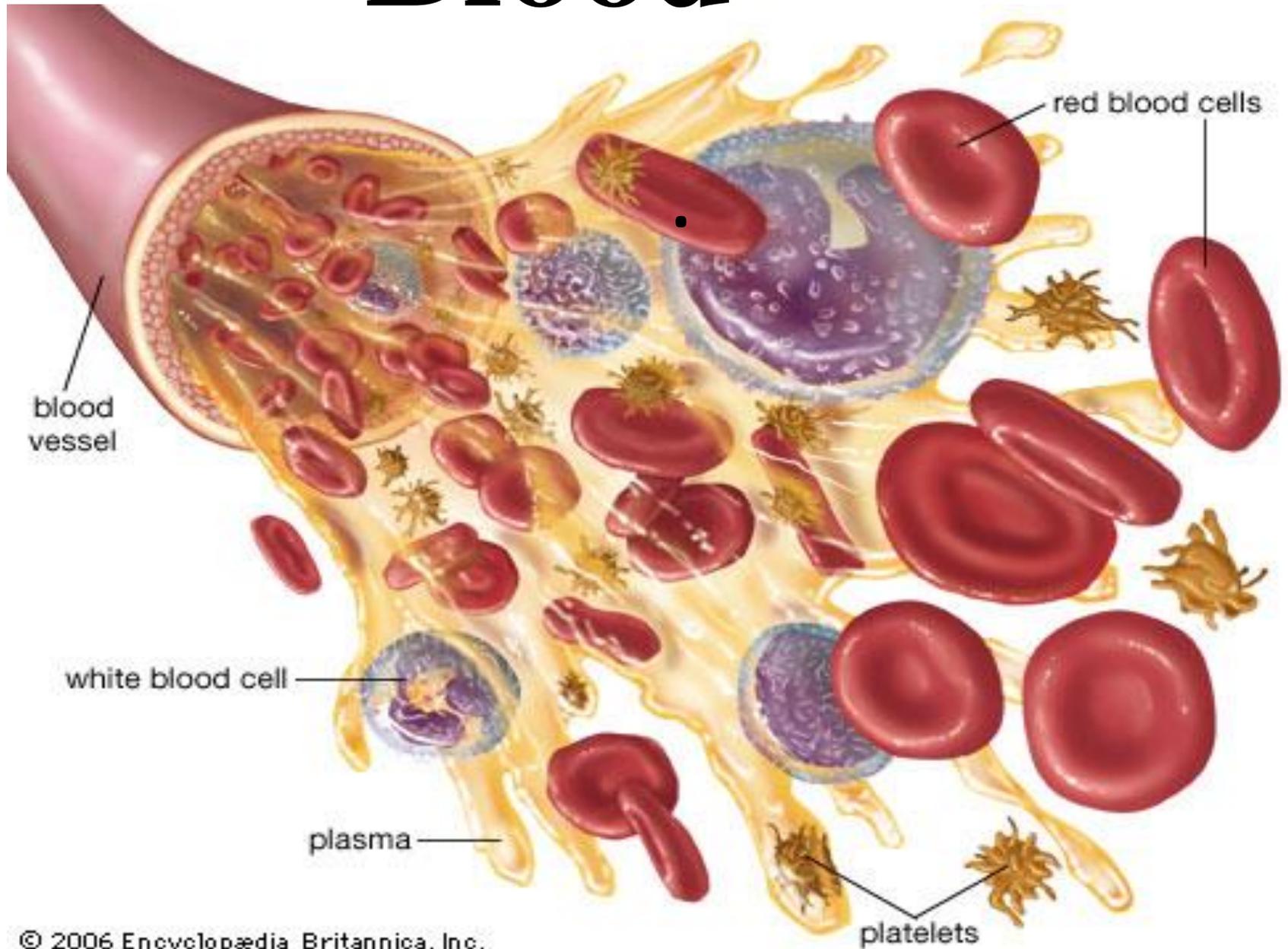
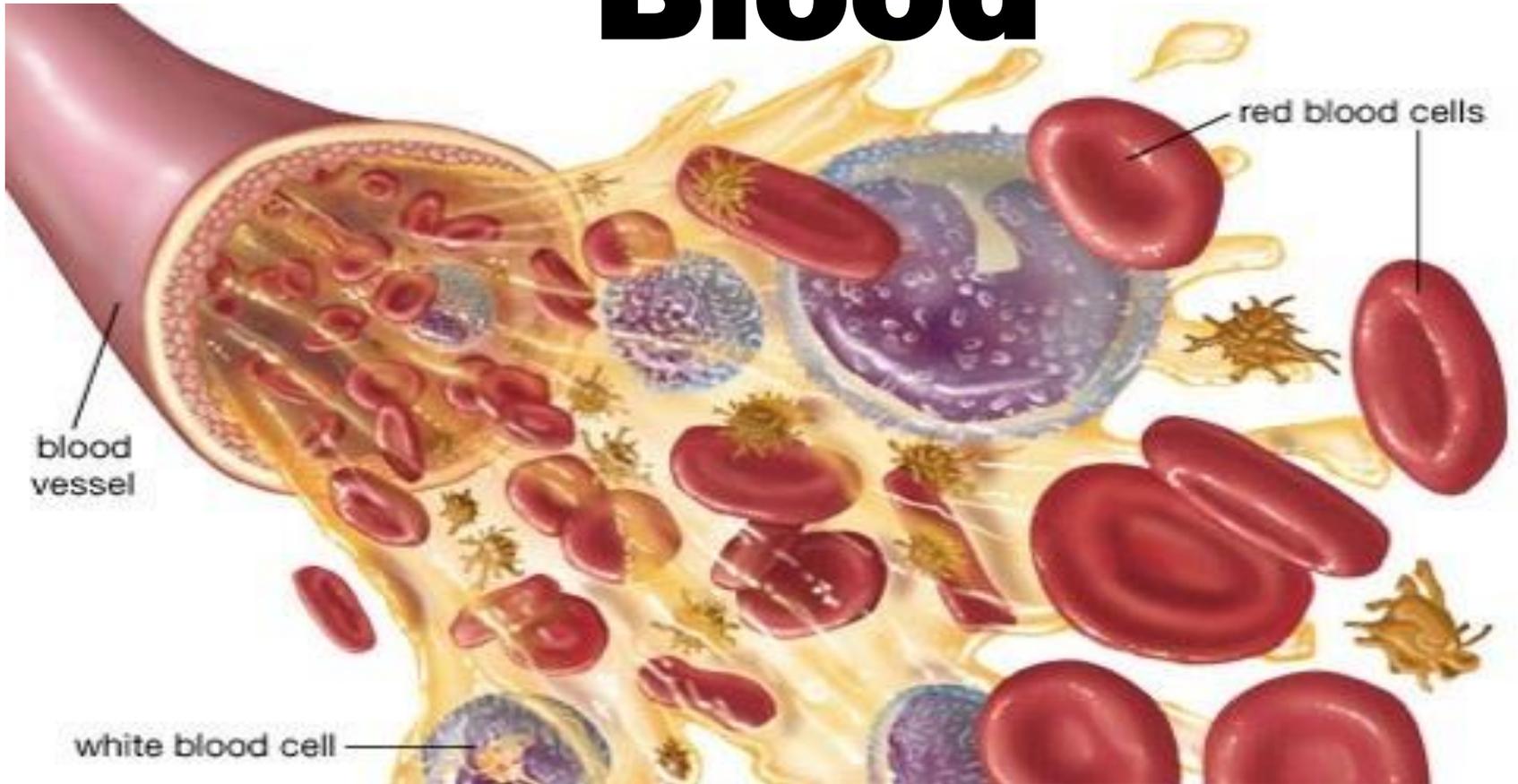


# Blood



# Blood



# leucocytes

# The formed blood elements

45 % of blood volume

❖ **Red blood corpuscles**  
= **Erythrocytes**  
(RBCs)

