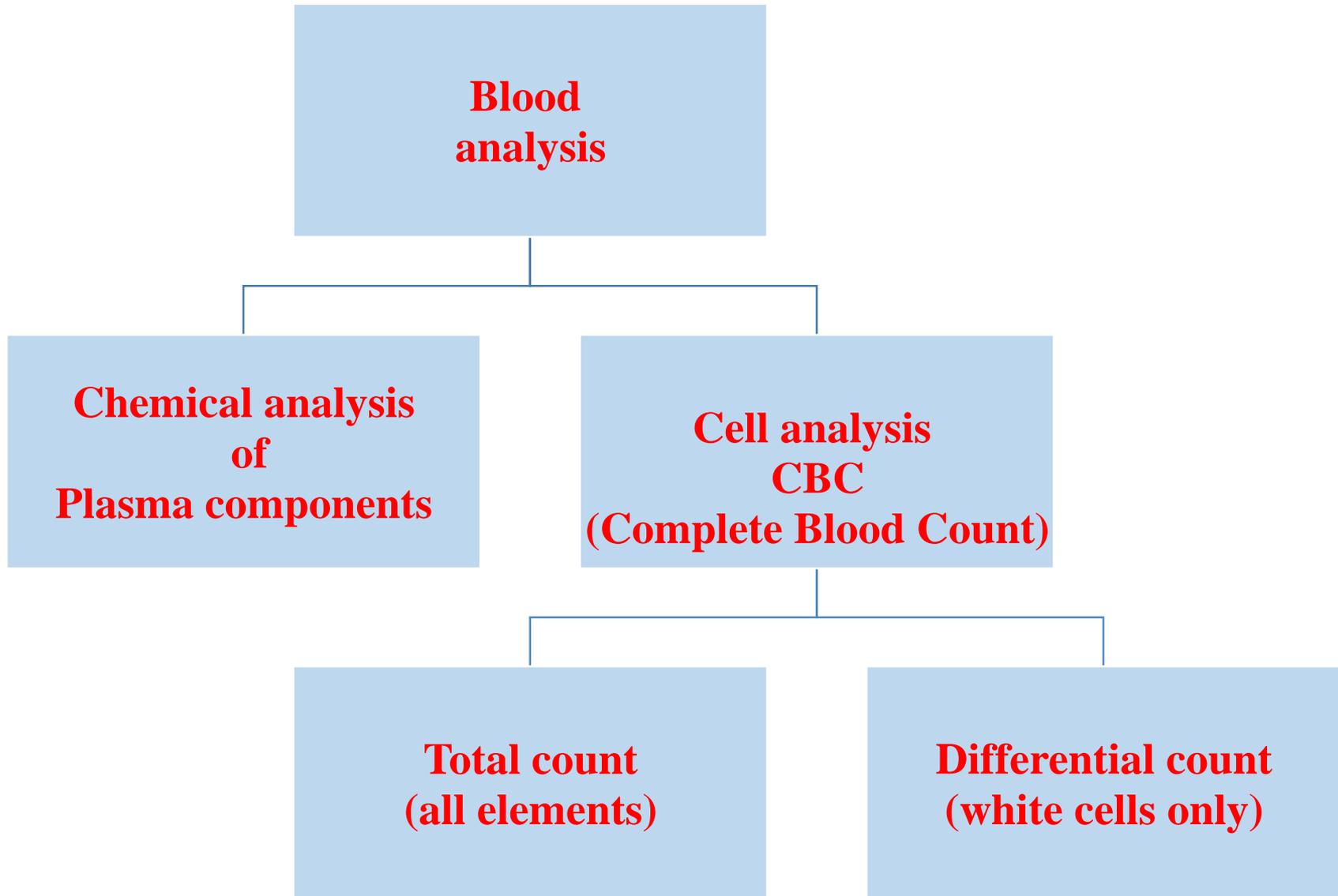




① Withdraw blood into a syringe and place in a glass tube.

② Place the tube into a centrifuge and spin for about 10 minutes.

③ Components of blood separate during centrifugation to reveal plasma, buffy coat, and erythrocytes.



Plasma

55% of blood volume:

❑ **Water 92%.**

❑ **Organic substances:7 %**

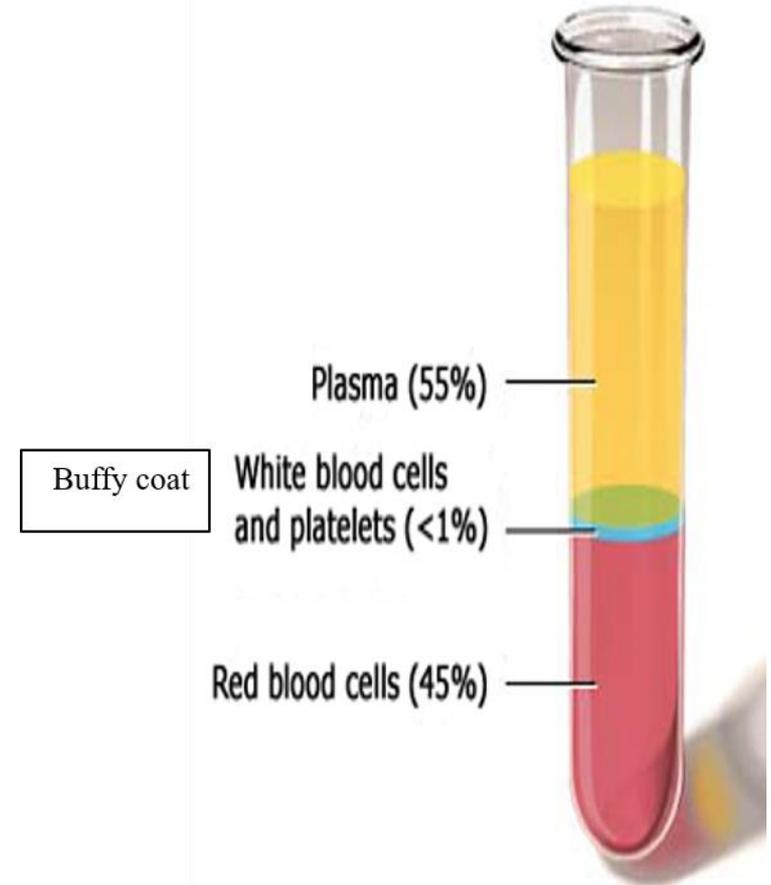
➤ plasma proteins

(albumin, globulin, prothrombin and **fibrinogen**)

➤ Hormones & enzymes.

❑ **Inorganic salts 1%**

(Na Cl, Bicarbonates, phosphates & calcium)



The Blood Film= Smear

Preparation of blood for laboratory study

- Why do we do a blood film ?
 - 1.To study blood elements.
 - 2.To make differential leukocytic count.

Steps :

- Put a small drop of blood
- Spread into a thin film
- Stain with Leishman or Giemsa stain
(methylene blue +eosin)

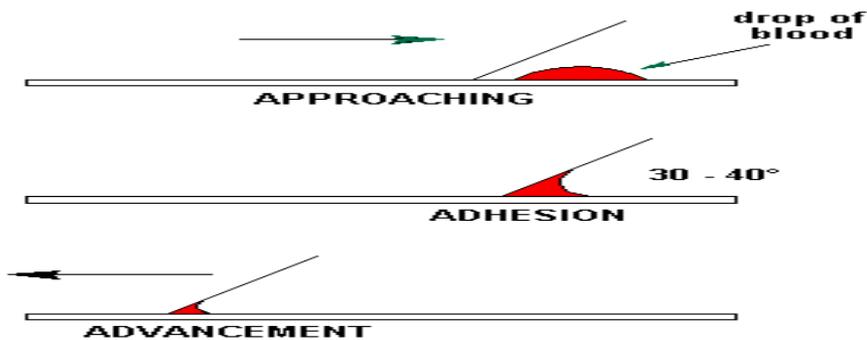
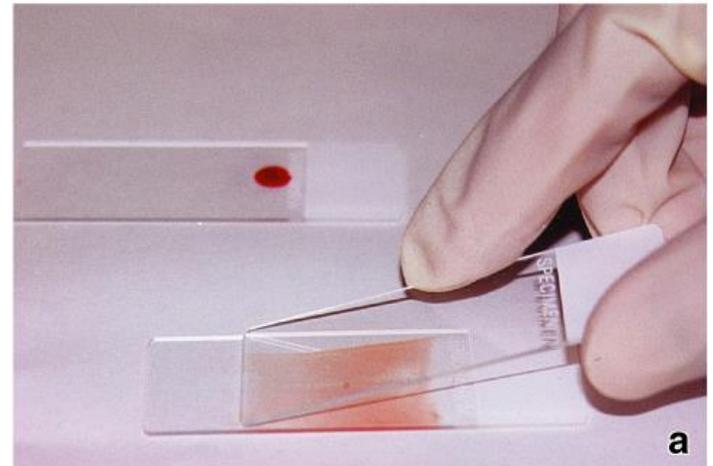


Fig. 7 - How to prepare a blood smear



Blood film

Why do we do a blood film ?

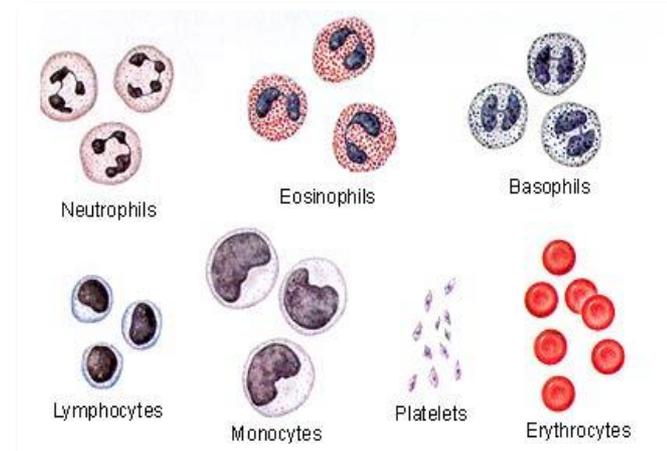
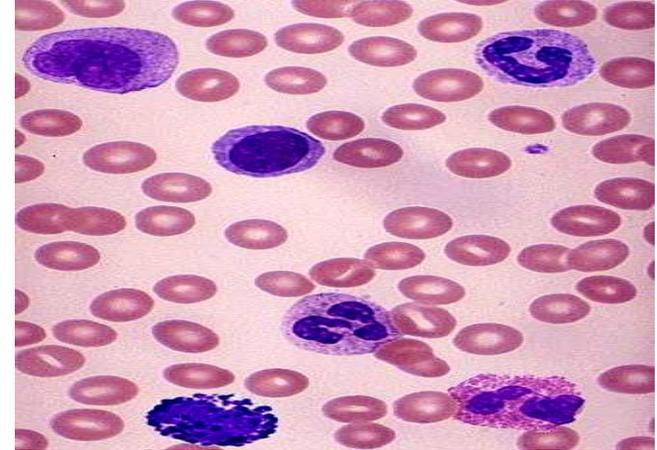
- 1.To study blood elements.
- 2.To make differential leucocytic count.

Steps :

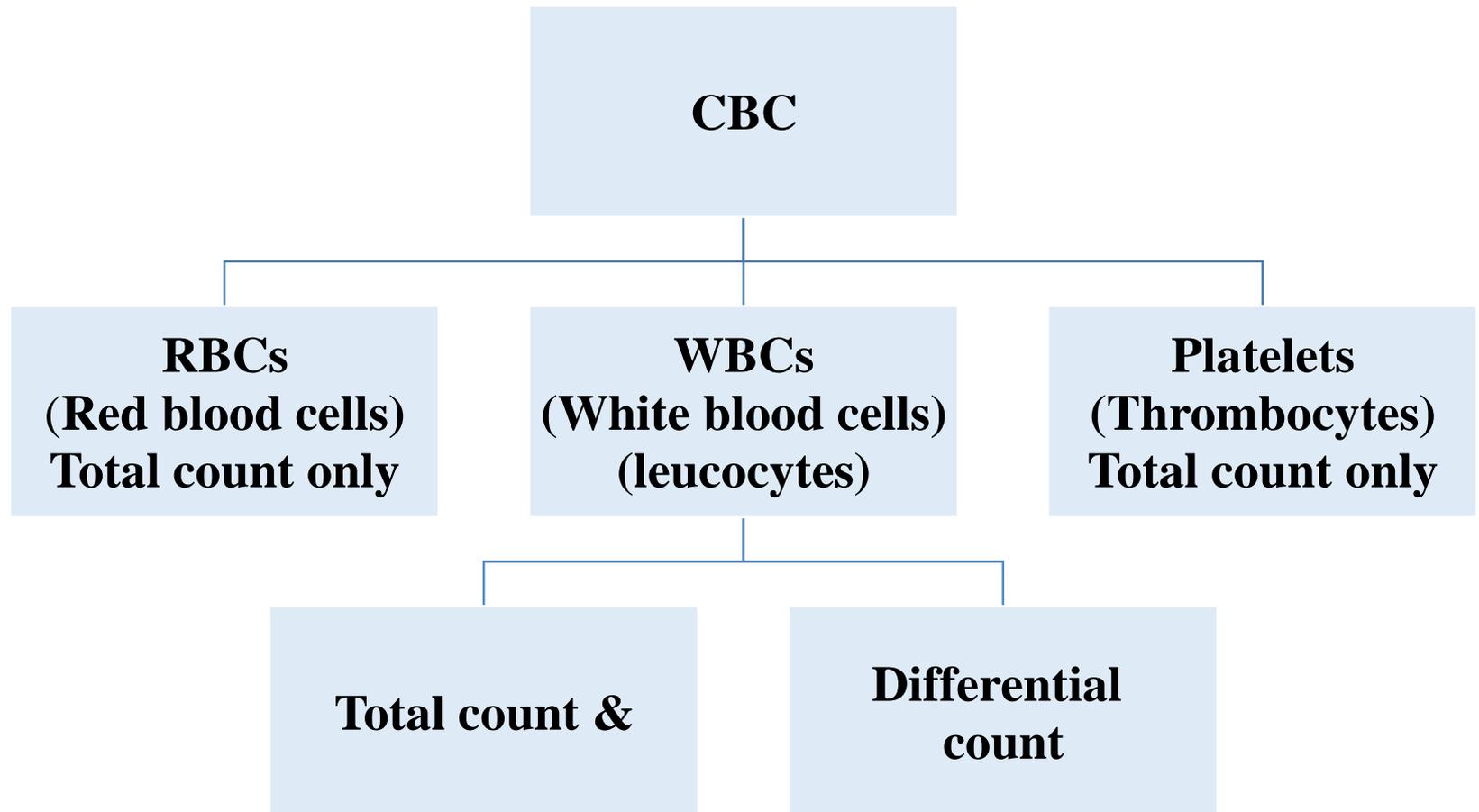
- Put a small drop of blood
- Spread into a thin film
- Stain with Leishman or Giemsa stain
(methylene blue +eosin)

Giemsa's / Leishman's = methylene blue + eosin

- ▶ basophilic (violet)
- ▶ eosinophilic (pink)
- ▶ azurophilic (red purple)



Complete blood count (CBC)



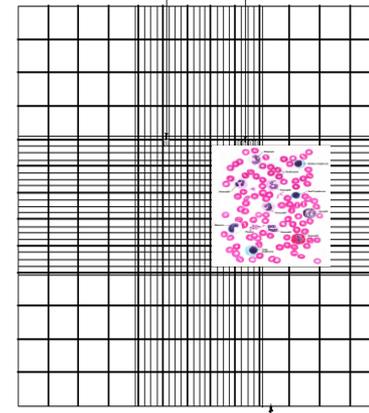
Complete blood count (CBC)

1-Total count :

It is the total number of blood elements (RBCs, WBCs, or Platelets) per cubic millimeter

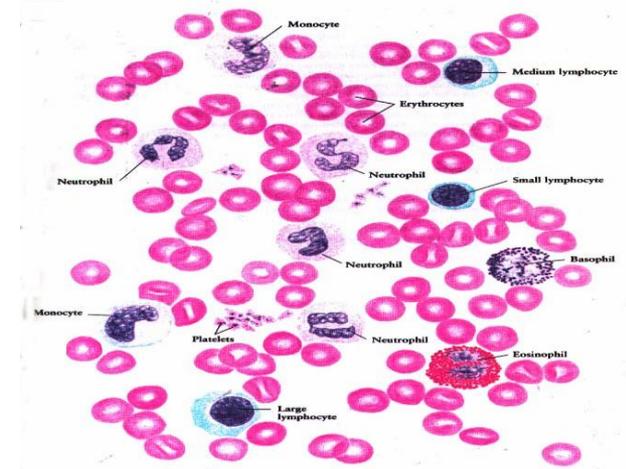
Measured by

- Hemocytometer
- Or Automatic counter



2-Differential leukocytic count

- the percentage of each type of leucocytes to the total count



Blood cell count=CBC

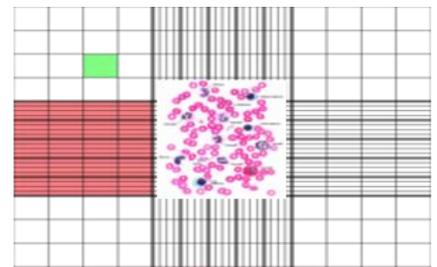
- **Manual method= Conventional**
= Hemocytometer= counting chamber.