❖ **Blood platelets**  
= **Thrombocytes**

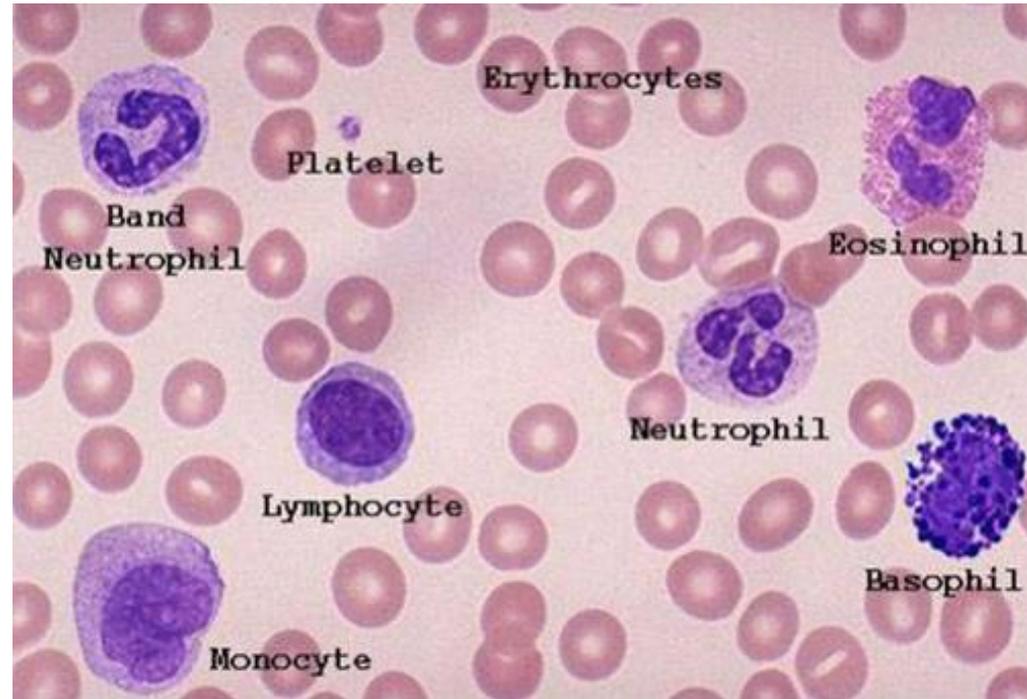
❖ **White blood cells**  
= **Leucocytes**  
(WBCs):

**1- Granular leucocytes**

(neutrophils, eosinophils, basophils)

**2- Agranular leucocytes**

(lymphocytes, monocytes)



## Stains of blood film

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

▶ basophilic (**violet**)

▶ eosinophilic (**pink**)

▶ azurophilic (**red purple**)

# Difference between RBCs & WBCs

## RBCs

- 4-5.5million/micro-liter/  
mm<sup>3</sup>
- Biconcave
- No nuclei. / no organelles
- Contain hemoglobin
- Life span=120 days
- No amoeboid movement
- Function : carry O<sub>2</sub>&CO<sub>2</sub>

## WBCs

- 4000-11000/micro-liter  
**=mm<sup>3</sup> blood.**
- Rounded
- (nuclei+ organelles)
- No hemoglobin
- From **days** to **years**
- Amoeboid movement
- Defense & immunity

# Leukocytes (WBCs)

## Normal total Count

4000-11,000 / mm<sup>3</sup> blood.

### Granular leukocytes:

1-Neutrophils. 60-70-%

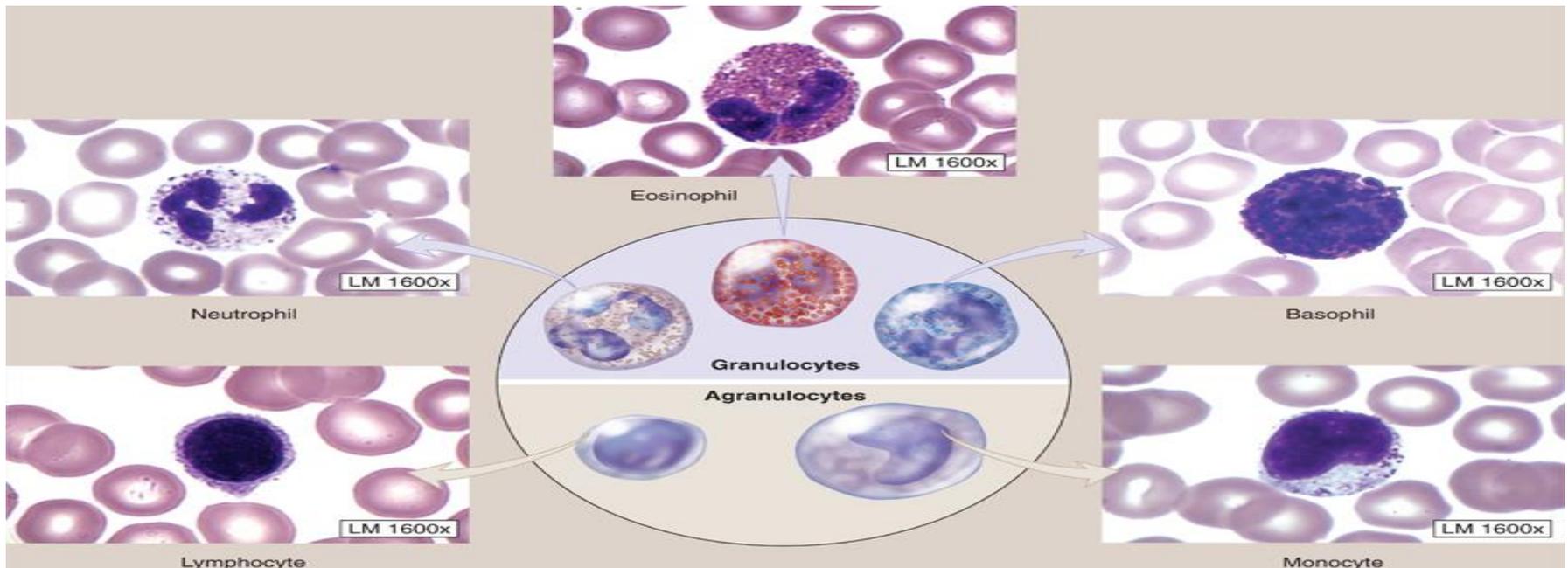
2-Eosinophils. 1-4%

3-Basophils. 1/2- 1%

### Agranular leukocytes:

1- lymphocytes.20-30%

2- Monocytes. 3-8%



# Neutrophils= Microphage =polymorphnuclear leucocytes =Pus cells

- ❑ Differential count **60-70%**
- ❑ Diameter=**10-12** microns
- ❑ Shape: **rounded**

## LM:

Nucleus : **multilobulated.**

2-8 lobes

**Barr body ??** Condensed **inactive X-**

Chromosome in females

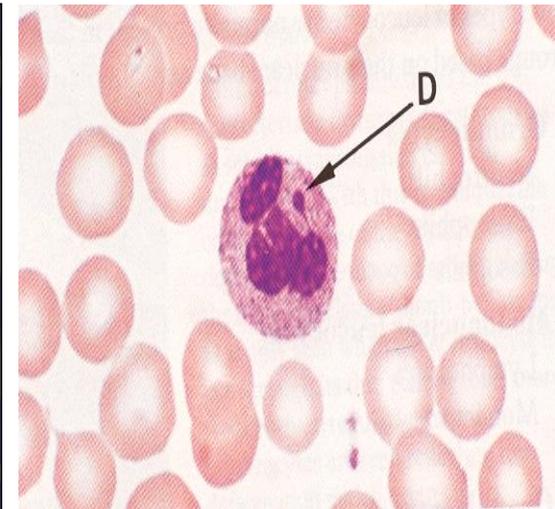
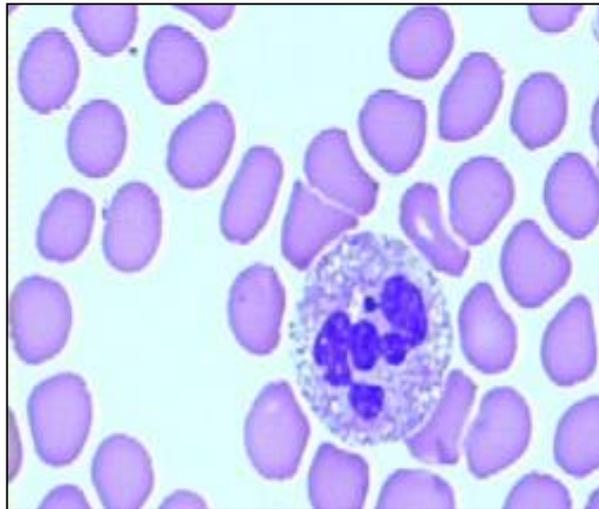
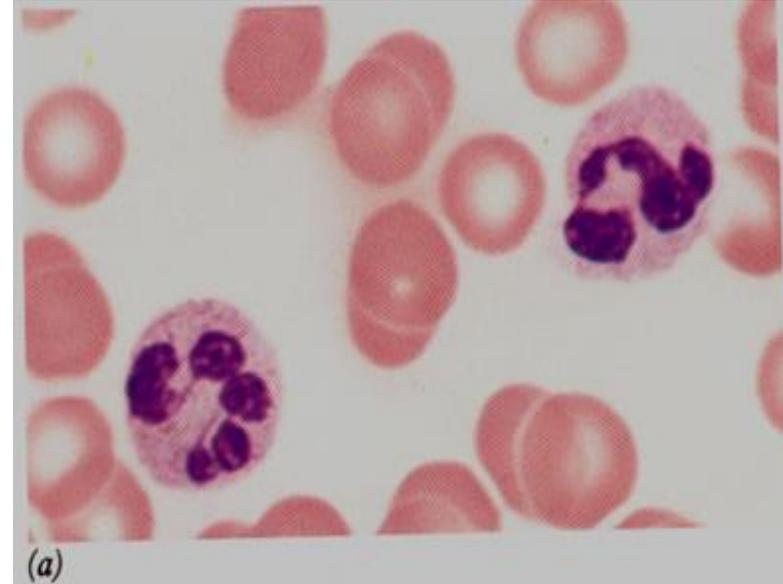
📄 Cytoplasm: contains

**1- specific granules**

(neutral & small )

**2- non specific:**

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



# EM of Neutrophil

**Shape:** irregular. When active

• Cytoplasm:

❖ Few organelles.

❖ **Granules:**

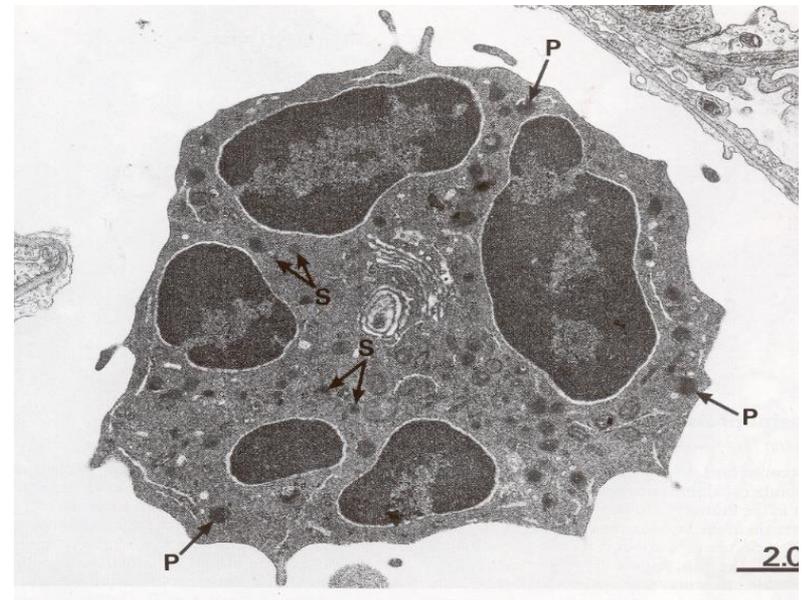
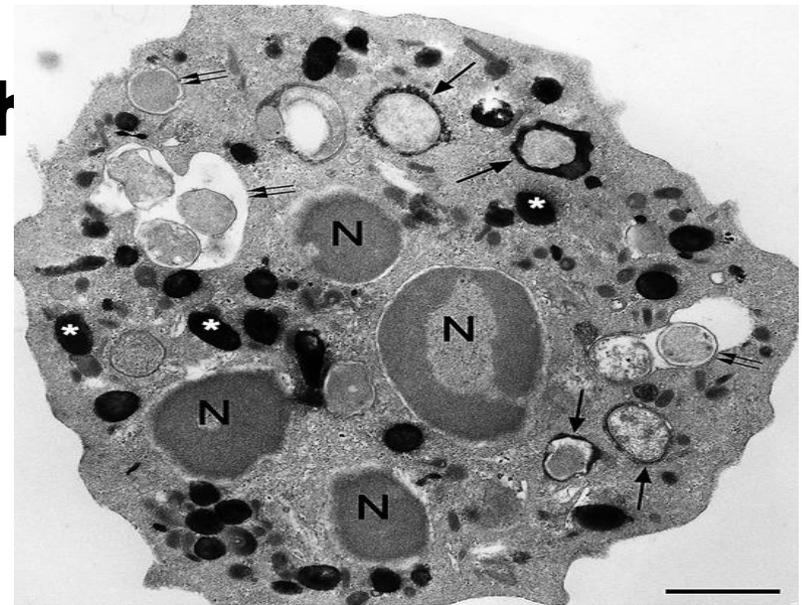
**1- specific granules**

Rice grain appearance =

**Collagenase**

**2- non specific azurophilic granules**

= Lysosomal hydrolytic enzymes.



# Neutrophils (polymorphs)=Pus cells

## Functions

### **The first line of defense.**

**1- Phagocytosis & destruction of**  
micro-organisms in the C.T. How...?

Chemotaxis → migration → phagocytosis →  
killing of bacteria by phagocytins &  
digestion by lysosomal enzymes (**1ry,**  
**azurophilic granules**) → death of  
neutrophils (**pus cells**)

**2. Stimulation of bone marrow** to form new  
neutrophils

**2- Attraction of monocytes** to the site of  
infection.

Life span: **1- 4 days** in blood

▶ ▶ CT

• **Secretion of cytokines:**

❖ Chemotaxis

❖ bone marrow stimulation

 **Production of pyrogens & pus**

# Abnormal neutrophil count

- **Neutrophilia:**

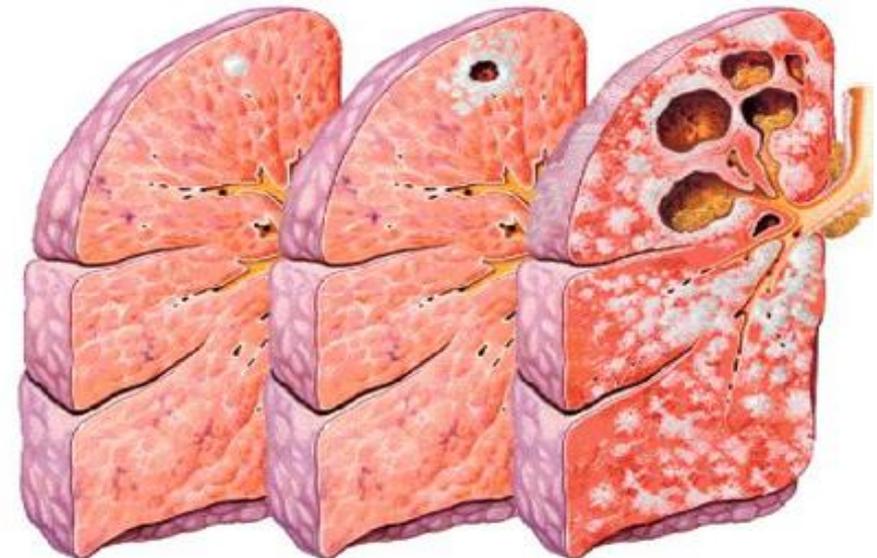
=in acute pyogenic **Pus** = acute inflammations e.g.:

- ❖ Appendicitis
- ❖ Tonsillitis



- **Neutropenia:**

- ❖ TB
- ❖ Influenza
- ❖ Measles



*Infección tuberculosa inicial en el lóbulo superior derecho*

*Placa inicial activa que progresa hacia una cavitación*

*Numerosas cavidades tuberculosas y erosión bronquial*

# Eosinophils

- ❑ Differential count : **1- 4%**
- ❑ Diameter=**12-15** microns.
- ❑ Shape: **rounded**

## L.M :

\*Nucleus: bilobulated C- shape

Cytoplasm contains

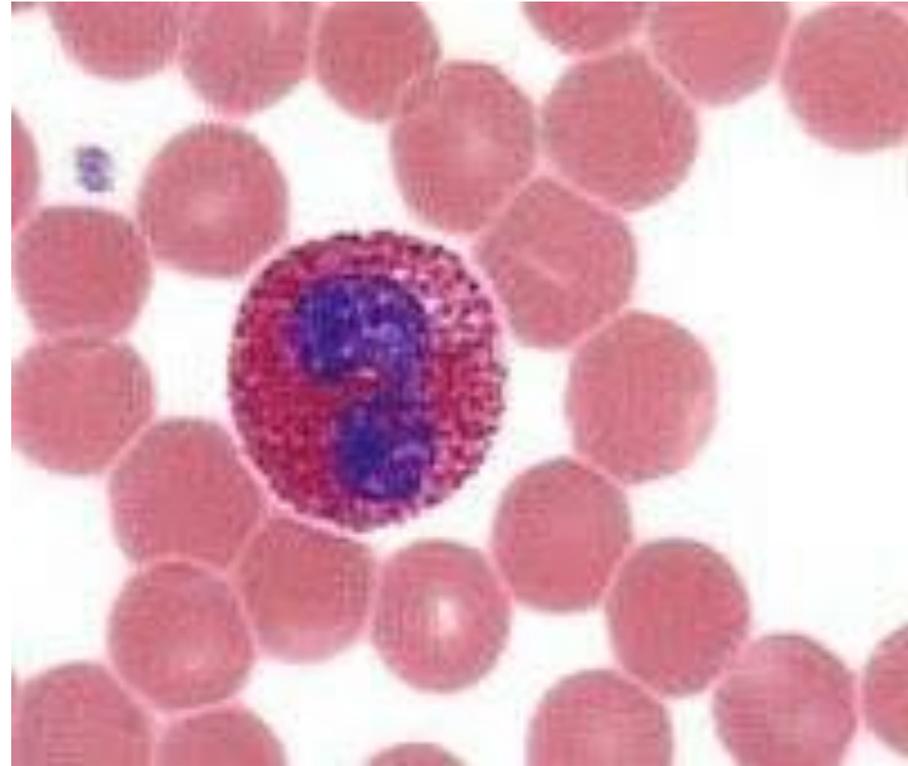
❖ **Specific granules.**

large **acidophilic**

❖ **Non specific granules**

**azurophilic granules**

=Lysosomal hydrolytic enzymes



# Eosinophils

**E.M:**

**Bilobed nucleus C- shape**

**Cytoplasm contains**

**glycogen, mitochondria, rER, & sER**

**□ specific granules**

**with crystalloid dense\_hydrolytic enzymes=Histaminase,  
peroxidase**

**□ non specific azurophilic granules**

**=Lysosomal hydrolytic enzymes**



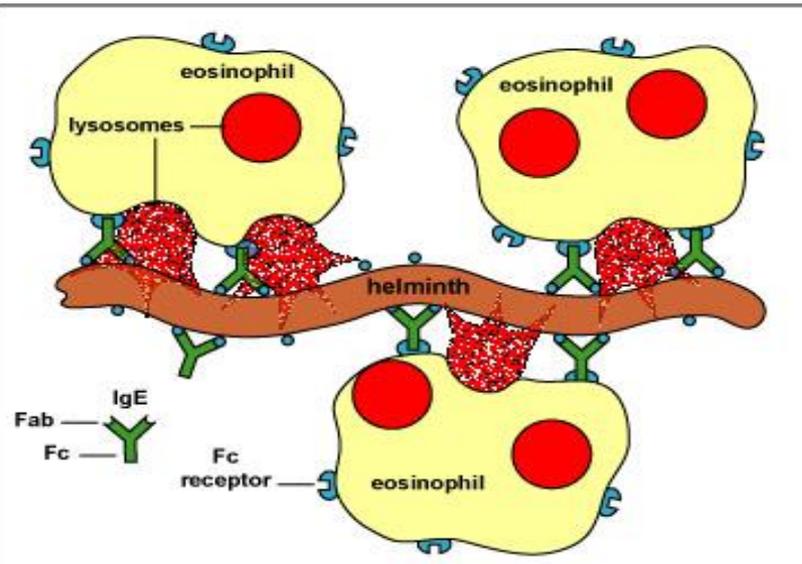
# Eosinophils

## Function of Eosinophils

- ▼ ▼ regulation of allergic reactions.
- Parasitic infestation. (**Not phagocytic**)

## Abnormal Eosinophil Count

- **Eosinophilia:**
  - Allergic reactions e.g. bronchial asthma, urticaria.
  - Parasitic infections e.g. Bilharziasis.
- **Eosinopenia:**
  - Bone marrow depression e.g. Steroid therapy.



Male and Female Schistosomes



# Basophils

## Mast cell of the blood

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

❑ Size : **10** microns

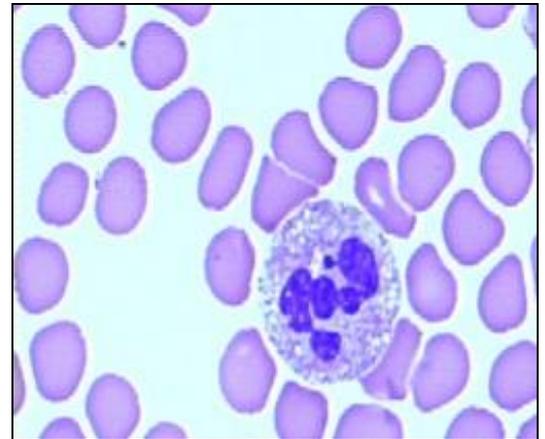
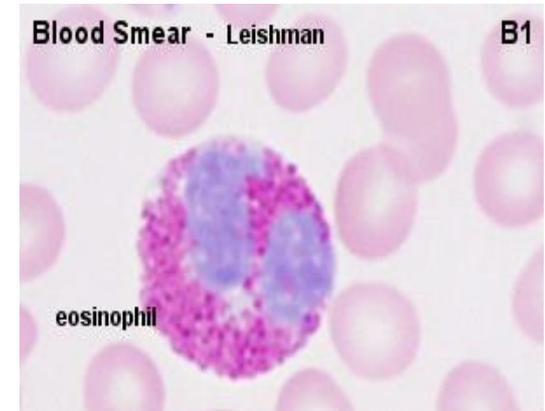
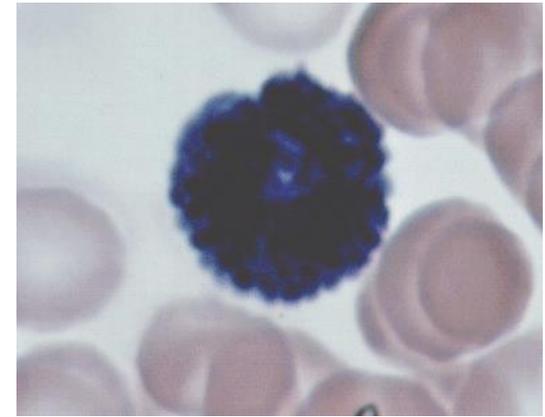
❑ Shape : Rounded

**LM:**

➤ Nucleus: bilobed, **(S-shaped)**

❖ **Obscured by** abundant deep blue granules.