- **Electronic method**
= automated hematology analyzer.

Total count

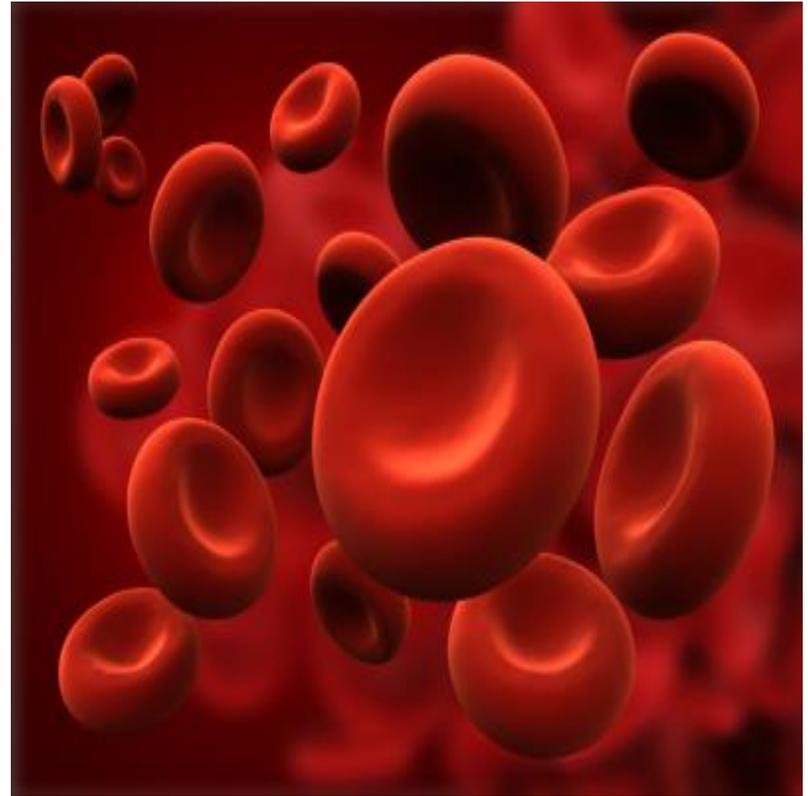
- ❑ RBC count 4.5-5 million/mm³ in female
- ❑ Total leukocytic count 4,000-11,000/mm³
- ❑ Platelet count 250,000- 350,000/mm³

Differential leukocytic count



Blood cells

1. Total or Differential count
2. Shape & size
3. Structure (nucleus + granules)
4. Function
5. Life span
6. Abnormalities



Red Blood corpuscles

Normal RBCs total count:

- In **males** ♀ 5- 5.5 millions / mm³ blood
- in **females** ♀ 4.5-5 millions / mm³ blood
- LM of RBCs:

❖ Shape: - Biconcave discs.

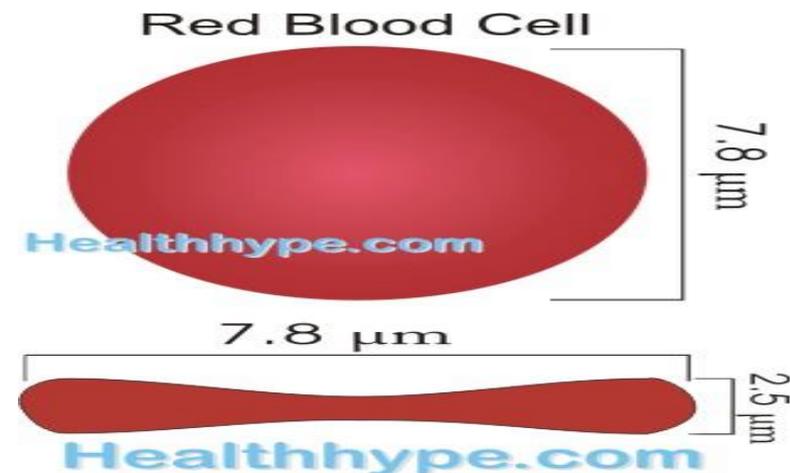
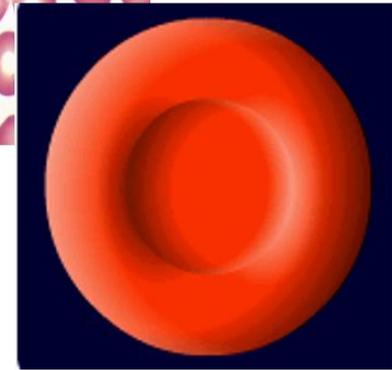
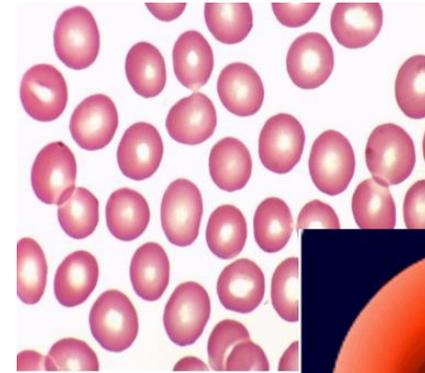
- Mature RBCs are membrane- bound corpuscle.

❖ Size:

- -Diameter 7.5 μm
- -Thickness 1 μm

❖ Nucleus: Anucleate.

❖ Cytoplasm **33%** of the corpuscular volume is Hemoglobin ■ heme “Fe”+ Globin ‘protein’



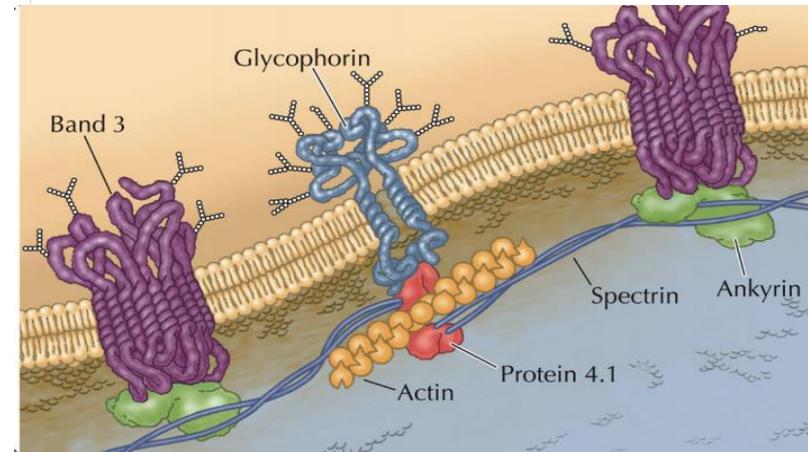
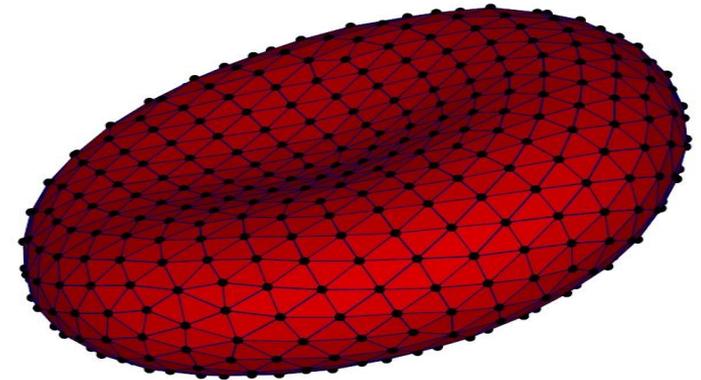
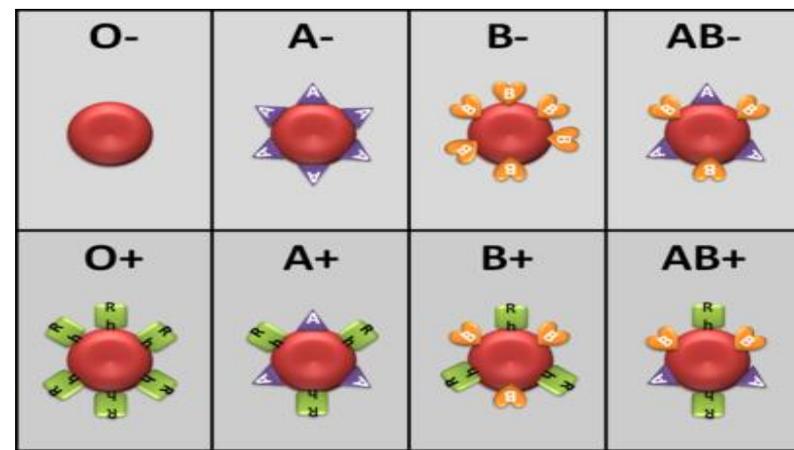
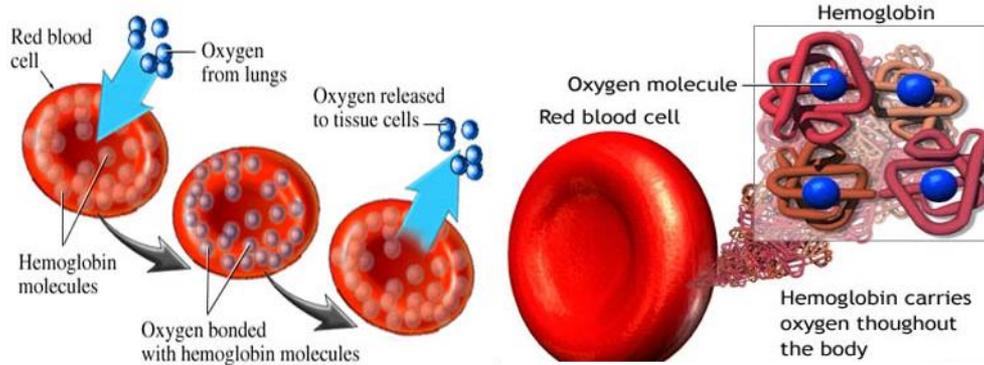
EM picture of RBCs:

➤ Glycocalyx

- responsible for the **ABO/ Rh** blood group.
- **No** nucleus, **No** typical organelles.
- Only few mitochondria
- subplasmalemmal **cytoskeleton**
- (**actin, spectrin & ankyrin**)
responsible for the flexibility of RBCs.

➤ Function of RBCs

Carry O₂ & CO₂



life span:

- 100-120 days

Then removed by Macrophages of spleen and liver sinusoids

Adaptation to function

1. Glycocalyx well developed

2. ▲ surface area (Biconcave)

3. ▲ amount of HB

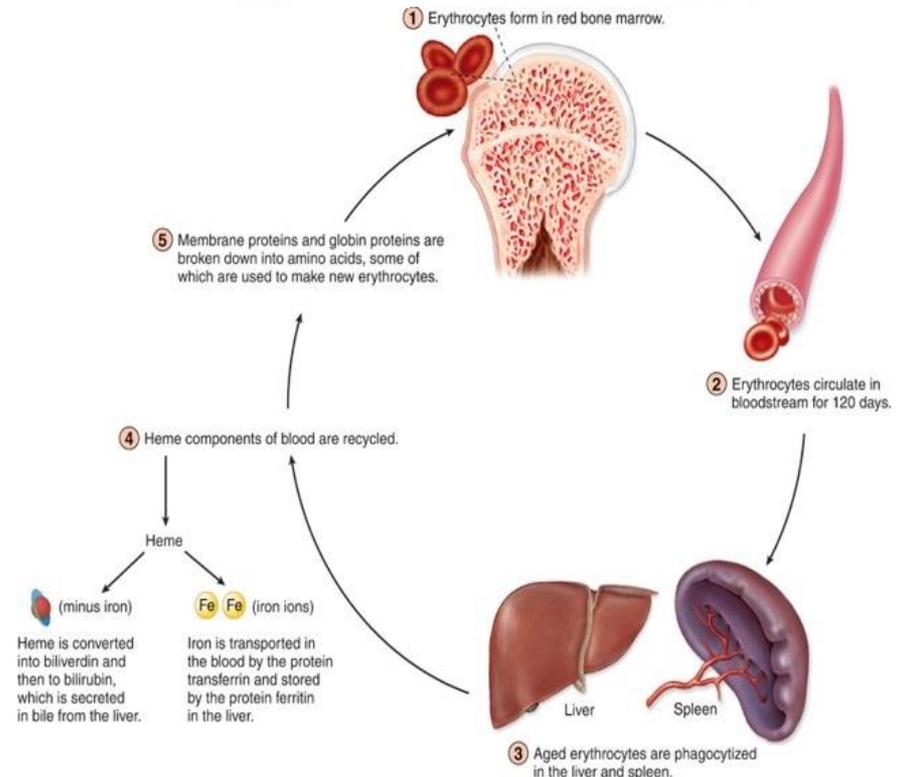
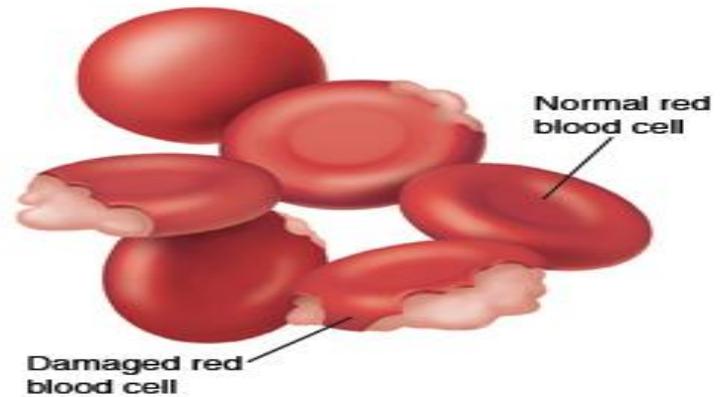
(no nucleus/ organelles)

4. ▲ ▲ HB at the periphery

5. Selective permeability

6. Carbonic anhydrase

7. ▲ flexibility to squeeze without damage (cytoskeleton)



Abnormalities of RBCs

Abnormalities of RBCs in **number**

□ **Anaemia:**

Decrease ??? in the total number of RBCs.