❖ granules stain red with toluidine blue = **(Metachromasia )**.



# Basophils

E.M.

\*Bilobed S- shape nucleus

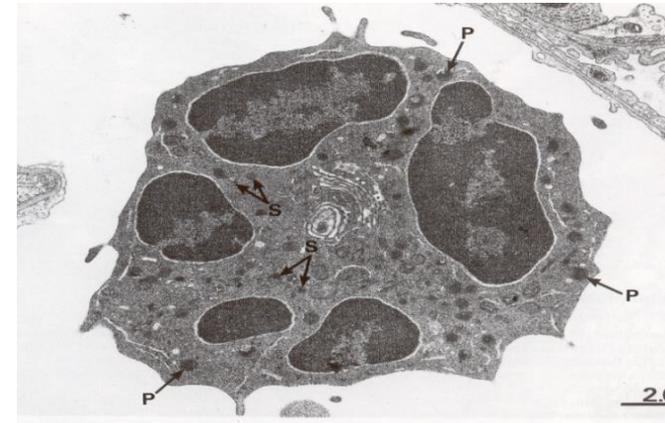
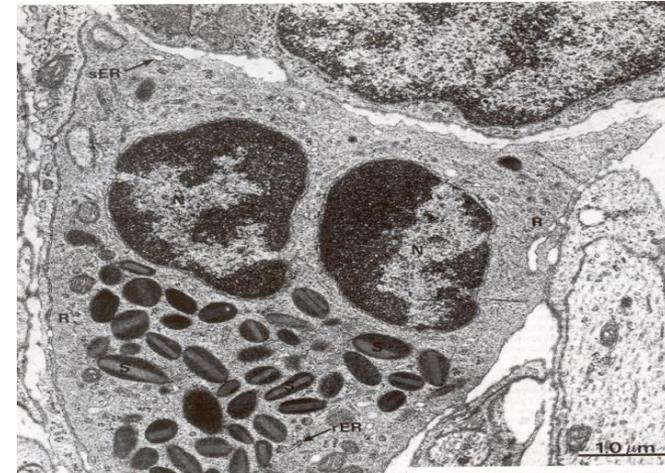
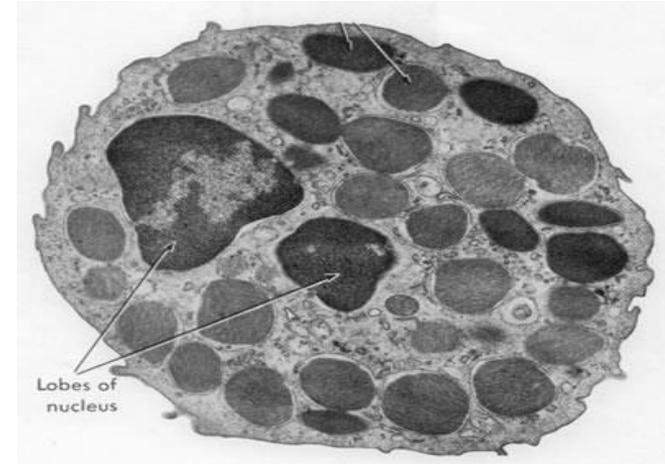
Mitochondria, ribosomes,  
glycogen in cytoplasm.

## 1- specific granules

- large
- Functional histamine, heparin

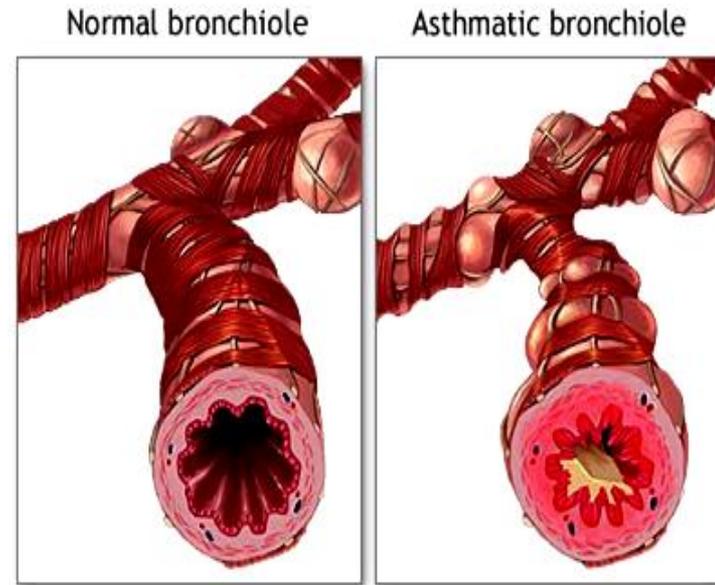
## 2 nonspecific azurophilic granules

= Lysosomal hydrolytic enzymes



# Functions

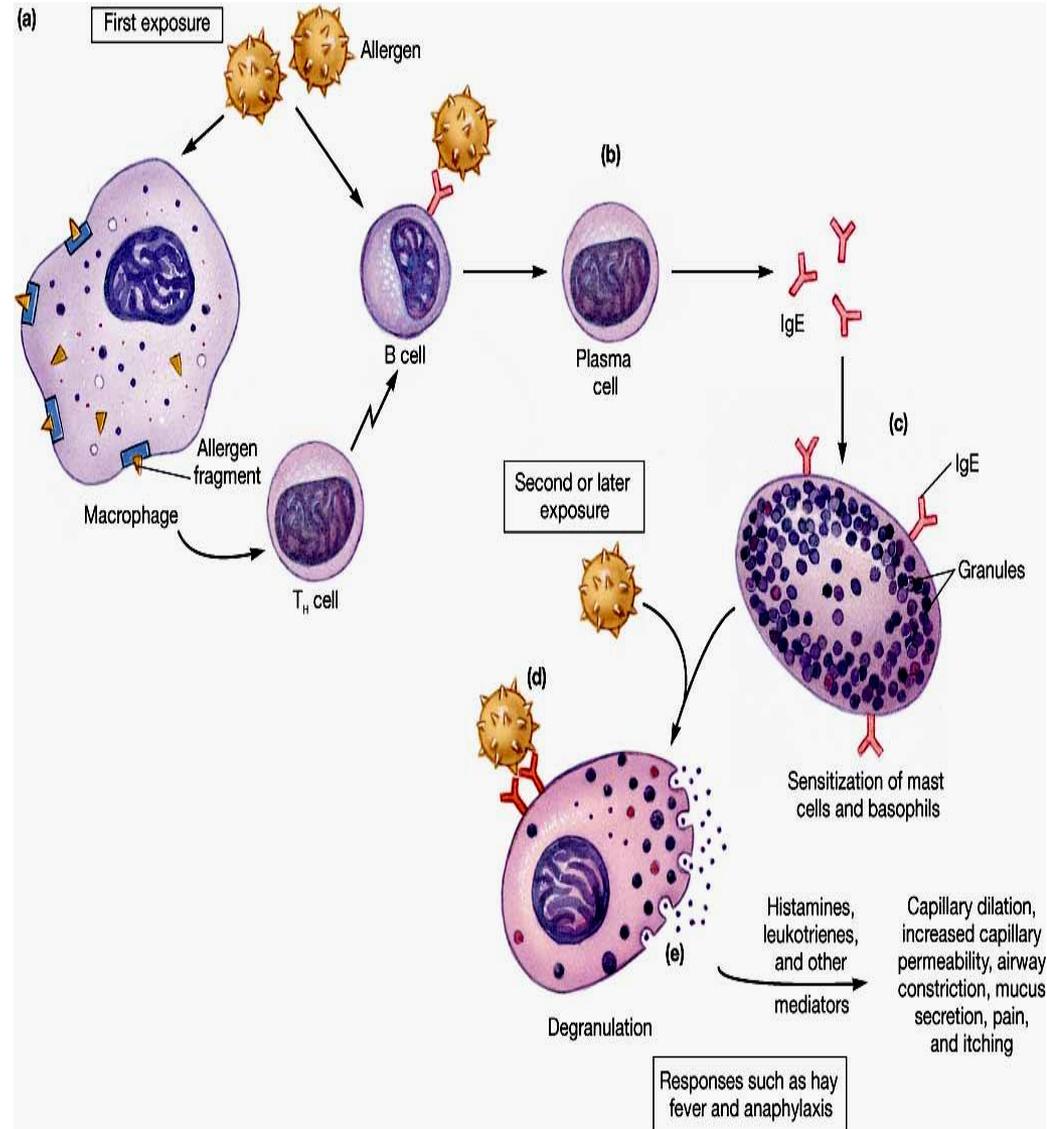
- Secretion of histamine which initiates allergic reactions.
- Secretion of heparin which is a natural anti-coagulant.
- **=Mast cell of blood:=**  
**hypersensitivity reaction**
- **1- heparin:** anticoagulant
- **2- histamine:** (anaphylaxis)



# Basophils abnormal count

## Basophilia:

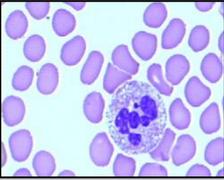
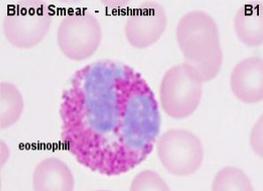
- viral infections as small pox and chicken pox.
- **Systemic allergy**



## Neutrophils

## Eosinophils

## Basophils mast cell of the blood .

	Neutrophils	Eosinophils	Basophils
Number	60-70% of leukocytic count	1-4% of leukocytic count	0-1% of leukocytic count
Size	10-12 $\mu\text{m}$ in diameter 	larger than neutrophils (12-15 $\mu\text{m}$ 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 <b>inactivated second X</b> 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"> <li>Kill parasites,</li> <li>associated with allergic reactions</li> </ul>	Basophils are responsible for the release of Histamine in systemic allergic reaction
Abnormality	<b>Neutrophilia:</b> i.e. abnormal increase in the number of neutrophils. This is observed in acute inflammations e.g. appendicitis, tonsillitis.	<u>1-Eosinophilia:</u> i.e. abnormal increase in the number - Allergic reactions e.g. asthma, urticaria	Basophilia in systemic allergic reaction

# Agranular leukocytes

## Monocyte

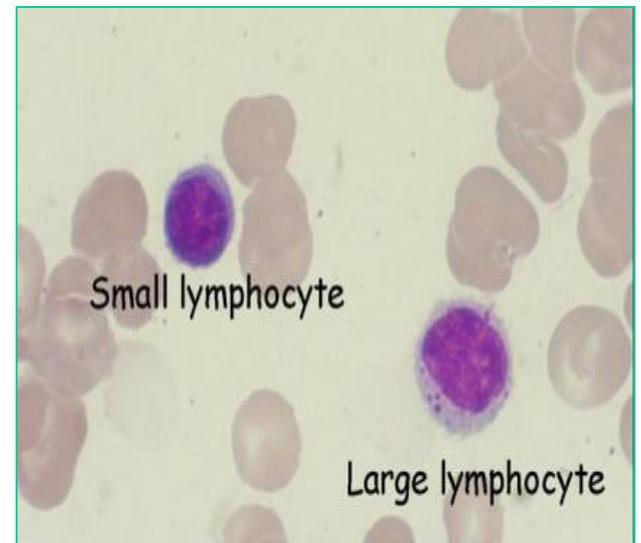
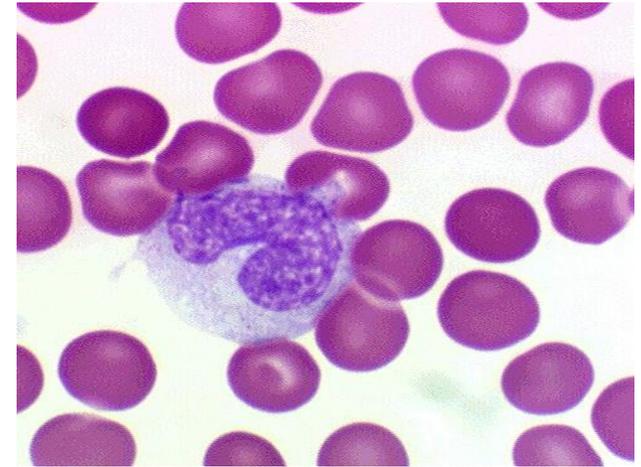
❑ Differential count: **3 - 8%**

❑ Size : **20** microns

❑ Shape : rounded

### LM:

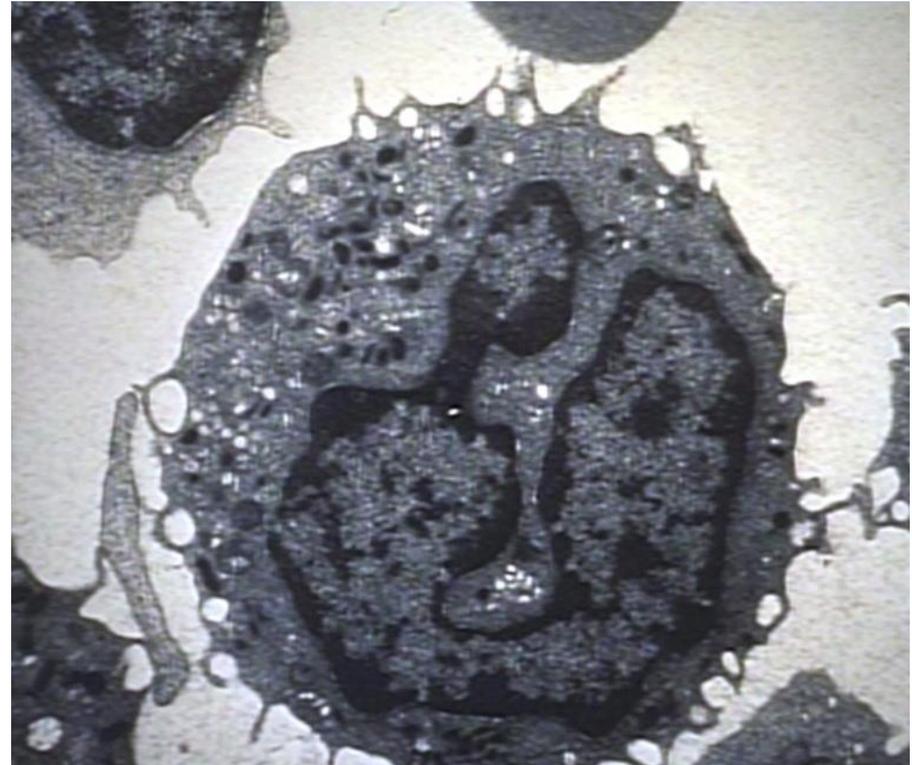
- **Largest** in blood film
- **Nucleus:**
  - ❖ Large, eccentric , Kidney- shaped (**Indented**)
- **Cytoplasm:**
  - ❖ Abundant, Pale basophilic,
  - ❖ **Finely granular**= non specific azurophilic granules