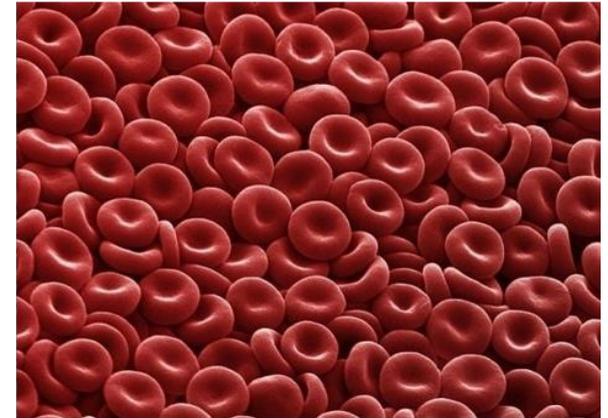
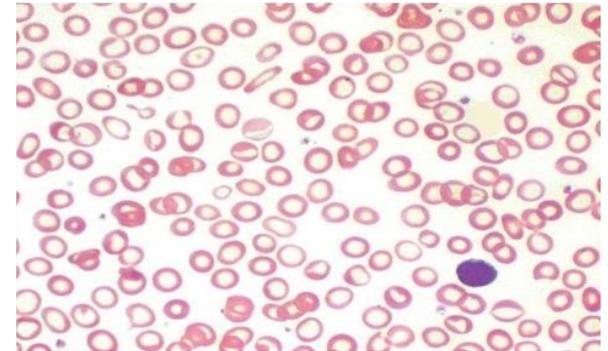
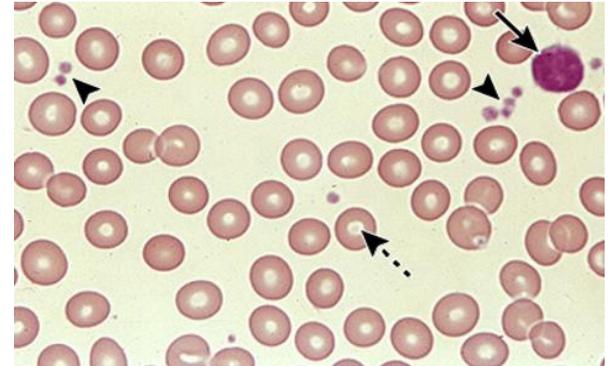
□ **Polycythaemia:**

increase in the total number of RBCs.

Causes: (decreased oxygen tension)

Physiological: newborns ,high altitude

Pathological: chronic lung and heart diseases.



Abnormalities of RBCs in size

Microcytosis:

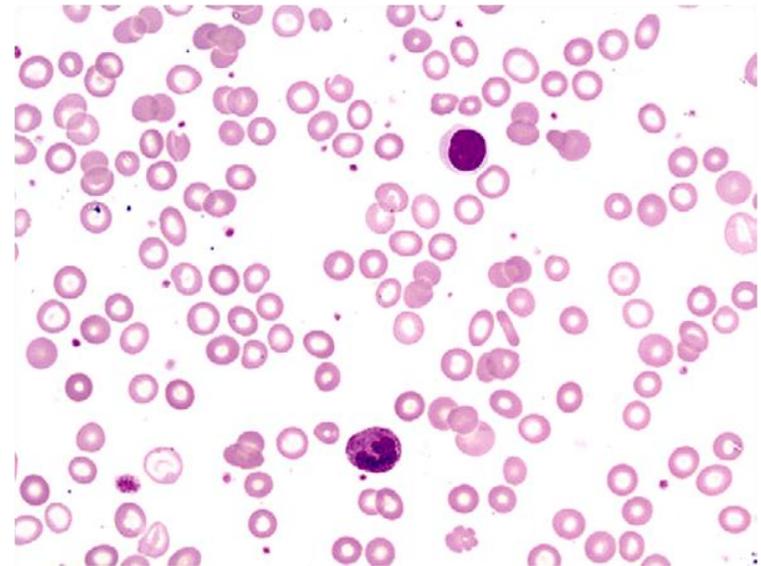
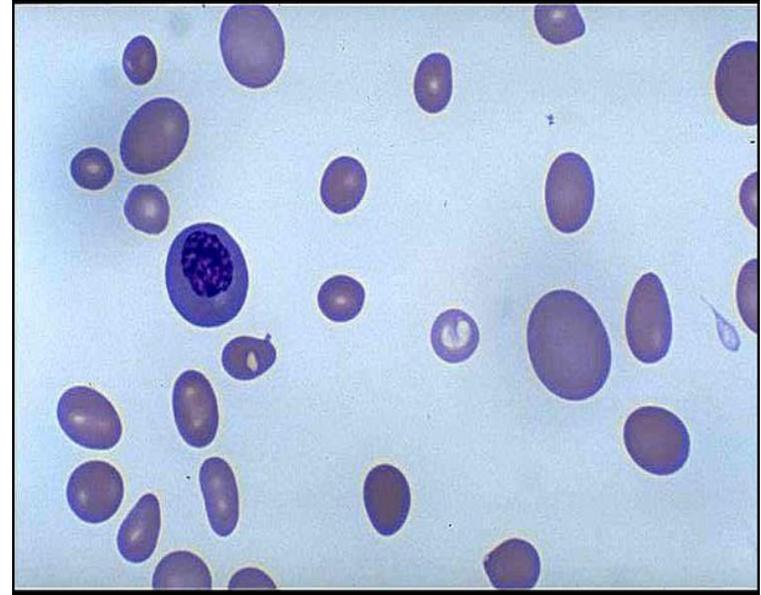
diameter of RBCs is **less than $6\mu\text{m}$** .
(Microcytic anaemia)

Macrocytosis

diameter of RBCs is **more than $9\mu\text{m}$** .
(Macrocytic anaemia)

Anisocytosis

Variable in size



Abnormalities of RBCs in shape

1. Rouleaux formation

In slow circulation

2. Poikilocytosis

Variable in shape

3. In hypertonic solution

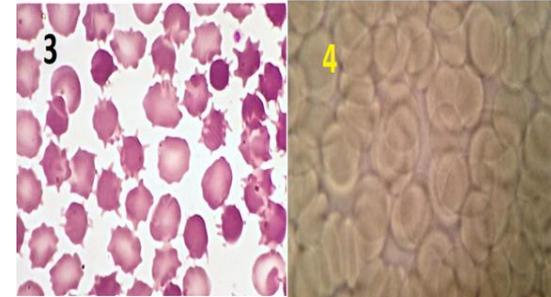
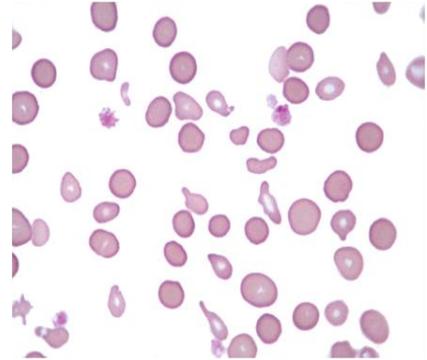
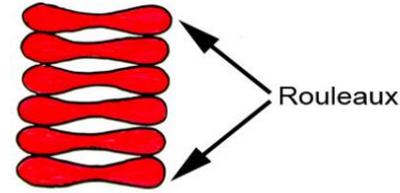
▶ **echinocytes(crenation)**

4. In hypotonic solution= swelling

▶ **Ghosts**

5. Sickle Cell Anemia

(abnormal Hemoglobin



Reticulocytes = immature RBCs

- Reticulocytes represent 1% of all RBCs in normal blood film.
- Nucleated → No nucleus

differ than mature RBCs

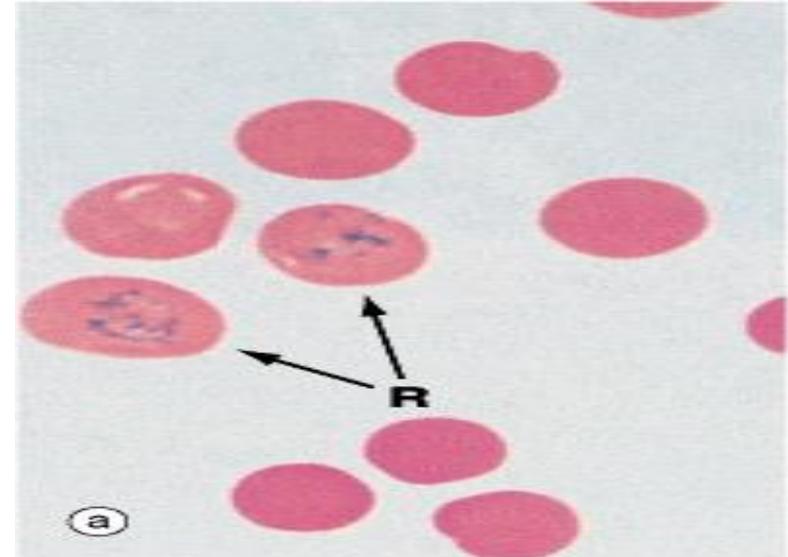
- slightly larger ($8\mu\text{m}$).
- Cytoplasm contains remnants of ribosomes.
- On staining with **cresyl blue** form a reticulate pattern.

Clinical significance:

An increase in this percentage indicates an

- accelerated rate of erythropoiesis.

To compensate for anemia or severe hemorrhage.



BLOOD PLATELETS

Origin: from megakaryocyte in the bone marrow.

- Cell fragments of megakaryocyte.
- Thrombocytes.
- Thromboplastids

❖ Normal Platelet Count

250,000-350,000/ mm³
(200,000-400,000)

Structure (L. M) :

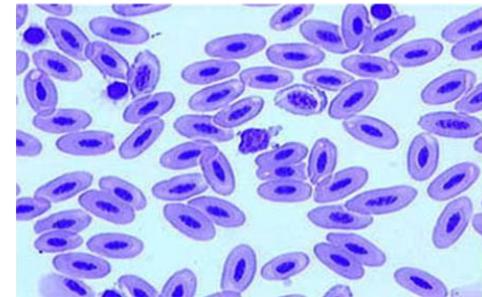
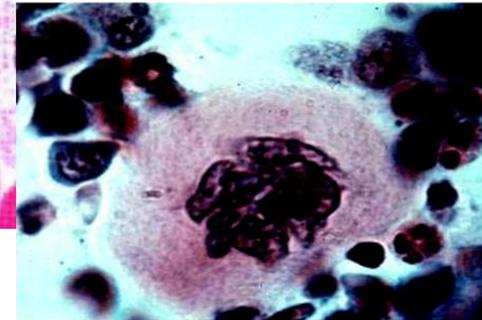
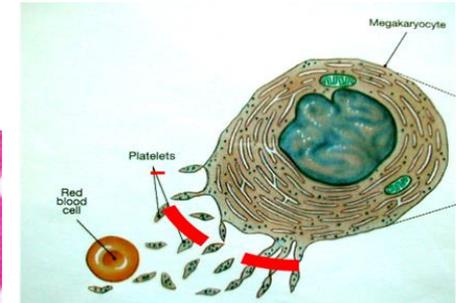
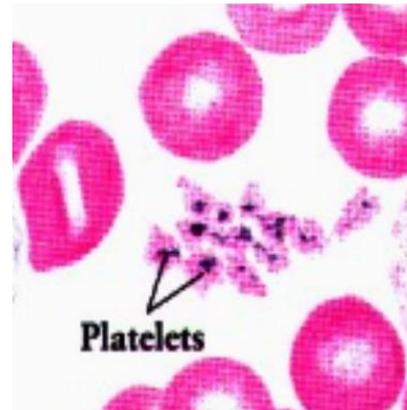
- **Shape:** Anucleate, biconvex discs.
- **Diameter** :2-3 μm.

central granular zone (**granulomere**)

Granulomere, granular central region

& peripheral clear zone (**hyalomere**)

Hyalomere at the periphery, there is a pale basophilic zone



EM of the platelet :

➤ Shape: Irregular, Pseudopodia.

➤ Diameter :2-3 μm .

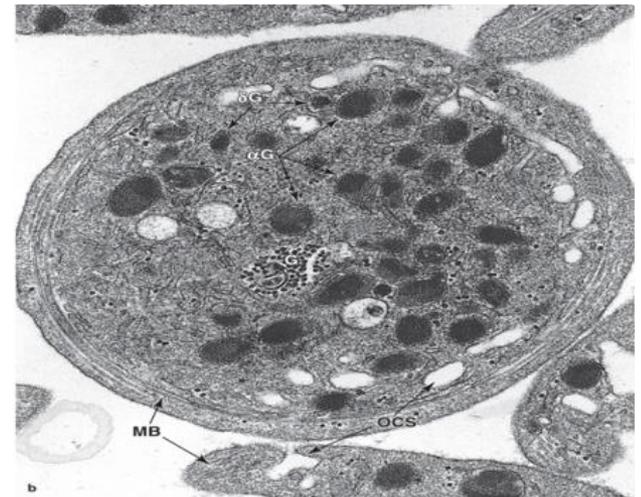
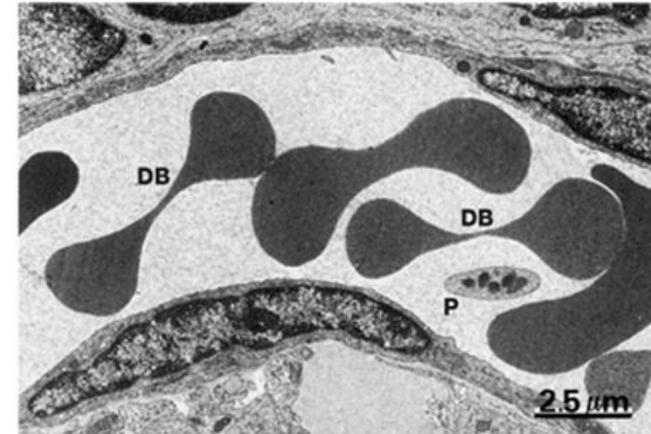
➤ Shape: Anucleate, biconvex discs.

➤ Platelet membrane:

▲ ▲ well developed cell coat glycoprotein for:

- Adhesion
- Aggregation

➤ Hyalomere &granulomere



Granulomere

- few mitochondria & ribosomes.
- scattered glycogen particles.
- 3 types of granules:

❑ Alpha (α) granules:

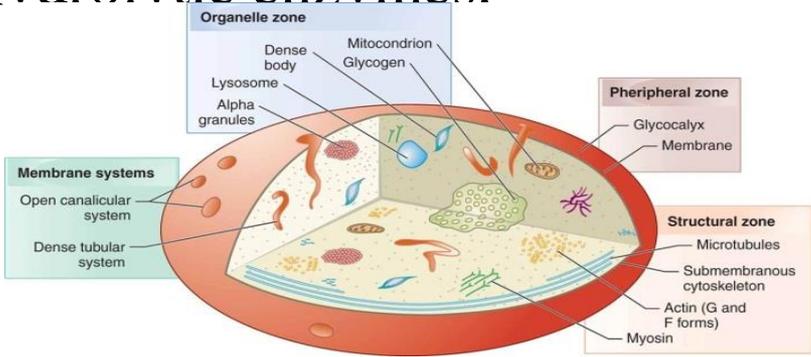
- Large, abundant, PD-GF, coagulation factors.

❑ Delta granules:

- Medium size, ATP, ADP, serotonin.

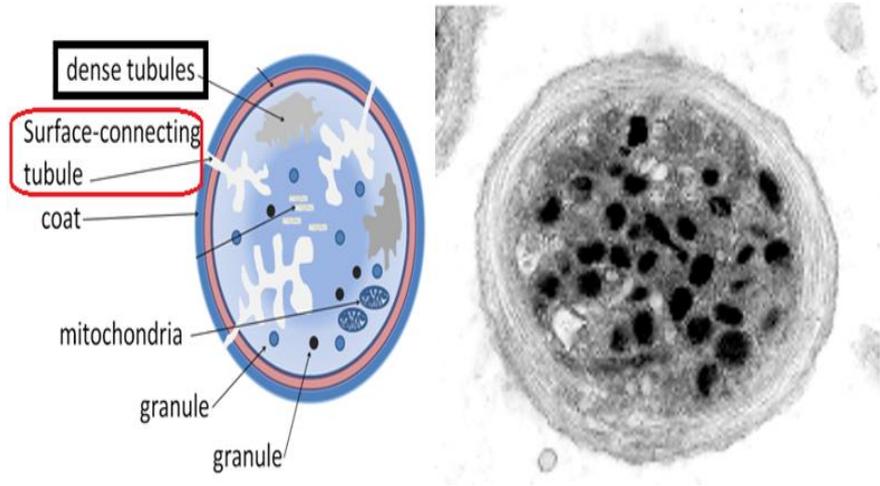
❑ Lambda (λ) granules:

hydrolytic enzymes.



Hyalomere

- Electron- lucent.
- Lacks organelles.
- It contains:
 - **circumferential bundle of 10-15 microtubules** ▶ ▶ discoid shape
 - **Actin & myosin** ▶ ▶ motility + clot retraction
 - **Canalicular system =tubular system.**



Functions of platelets

- Platelet aggregation → white thrombus
- Local blood coagulation → red thrombus
- Serotonin → Vaso-constriction
- **Clot retraction** → by microfilaments
- Clot removal → by **proteolytic enzymes**

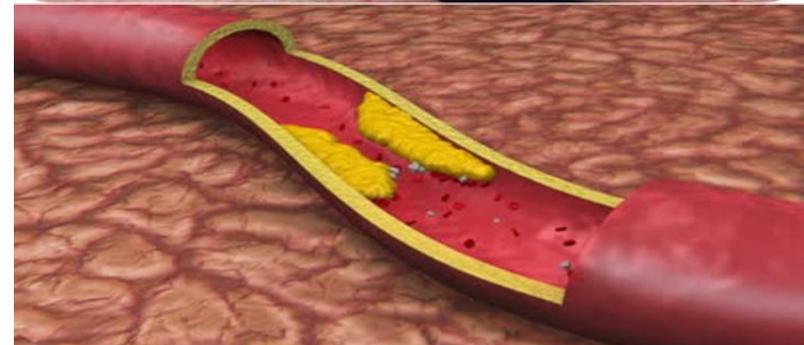
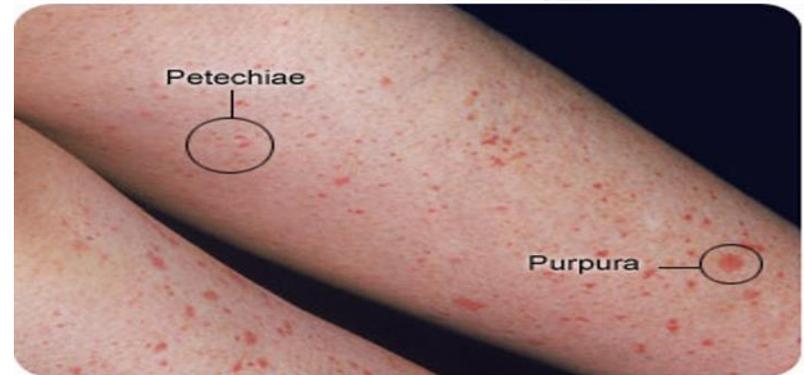
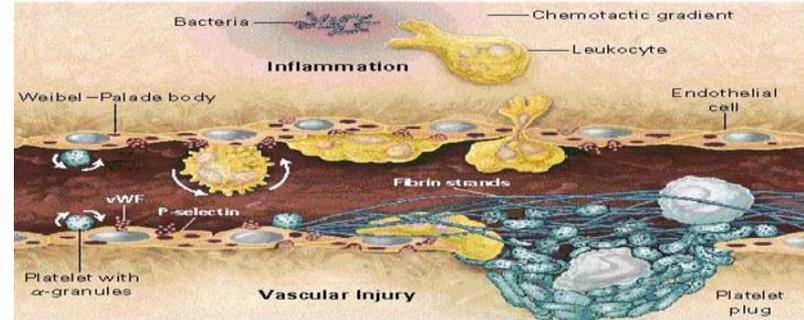
Life span: 10- 14 days in blood

Abnormality of the platelets :

Thrombocytopenia ▼ ▼ ▼

Thrombocytopenia (purpura)

▲ ▲ ▲ **Thrombocythemia**



RBCs

Red blood corpuscle

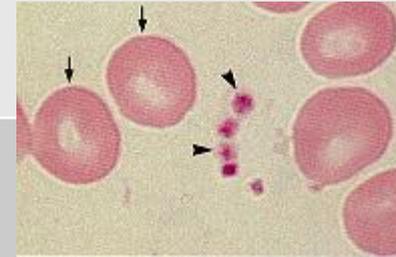
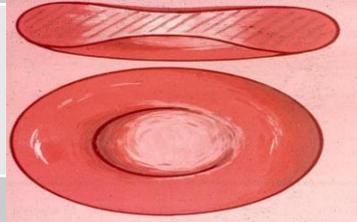
Erythrocytes – Greek: “Red

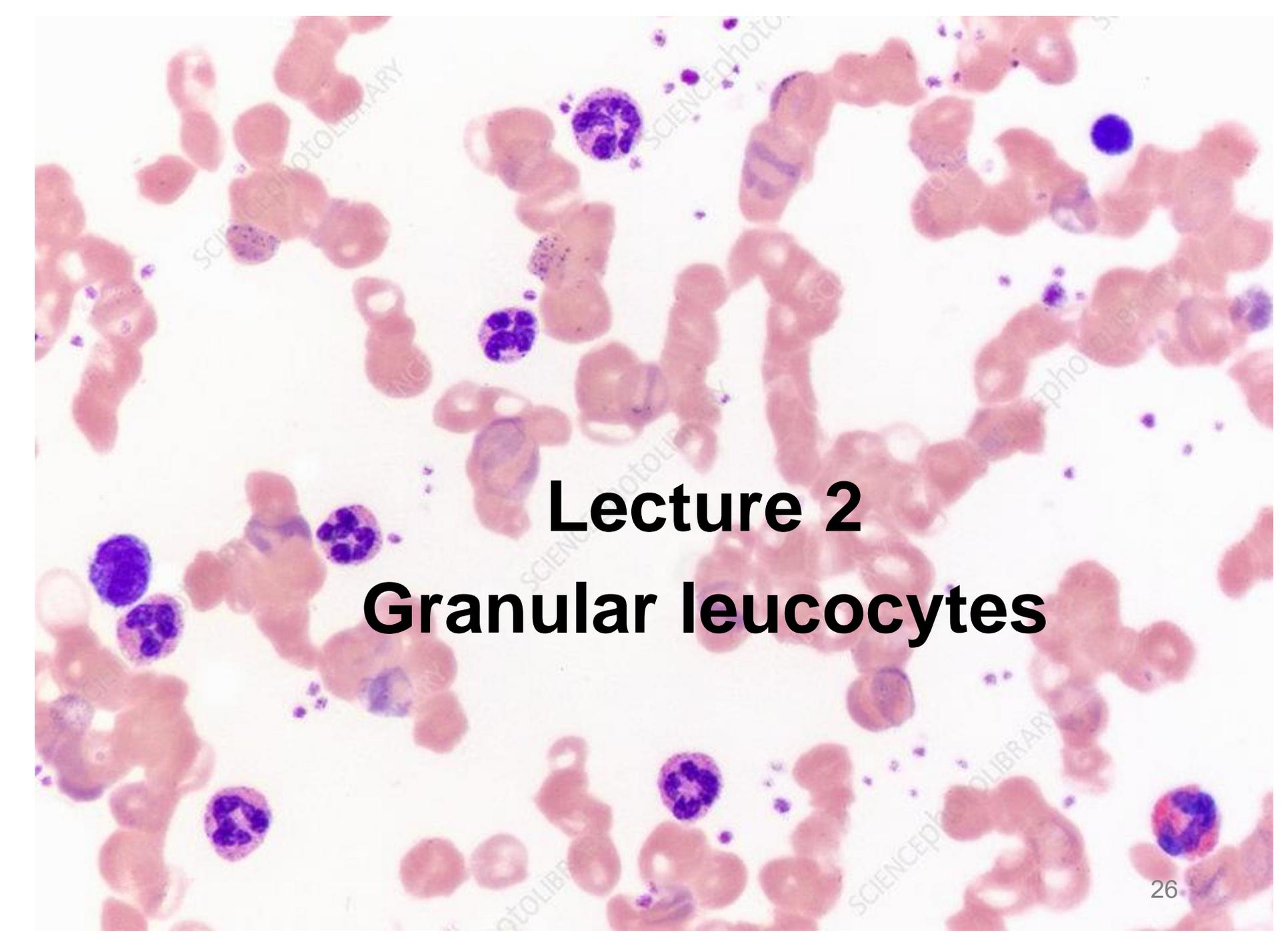
Platelets

Thrombocytes

Thromboplastides

Number	<u>males</u> is 5 - 5.5 millions / mm ³ <u>females</u> it is 4.5-5 millions / mm ³ blood.	250,000-350,000/mm ³ 200,000- 400,000
Size	7.5–8.5 μm Macrocytes > 9 μm, Microcytes < 6 μm Anisocytosis = variation in si	3μm 2-5 μm diameter
Shape	biconcave disc	Biconvex
Structure	no nuclei & other organelles only few mitochondria Bag of Haemoglobin	Fragments of megakaryocyte Not true cell (Non-nucleated) Granulomere & Hyalomere
Life span	100-120 days..	10- 14 days in blood
Function	Carry O2 & Co2	- the process of thrombus formation (blood clotting) in response to any vascular endothelial injury to prevent excessive blood loss. - clot retraction and removal of the blood clot after healing of the vessel wall to re-establish the flow of the blood.
Abnormality	Polycythaemia: i.e. increase in the total number of R.B.Cs. Anaemia: i.e. decrease in the total number of R.B.Cs. Sickle Cell Anemia	INCREASE → Thrombosis Decrease → Bleeding





Lecture 2

Granular leucocytes

The formed blood elements

Stains of blood film

Giemsa's / Leishman's

= methylene blue+ eosin

- ▶ basophilic (**violet**)
- ▶ eosinophilic (**pink**)
- ▶ azurophilic (**red purple**)

Blood cells = 45 % of blood volume

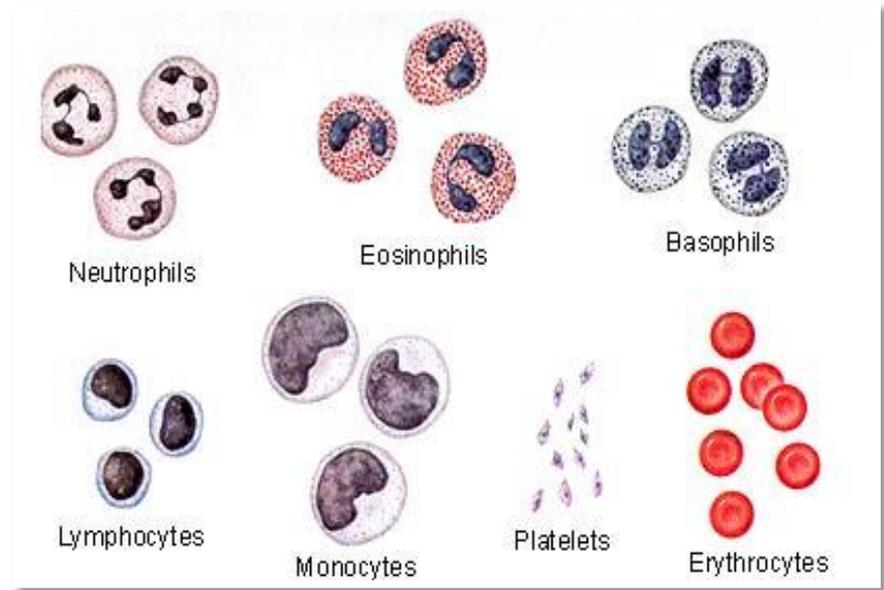
- ❑ Red blood **corpuscles** =Erythrocytes (RBCs)
- ❑ Blood platelets = Thrombocytes
- ❑ White blood **cells** =Leukocytes (WBCs):

➤ Granular leucocytes

(neutrophils, eosinophils, basophils)

➤ Agranular leucocytes

(lymphocytes, monocytes)



Leukocytes (WBCs)

Normal total Count

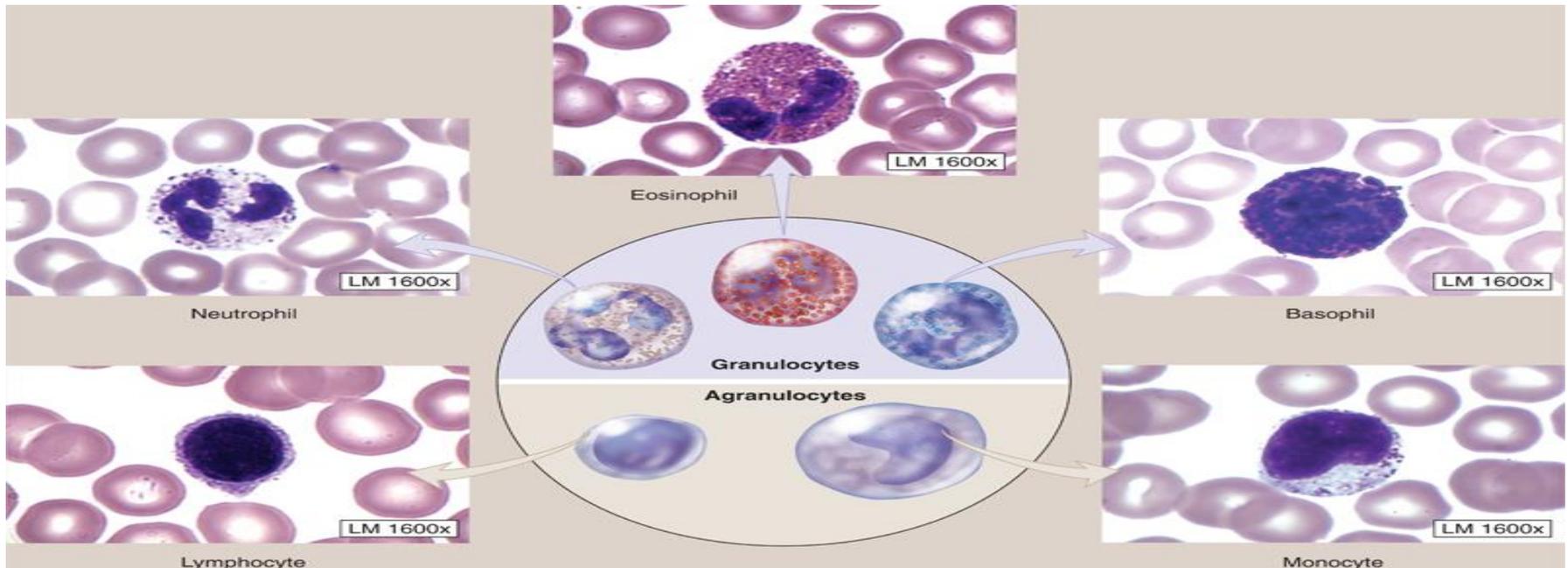
4000-11,000 / mm³ blood.