# Monocyte

## EM:

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



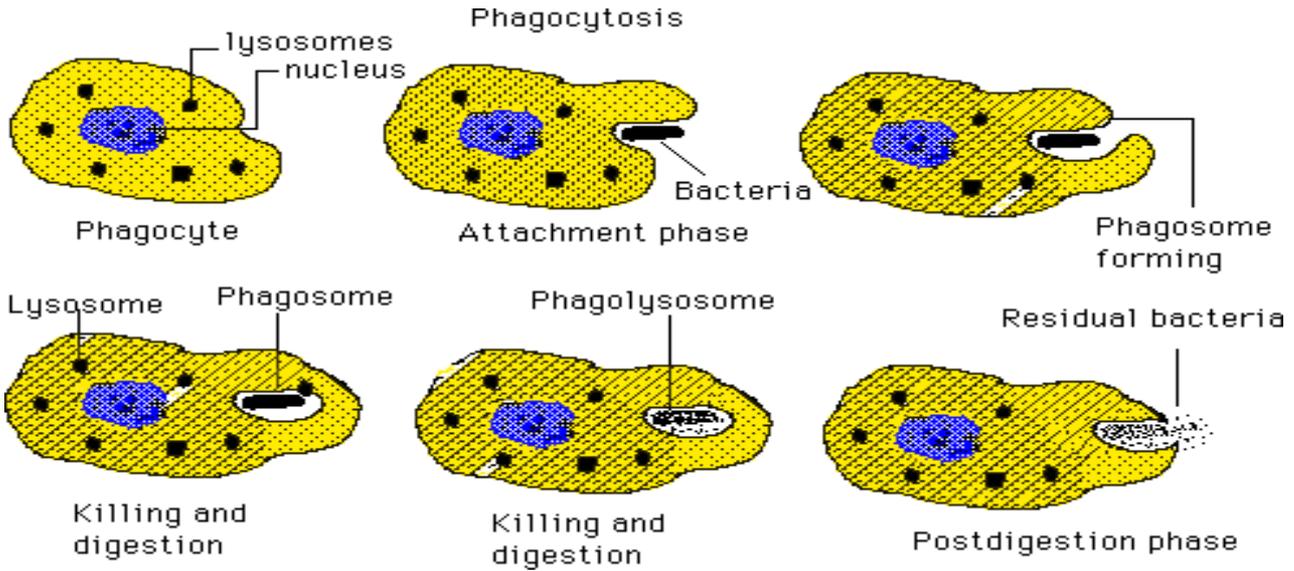
**Life span :** 1-2 days  
circulation in the blood,  
then enter the CT



macrophages

# Functions

- Trans- migration & differentiation to tissue **macrophages**
- Immunologic function:
  - **Phagocytosis and intracellular digestion of bacteria, virus**
  - **Ag- presenting cell**



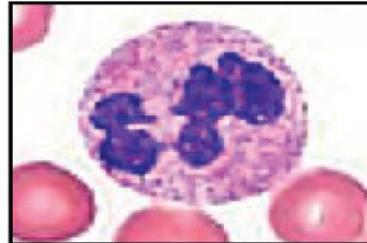
Key



Basophil



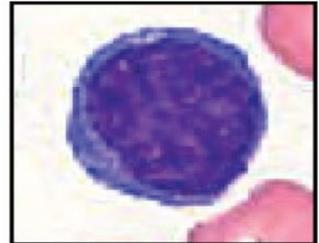
Eosinophil



Neutrophil

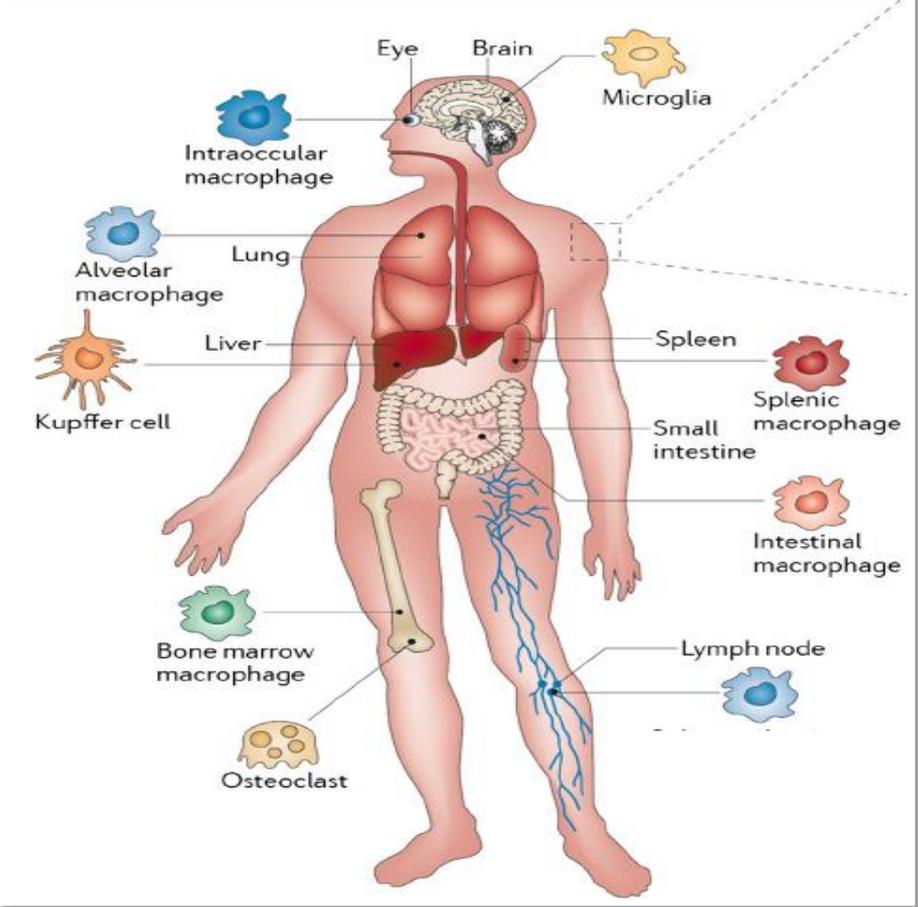


Monocyte

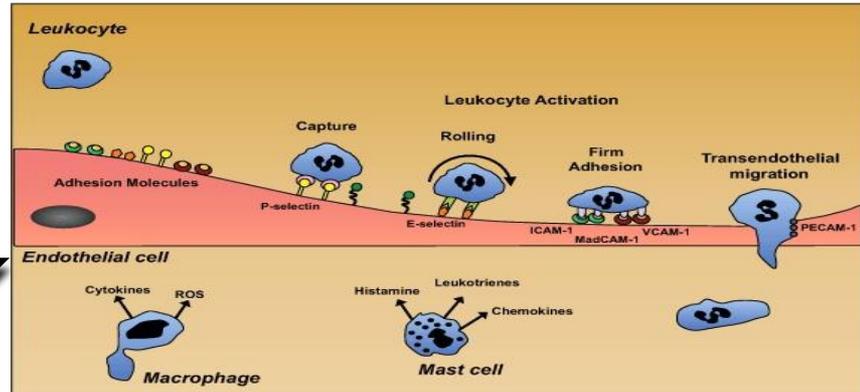


Lymphocyte

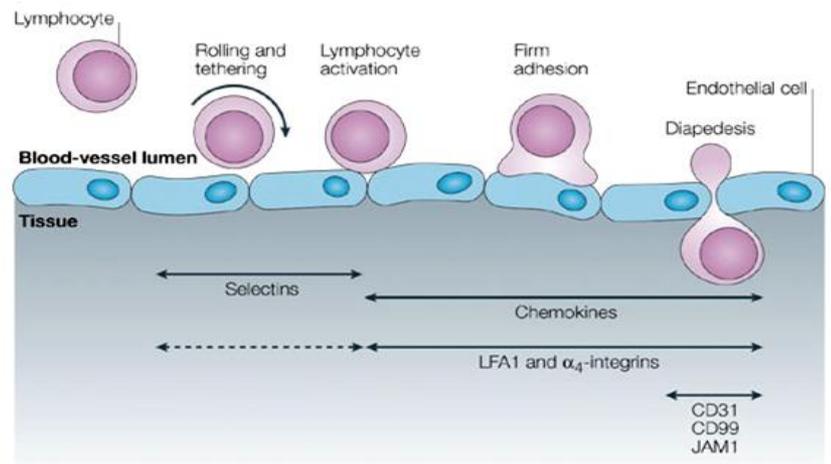
**Diffuse mononuclear phagocytic system**