I-Granular leukocytes:

- Neutrophils. 60-70-%
- Eosinophils. 1- 4%
- Basophils. 1/2- 1%

Agranular leukocytes:

- lymphocytes.20-30%
- Monocytes. 3-8%



Difference between RBCs & WBCs

RBCs

- 4,5- 5million / mm³
- Biconcave
- No nuclei. / no organelles
- Bag filled with hemoglobin
- Life span=120 days
- No amoeboid movement
- Function : carry O₂&CO₂

WBCs

- 4000-11000/ mm³
- Rounded
- Contain (nuclei+ organelles)
- No hemoglobin
- Life span= from **days** to **years**
- Amoeboid movement
- Defense & immunity

Neutrophils= Microphage (polymorphnuclear leukocytes)

Differential count **60-70%**

Size = **10-12** microns

Shape: rounded

LM:

Nucleus : **multilobulated** = 2-8 lobes

Barr body ?? Condensed chromatin
inactive **X- Chromosome in females**

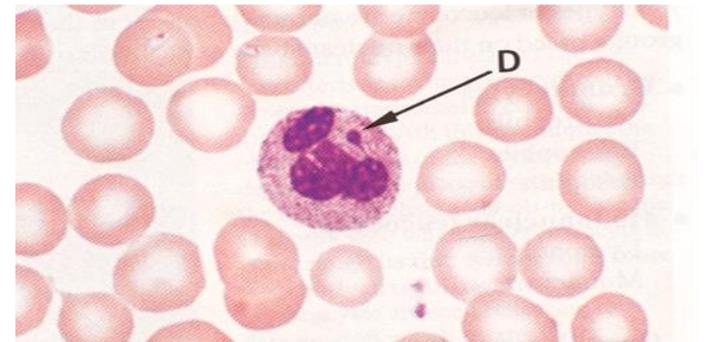
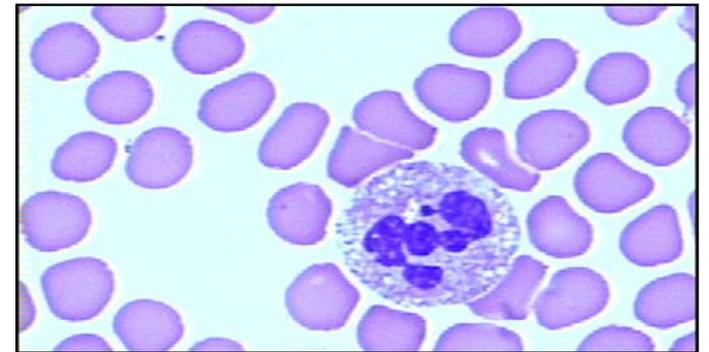
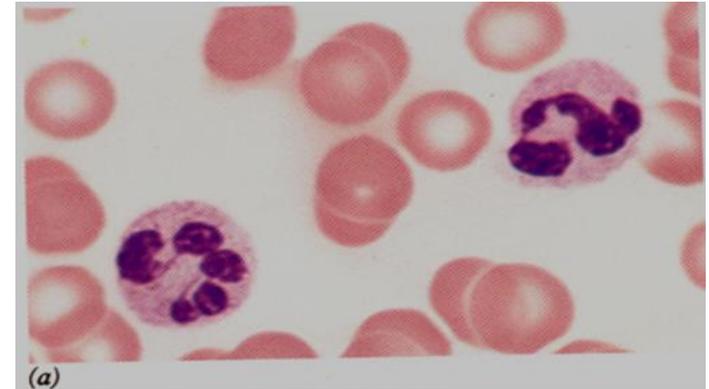
Cytoplasm: contains

❑ **Specific granules**

(neutral & small)

❑ **Non specific:**

azurophilic granules (few
& large ,stained by **azure**)

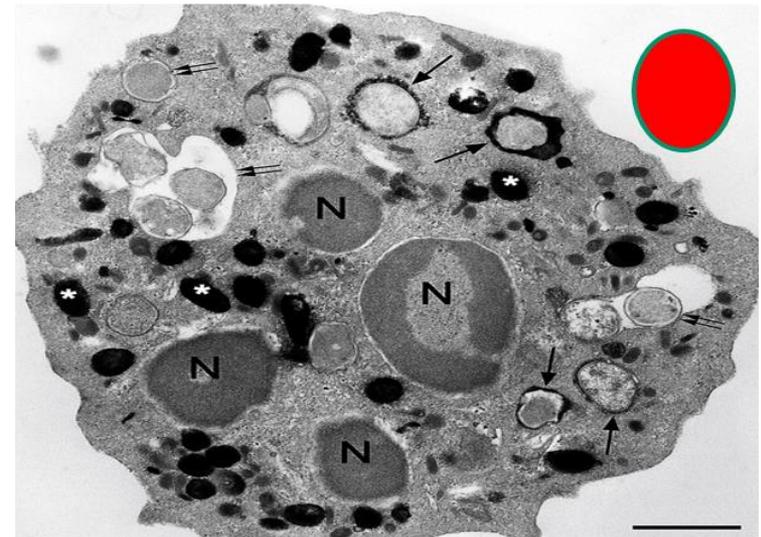
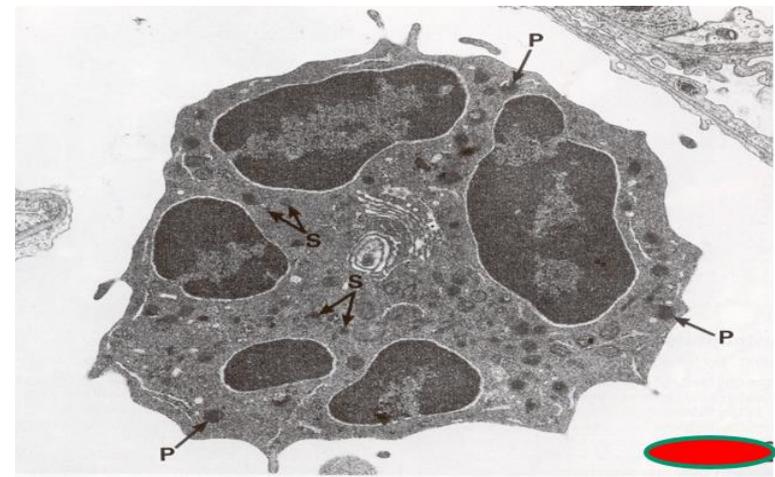


EM of Neutrophils

- Shape: irregular. When active
- Cytoplasm : Few organelles.
- **Granules:**
specific granules
Small , Numerous , Rice grain
appearance , **functional enzymes**
e.g. Collagenase

Non specific (Azurophilic)

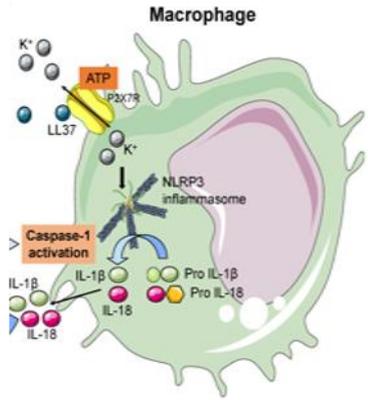
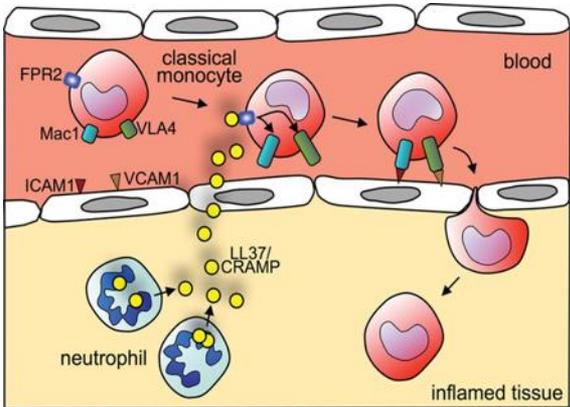
- **Large , few , dense**
Contain lysosomal hydrolytic
enzymes.



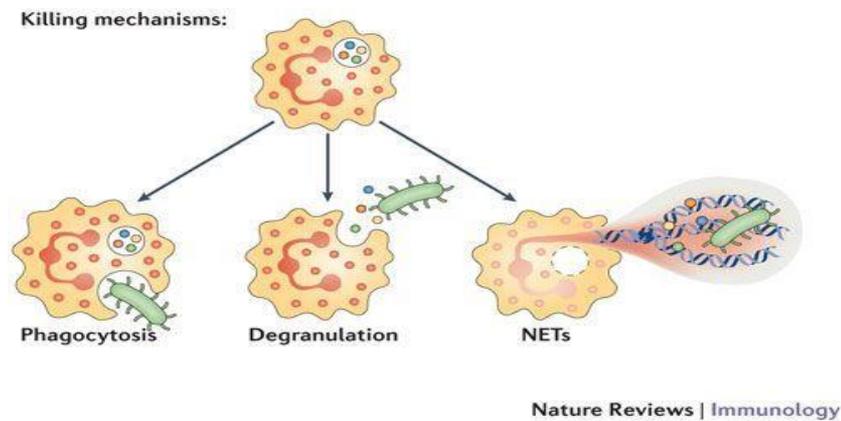
Functions

❑ The first line of defense.

- Micro-organisms in the C.T.
- Attraction of monocytes to the site of infection. ➡ Macrophages

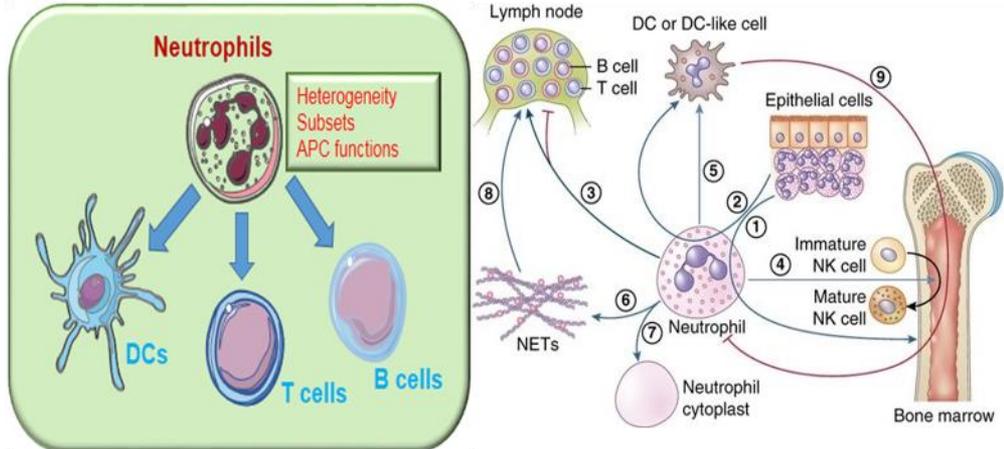
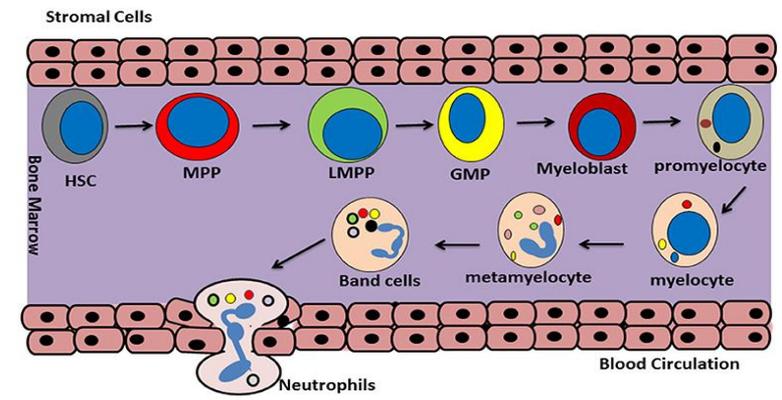


Phagocytosis → killing of bacteria by phagocytins (specific secondary granules)
 → **Secretion of cytokines**



- Stimulation of bone marrow to form new neutrophils

➤ Chemotaxis → migration →



➤ digestion by lysosomal enzymes (try, azurophilic granules)

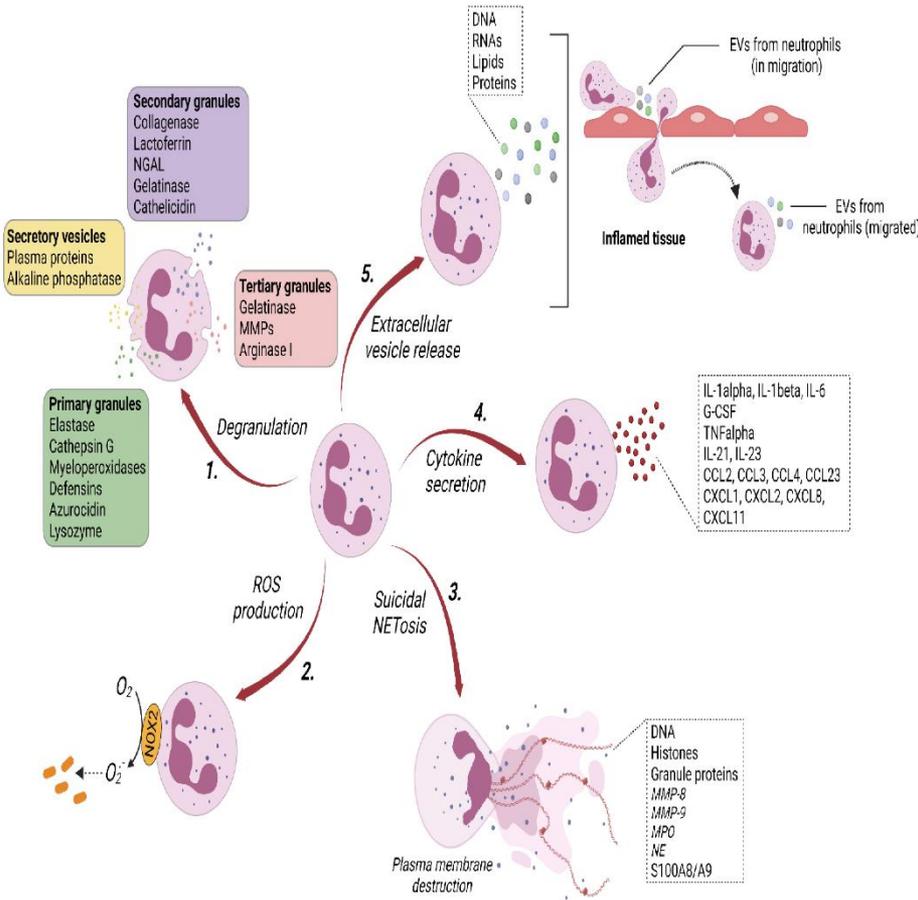
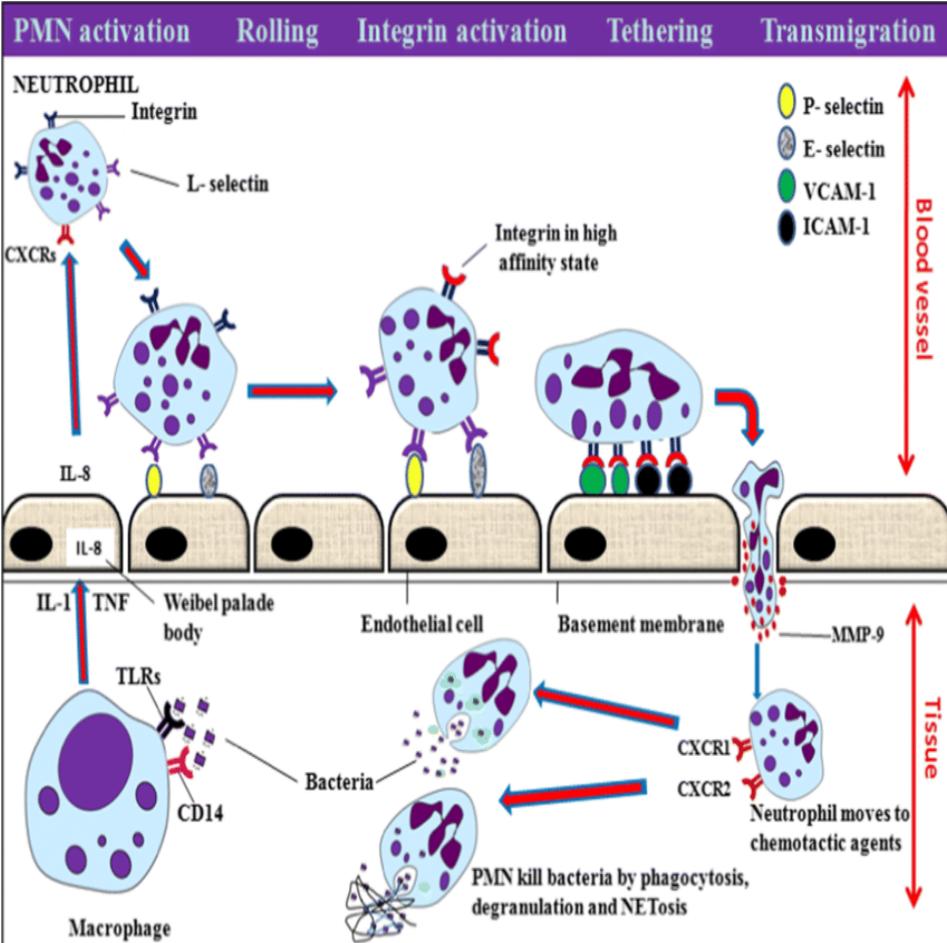
➤ destruction of invader & CT by **Collagenase**

• death of neutrophils Production of pus (**pus cells**)

Life span: 1- 4 days in blood

Neutrophil and macrophage activation and migration at the site of inflammation.

The main phagocytic cells are macrophages in the tissues and neutrophils in the bloodstream. Initially, macrophages in the tissue sense the presence of invaders ➔ act on the endothelial cells (ECs) and cause the release of interleukin binds to receptors on neutrophil surface causing neutrophil activation. ➔ Activated neutrophil helps in transmigration. Chemokine receptors help neutrophils to move towards chemotactic gradients and after reaching its target, they attach, ingest and kill the foreign agent by various mechanisms



Abnormality of neutrophil count

Neutrophilia ▲ ▲

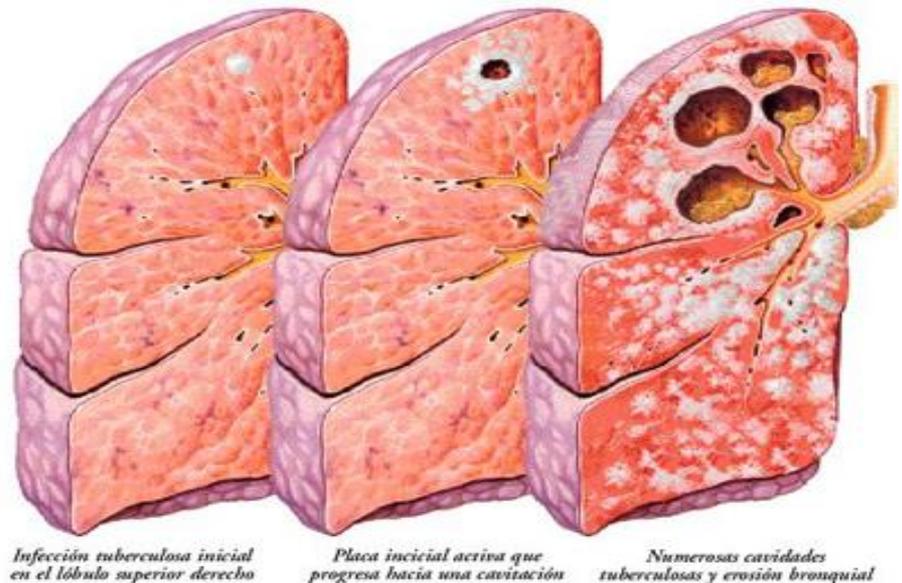
in **acute pyogenic infection** =
acute inflammations e.g.:

- ❖ Appendicitis
- ❖ Tonsillitis



Neutropenia: ▼ ▼

- ❖ Chronic infection e.g. TB
- ❖ Severe viral infection e.g. Influenza , Measles

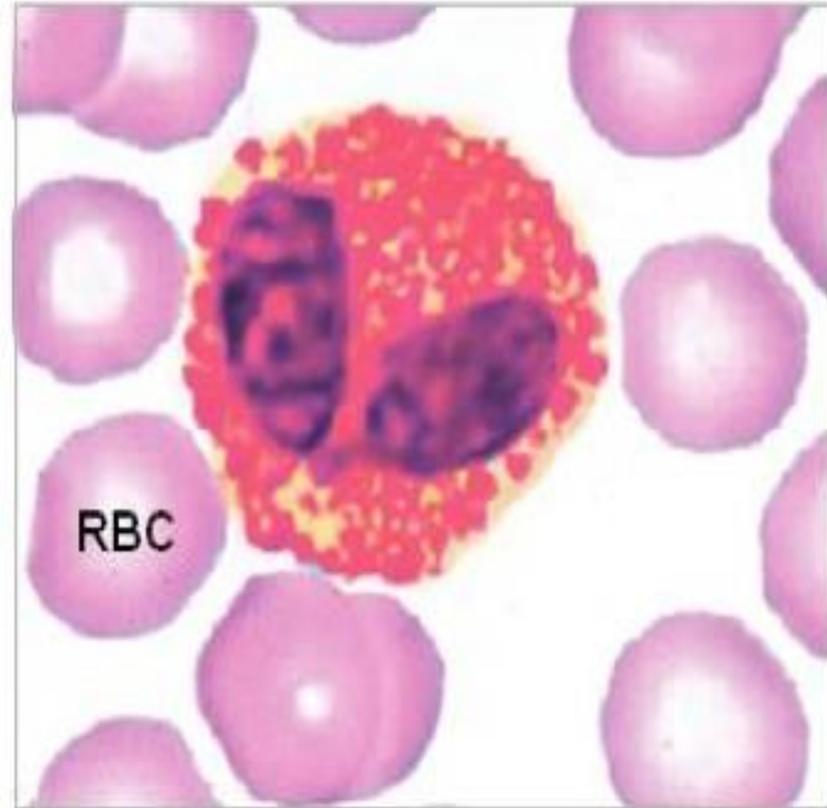


Eosinophils

- ❑ **Differential count** : 1- 4%
- ❑ **Size** : 12-15 microns.
- ❑ **Shape**: rounded
- ❑ **L.M.**

- ❑ **Nucleus**: bilobed C- shape

- ❑ **Cytoplasm** contains:
 - large **specific acidophilic granules**.
 - Few azurophilic granules

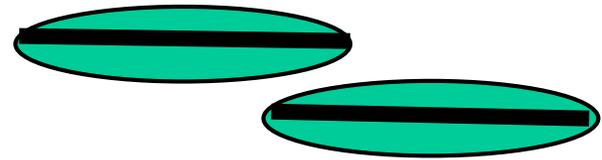
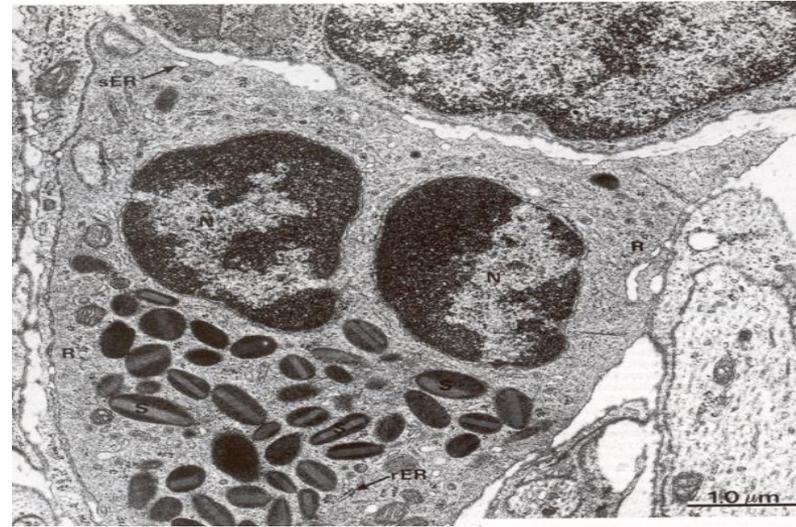


E.M:

- Bilobed C- shaped nucleus
- Cytoplasm contains
- Few organelles mitochondria, rER, & sER & glycogen
- **Specific granules** (Large, ovoid, crystalloid core contain many hydrolytic enzymes histaminase, eosinophil peroxidase)
- Few non specific granules

= **azurophilic granules**

Small, spherical Lysosomal hydrolytic enzymes



Function of Eosinophils

- Migrate to mucosa of GIT, respiratory, genito-urinary & skin.
- regulation of allergic reactions.
- Parasitic infection. (Not phagocytic)

Life span: several days up to week

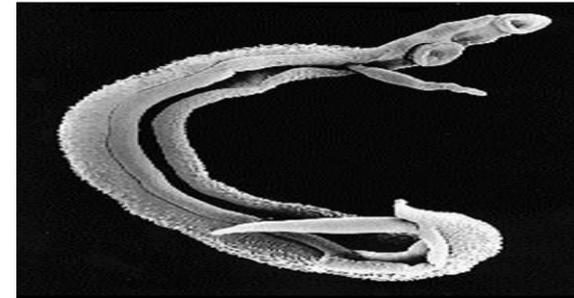
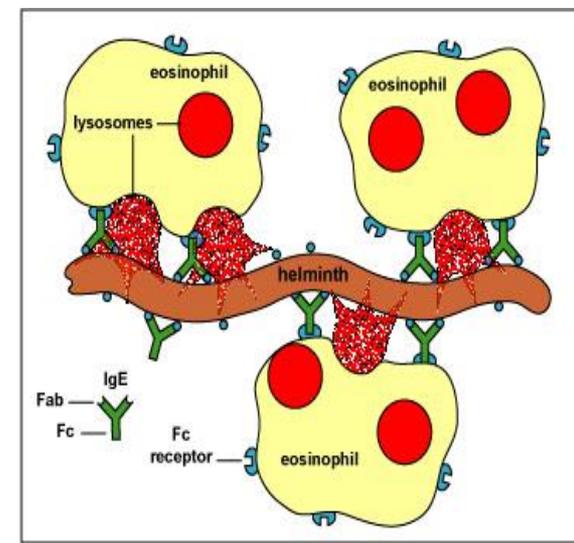
Abnormal Eosinophil Count

❑ **Eosinophilia = increase** ▲ ▲

- **Allergic** reactions e.g. bronchial asthma, allergy, **parasitic** infections e.g. Bilharziasis.

❑ **Eosinopenia = decrease** ▼ ▼

- Steroid therapy. Bone marrow depression.



Basophils

Mast cell of the blood

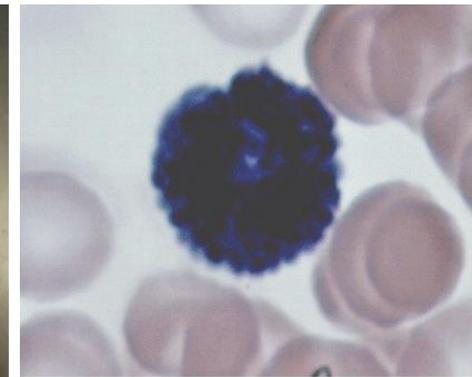
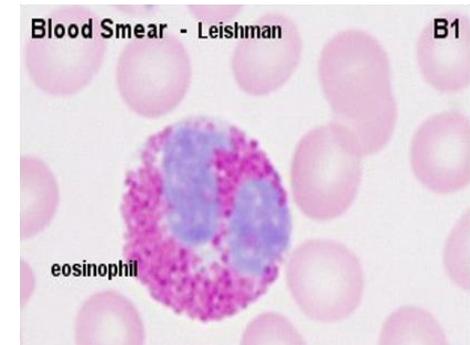
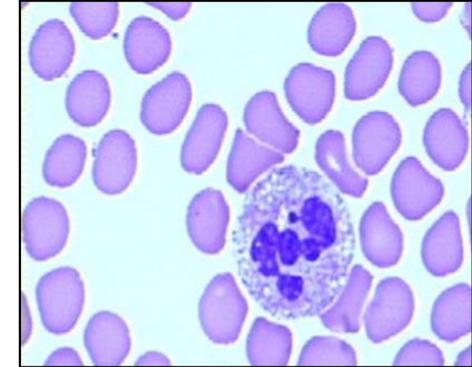
Differential count : $\frac{1}{2}$ - 1%

Size : **10** microns

Shape : Rounded

LM:

- **Nucleus:** Bilobed, (**S-shaped**)
- ❖ **obscured by large granules**
- **Cytoplasm:**
- ❖ **abundant deep blue granules.**
- ❖ **Metachromasia.**



E.M.

Nucleus : Bilobed S shape nucleus

Cytoplasm: mitochondria, ribosomes,
glycogen

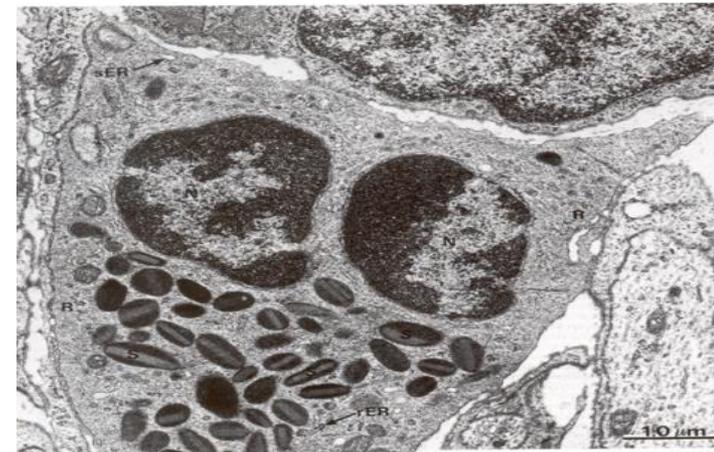
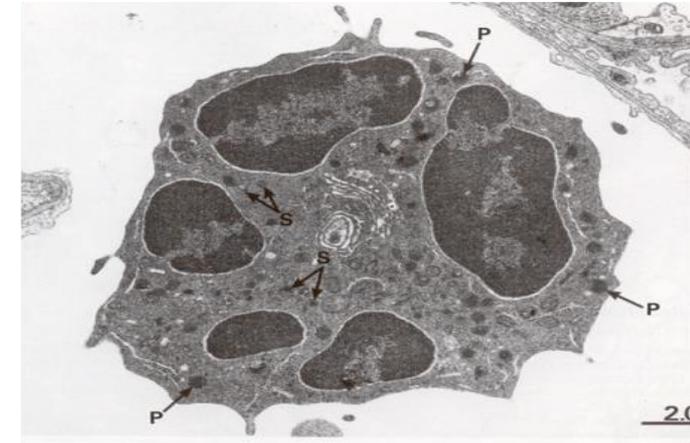
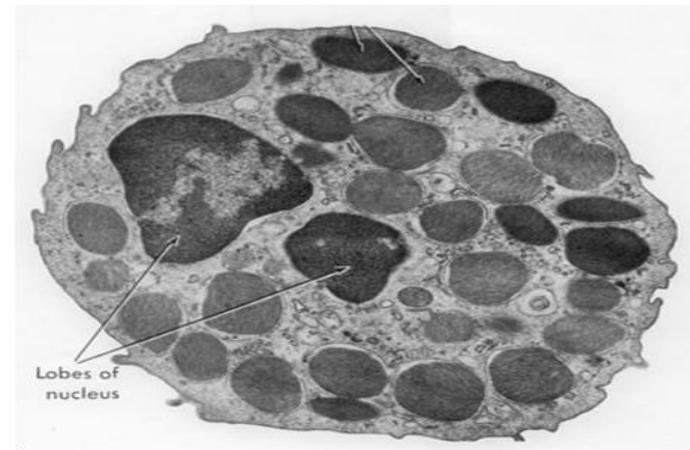
Granules :

specific granules

- Large, contain histamine, heparin

Non specific (azurophilic granules)

- Contain lysosomal hydrolytic enzymes.

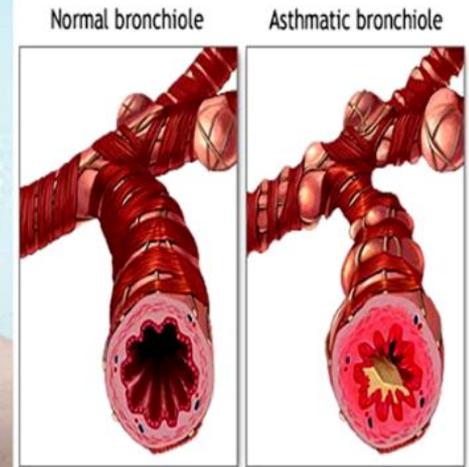
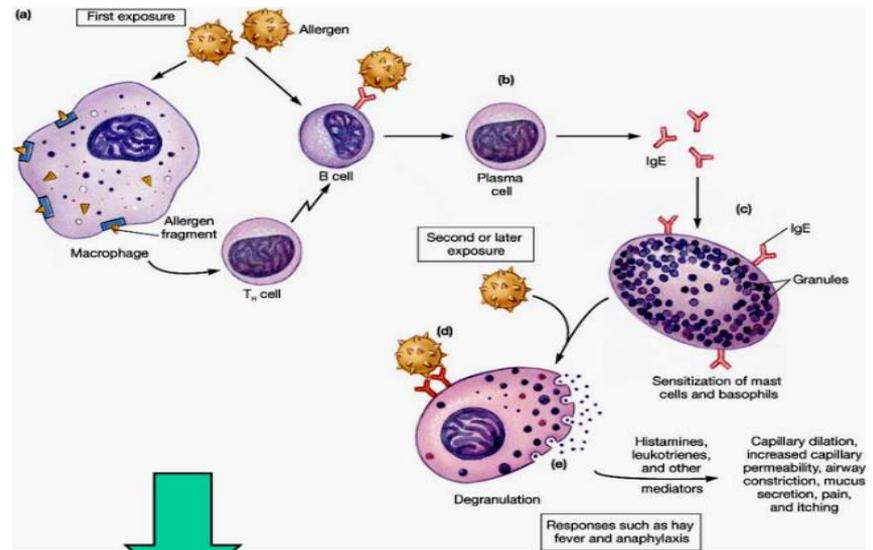


Functions

=Mast cell of blood:=

- **heparin:** anticoagulant
- **histamine:** (anaphylaxis)
- Secretion of histamine which initiates allergic reactions.
- Secretion of heparin which is a natural anti-coagulant.
- Secretion of eosinophil chemotactic factor to limit allergic reaction.

hypersensitivity reaction



Life span: **1-2** week

Abnormal count

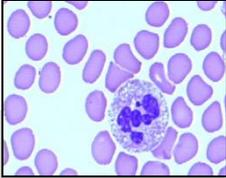
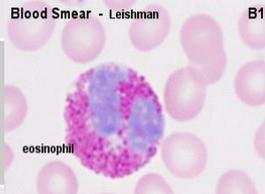
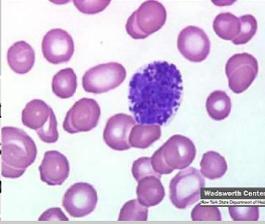
Basophilia:increase ▲ ▲

➤ viral infections e.g.

small pox and chicken pox.

➤ **Systemic allergy**



	Neutrophils	Eosinophils	Basophils mast cell of the blood .
Number	60-70% of leukocytic count	1-4% of leukocytic count	0-1% of leukocytic count
Size	10-12 μm in diameter 	larger than neutrophils (12-15 μm in diameter,	(10 mm) in diameter,
Shape	spherical in shape + Neutral granules	spherical in shape + Acidophilic granules	spherical in shape (basophilic) specific granules with heparin and histamine
Structure	multi-lobed nucleus human females may have inactivated second X chromosome (Barr body drum stick)	bi-lobed nucleus C-shape or	S-shape lobed nucleus, obscured by basophilic granules
Life span	lifespan 1-4 days in circulation;	several days Up to week 	1-2 weeks 
Function	first line of defense against any invading micro-organism	<ul style="list-style-type: none"> • Kill parasites, • associated with allergic reactions 	Basophils are 1 release of Hist allergic reactio
Abnormality	Neutrophilia: i.e. abnormal increase in the number of neutrophils. This is observed in acute inflammations e.g. appendicitis, tonsillitis. Neutropenia: i.e. abnormal decrease in the number of neutrophils e.g. in influenza, typhoid fever.	<u>1-Eosinophilia:</u> i.e. abnormal increase in the number - Allergic reactions e.g. asthma, urticaria -Parasitic infections e.g. Bilharziasis. <u>2-Eosinopenia:</u> i.e. 1 decrease in the number prolonged corticosteroid therapy .	Basophilia in systemic allergic reaction

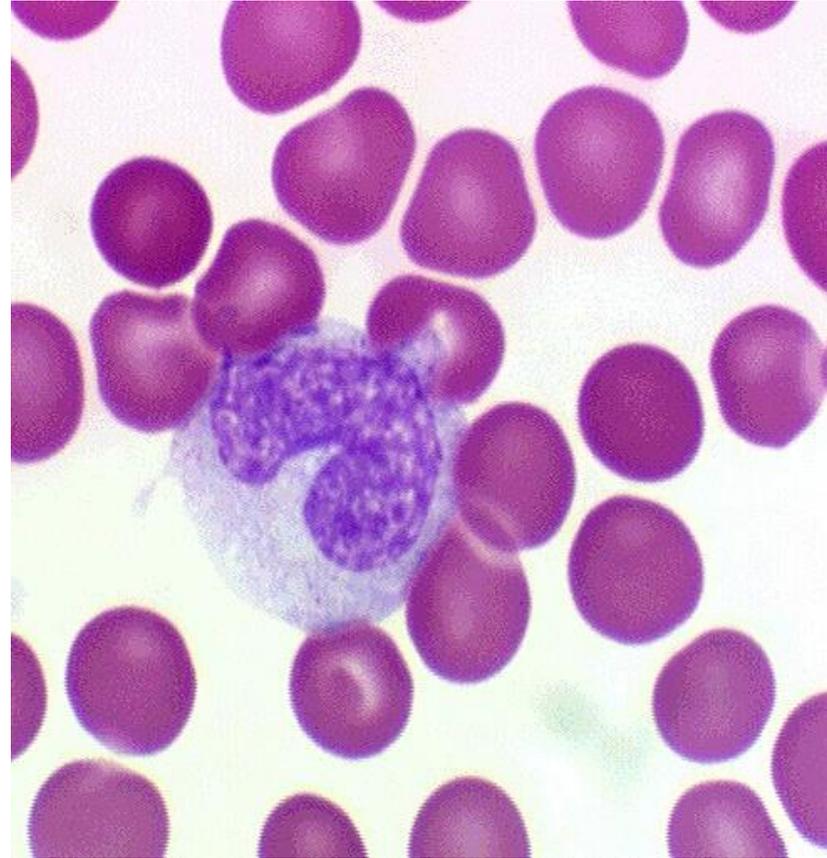
Agranular leukocytes

Monocyte

- **Differential count: 3 - 8%**
- **Size : 20 microns = Largest** in blood film
- **Shape : rounded**

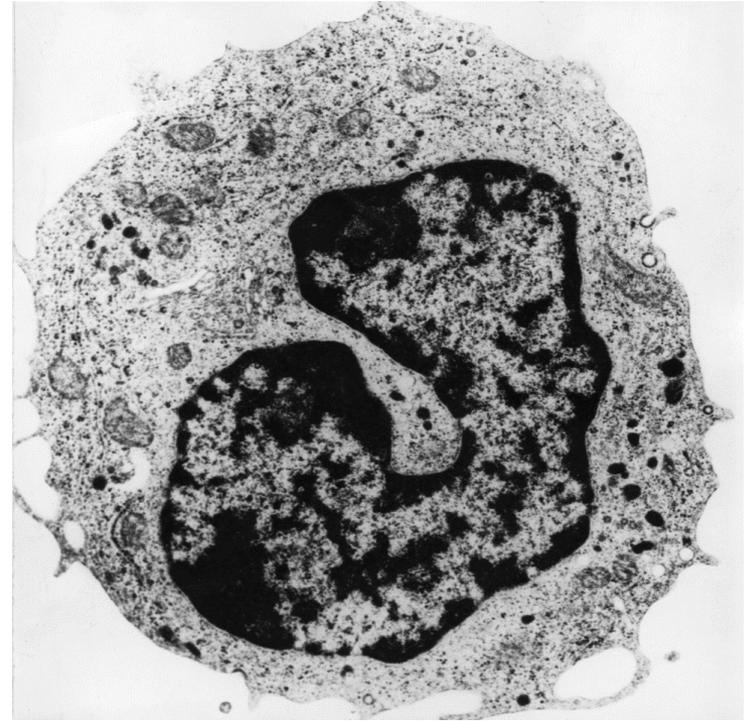
LM:

- **Nucleus:**
 - ❖ Large, eccentric , Kidney- shaped (**Indented**)
- **Cytoplasm:**
 - ❖ Finely granular, abundant pale basophilic non specific granules
=Azurophilic granules



EM:

- ❑ Irregular = Pseudopodia
- ❑ Nucleus: Large, eccentric kidney-shaped (Indented)
- ❑ The cytoplasm contains
 - a moderate amount of organelles.
 - Non specific (Azurophilic granules) few small dense granules containing lysosomal hydrolytic enzymes.



Function :

- Trans- migration & differentiation to tissue

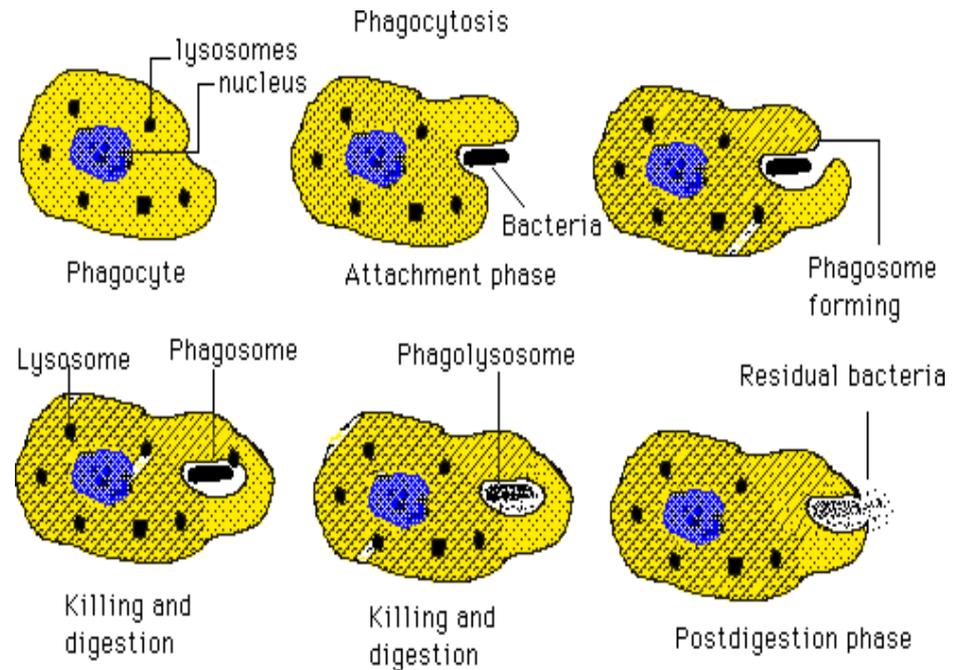
MACROPHAGE

- Immunologic function:

- Phagocytosis and intracellular digestion of bacteria, virus
- Ag- presenting cell

Life span : 1-2 days

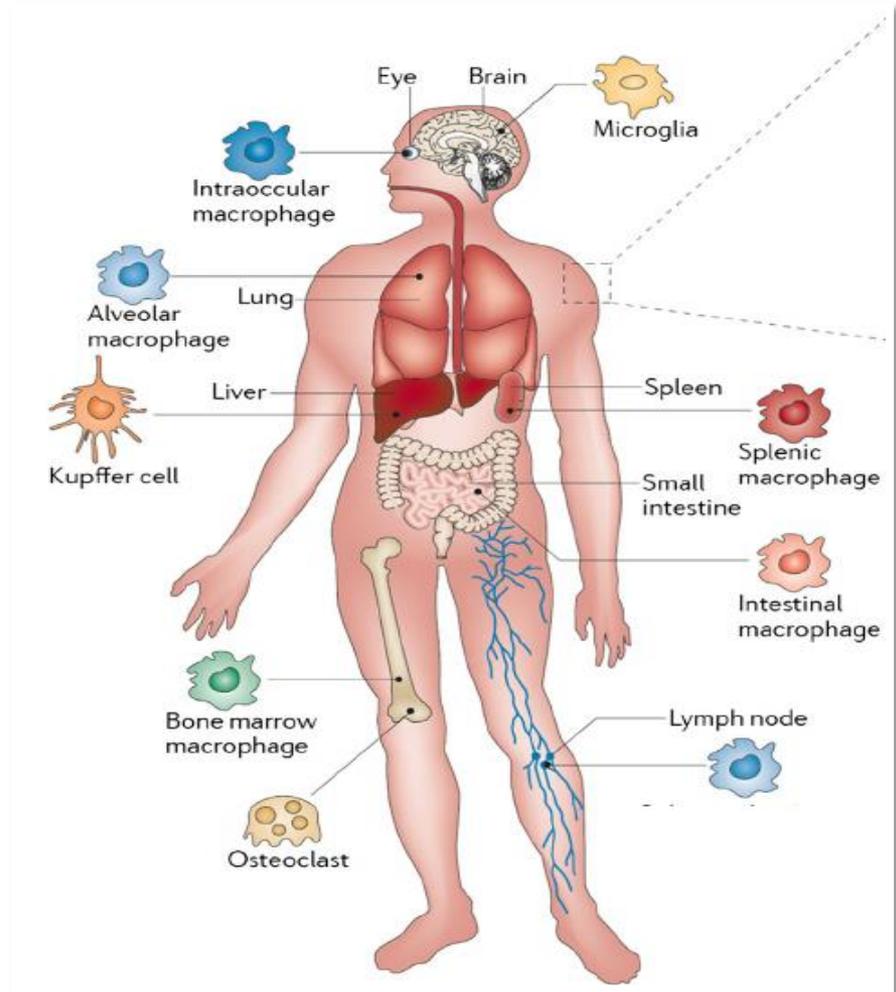
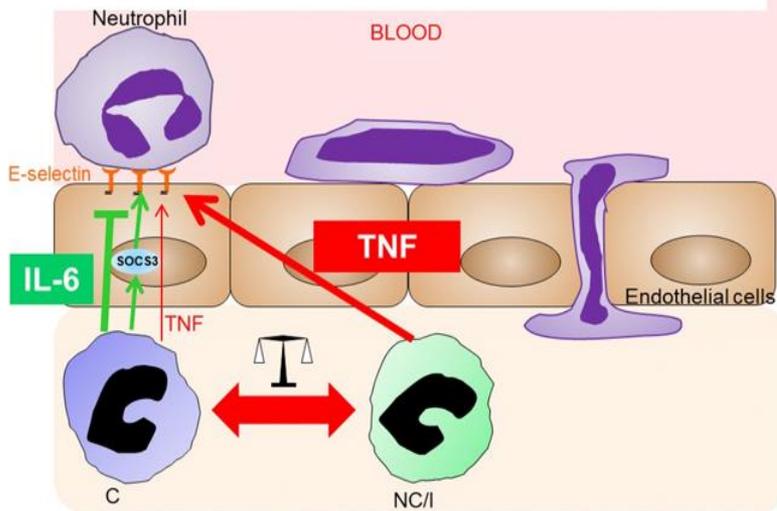
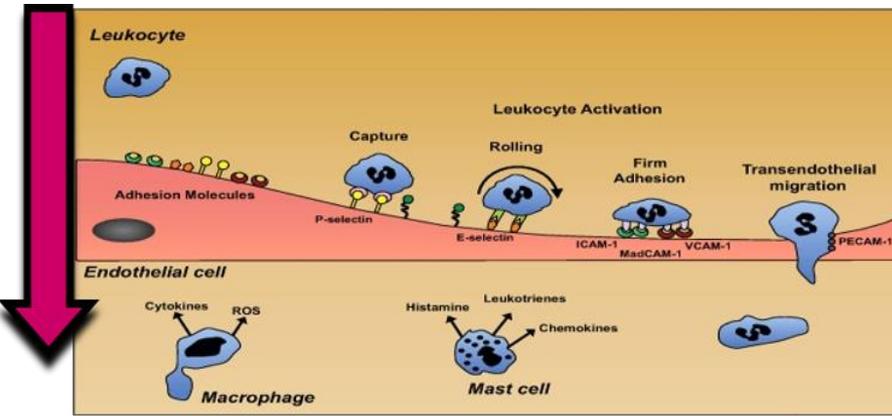
circulation in the blood, then enter the CT and transform into macrophages



- Circulate from region to another & Function in CT=

Immunological function

Mononuclear phagocytic cells



Abnormal Monocyte count

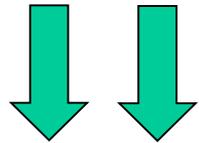
Increase number = Monocytosis

Causes:

1- Malaria

2- Chronic infections (glandular fever , syphilis, T.B.)

3-Lymphomas & Leukemia.

 in number of **Monocyte**

Causes:

▪ **Bone marrow depression**

➤ drugs

➤ Irradiation

➤ Severe chronic diseases

Lymphocytes

- Differential count: 20-30%

- Size : 9-12 microns

- According to the sizes:

➤ large lymphocytes.

➤ Medium-sized lymphocytes.

➤ Small lymphocytes:



❖ Diameter = RBC.

❖ Most numerous.

❖ Functionally mature.

3 functional types:

➤ T- lymphocytes:

- Start development in bone marrow.
- Differentiate in thymus.
- Cell-mediated IR.

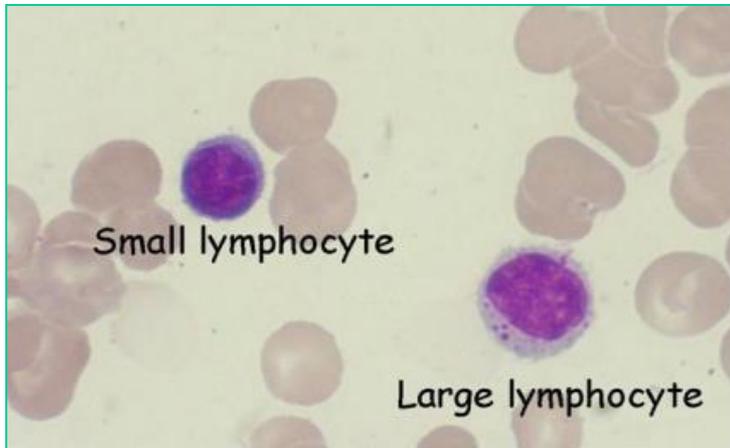
➤ B-lymphocytes:

- Develop & differentiate in bone marrow.
- Humoral immune response.

➤ Natural killer cells = Null cells

➤ Develop in bone marrow.

- Lack CDs of B or T.
- Are null cells(non B, nonT).
- They don't enter the thymus to be competent.
- They act nonspecifically to kill virally infected cells & tumor cells

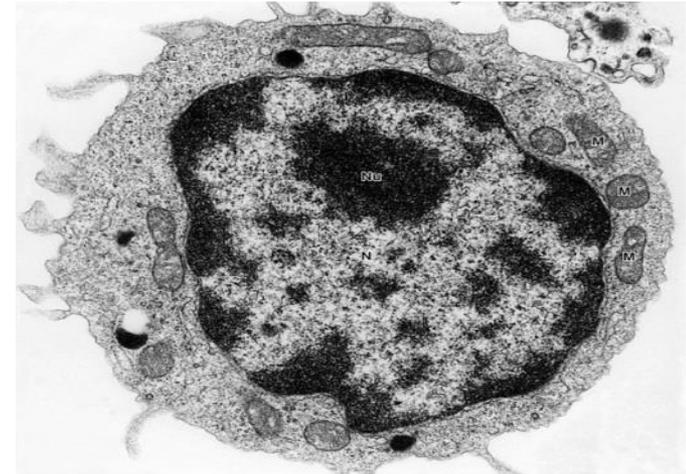


❖ LM:

- **Shape = rounded**
- Large nucleus, thin cytoplasmic rim
- No stained granules in the cytoplasm (except small **Azurophilic granules**)
- **Small most common 90%**
- **Types: B- and T-lymphocytes (morphologically not distinguishable)**
- **Null-cells** (somewhat smaller size) Non B Non T

❖ EM:

- **Nucleus:** dense clumps.
- **Cytoplasm thin rim**
- No specific granules
Lysosomes= small & dense **Azurophilic granules**
- Many **free ribosomes** & few **mitochondria + 2 centrioles**
- ▲▲ The cell coat = **antigenic markers.**



Antigenic markers of lymphocytes

The cell coat: Large no. of cell receptors.

1. Major histocompatibility complex (MHC)

Glycoprotein + specific a.a. sequence.

- Tissue typing & antigenic recognition.
- 2 subclasses:
MHC I & MHC II.

2- The cluster of differentiation antigens (CDs):

- Cell- surface glycoprotein + specific a.a. sequence.
- Expressed on **different types of lymphocytes**
- Marker proteins upon which 

Functional types of lymphocytes.

Antigenic markers of lymphocytes

Major histocompatibility complex (MHC)

❖ MHC I:

- On all nucleated cells.
- Glycoprotein + specific a.a. sequence.
- Tissue typing.
- Endogenous antigenic recognition:
 - virus- infected cells.
 - malignant cells.

❖ MHC II:

- Expressed on antigen-presenting cells.
- Glycoprotein + specific a.a. sequence.
- Tissue typing.
- Exogenous antigenic recognition:
 - Phagocytosed foreign Ags.

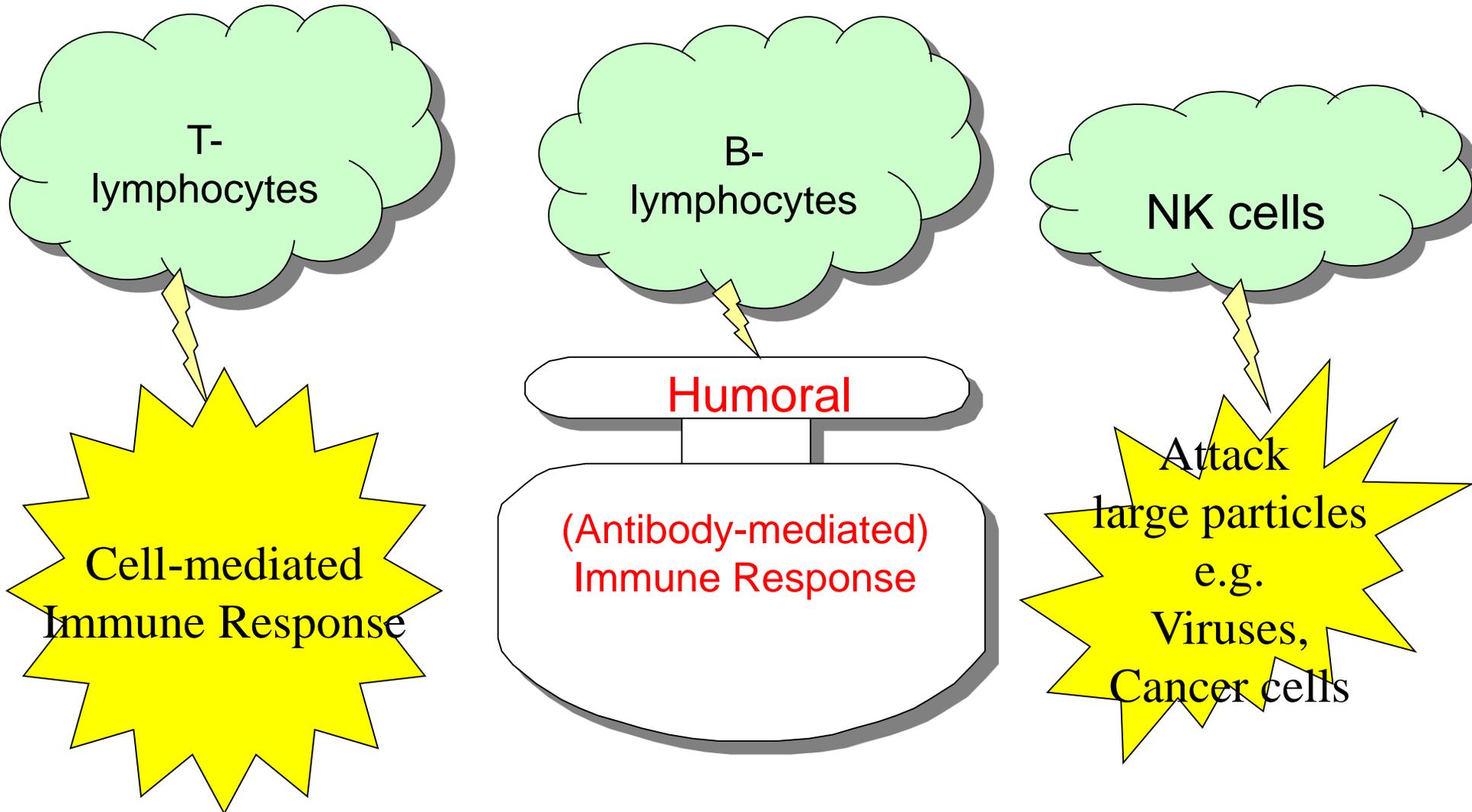
Function :

- ✦ After stimulation T-cells and B-cells become : Effector cells & Memory cells
- ✦ B cells form plasma cells, function in humoral immunity via immunoglobulins
- ✦ T cells function in cell-mediated immunity
- ✦ Effector T-cells: T helper cells, T suppressor cells, cytotoxic T cells
- ✦ Some T cells with “memory” of antigen exposure survive long periods; immunization
- ✦ Null Cells are composed of: Stem cells and Natural killer cells
- ✦ NK cells kill some foreign and virally alerted cells

❖ Life span:

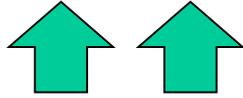
- months-----
years

Functions of Lymphocytes



Abnormal lymphocyte count

1-Lymphocytosis:



Causes:

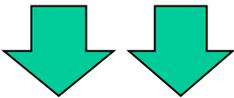
Physiological: in children

Pathological:

1-chronic infections tuberculosis, syphilis,

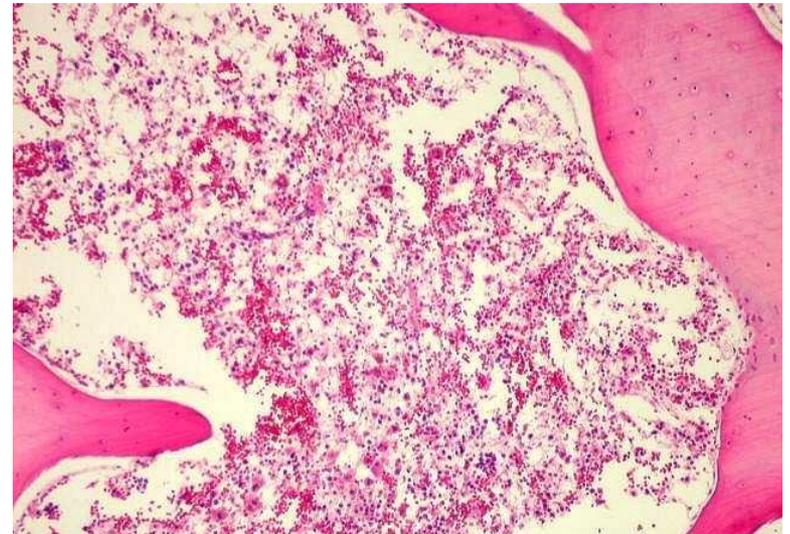
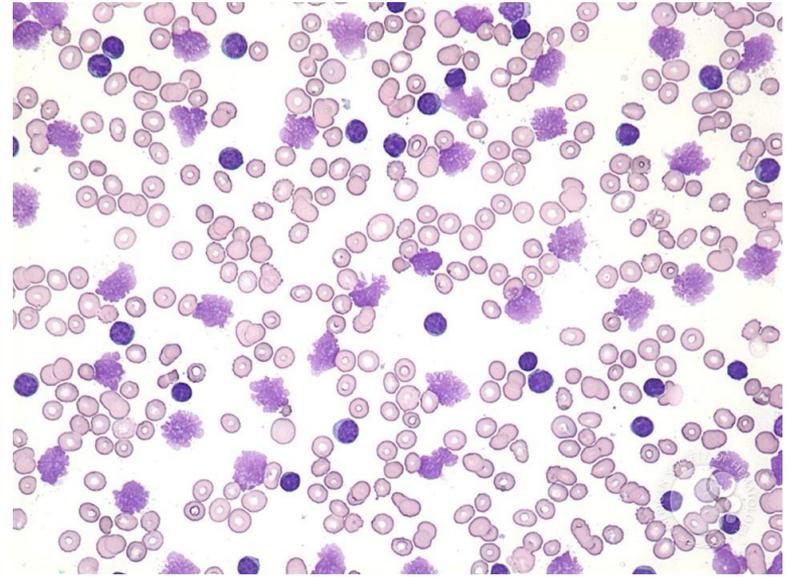
2-leukemia, Lymphoma.

2-Lymphopenia:



Bone marrow depression.

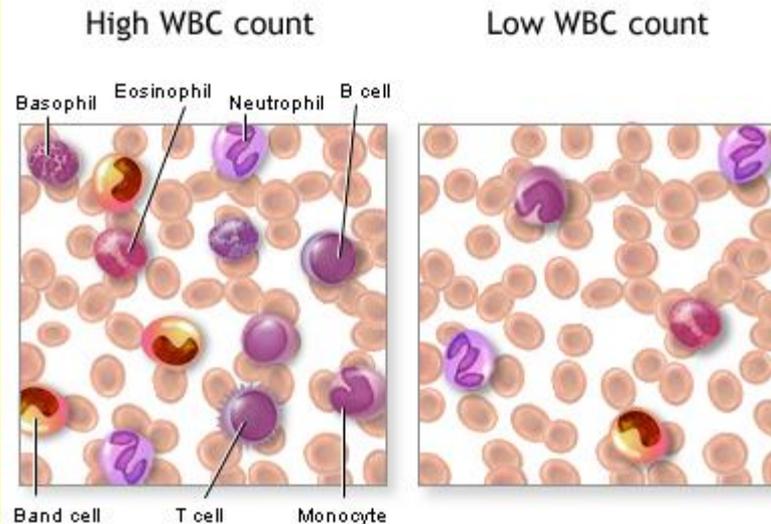
- ❖ drugs
- ❖ Irradiation
- ❖ Severe chronic diseases



Abnormalities in leukocytic count

leukocytosis

- Infection
- Inflammations
- Allergic reaction
- Leukaemia



- Bone marrow depression
- drugs
- Irradiation
- Severe chronic diseases
- Typhoid fever
- Measles

Leukopenia

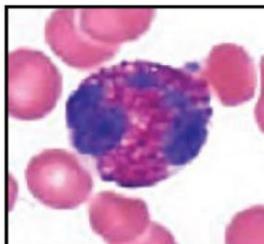
Acquired Causes of decrease in number

Decreased Production	Increased Destruction	Shift to Marginating Pool
Bone marrow	Peripheral circulation	Move from the circulating pool to attach along the vessel wall
Medication: Chemotherapy Antibiotics, etc	Autoimmune diseases (Rheumatoid arthritis, SLE, etc)	Severe infection Endotoxin release Hemodialysis Cardiopulmonary bypass

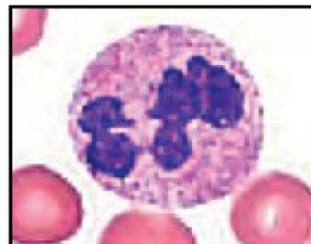
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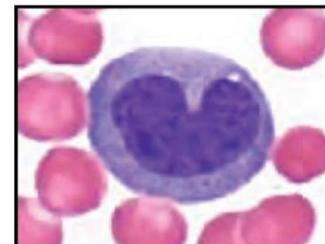
Basophil



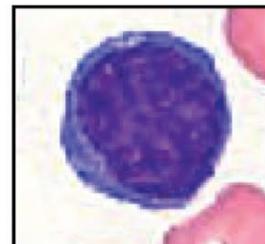
Eosinophil



Neutrophil



Monocyte



Lymphocyte

Monocyte

Lymphocyte

Subsets T, B, natural killer

Number	3-8% of WBCs	20-25 % of WBCs Next most common after neutrophils
Size	12-20 μm diameter	9-11 μm diameter Small , medium , large
Shape	Spherical	Spherical
Structure	Spherical , Nucleus kidney-shaped No obvious granules	Spherical , Nucleus indented No obvious granules
Life span	Circulate for 3-4 days before enter into tissues and organs	variable life spans Month – years (memory cell)
Function	Precursor of <u>macrophages</u> in tissues Macro = “big”; phage = “eat” Phagocytic function	B Cells involved in humoral immunity T Cells involved in cell-mediated immunity <ul style="list-style-type: none"> • T helper cells, • T suppressor cells, • cytotoxic T c & memory cell
Abnormality	<i>Monocytosis</i> : is an abnormal increase in the number of blood monocytes. It occurs in diseases like tuberculosis, malaria, and leukemia.	<i>Lymphocytosis</i> : It is an abnormal increase in the number of lymphocytes as in: leukemia, lymphoma, and viral infections.