Circulate from region to another & Function in CT= **Immunological function**



CT



# ● **Abnormal Monocyte count**

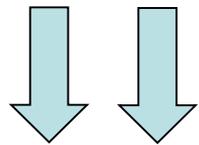
**Monocytosis= increase number**

## **Causes:**

1- Malaria

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

3-Lymphomas & Leukemia.

 in number of **Monocyte**

## ▪ **Bone marrow depression**

- **drugs**
- **Irradiation**
- **Severe chronic diseases**

# Agranular leukocytes

## lymphocyte

- **Differential count: 20-30%**

- **Size : 9-12 microns**

- **According to the sizes:**

- **1- large lymphocytes.**

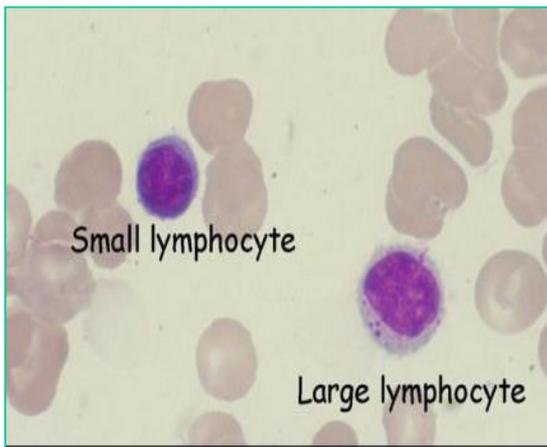
- **2- Medium-sized lymphocytes.**

- **3- Small lymphocytes:**

- **1. 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:**

- **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:

# Lymphocytes

# EM:

- **Shape = rounded**
- Large nucleus, thin cytoplasmic rim
- No stained granules in the cytoplasm (except small **Azurophilic granules**)

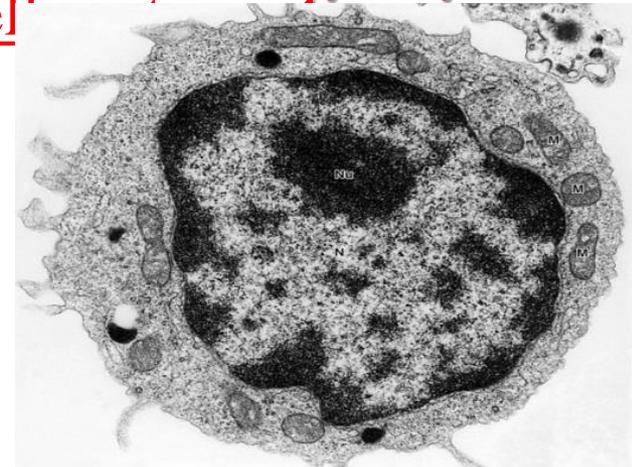
☐ **Small most common 90%**

☐ **Types: B- and T-lymphocytes (morphologically not distinguishable)**

☐ **Null-cells** (somewhat smaller size)  
Non B Non T

- **Nucleus:** dense clumps.
- **Cytoplasm** thin rim
- Many **free ribosomes & few mitochondria + centrioles**
- ☐ No specific granules
- ☐ **Azurophilic granules = lysosomal hydrolytic enzymes.**

▲▲ The cell markers.



# Antigenic markers of lymphocyte

**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 lymphocyte

## Major histocompatibility complex

### ❖ 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.

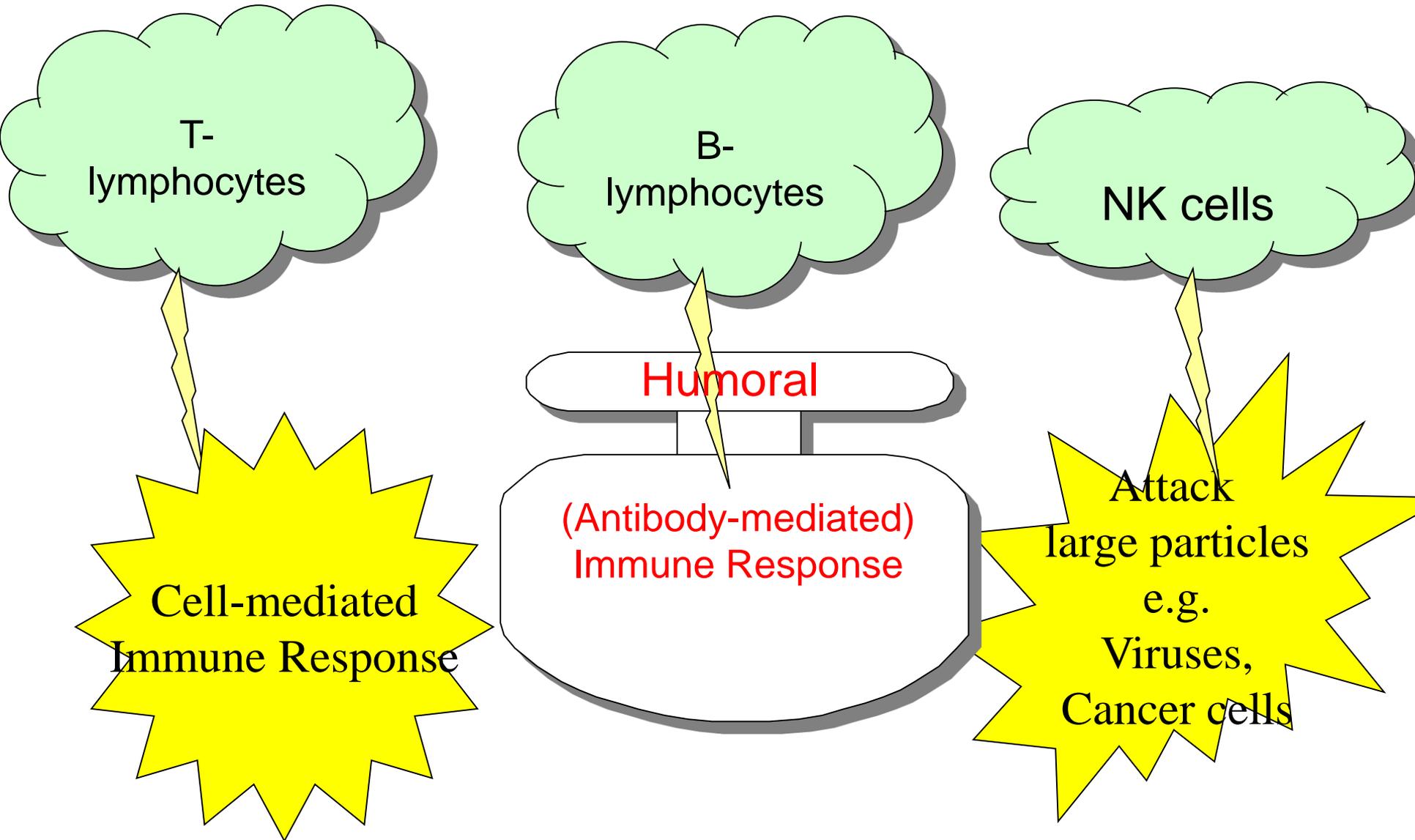
# Lymphocytes

## Function :

- ❖ After stimulation T-cells and B-cells become :  
Memory cells and **Effector 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:

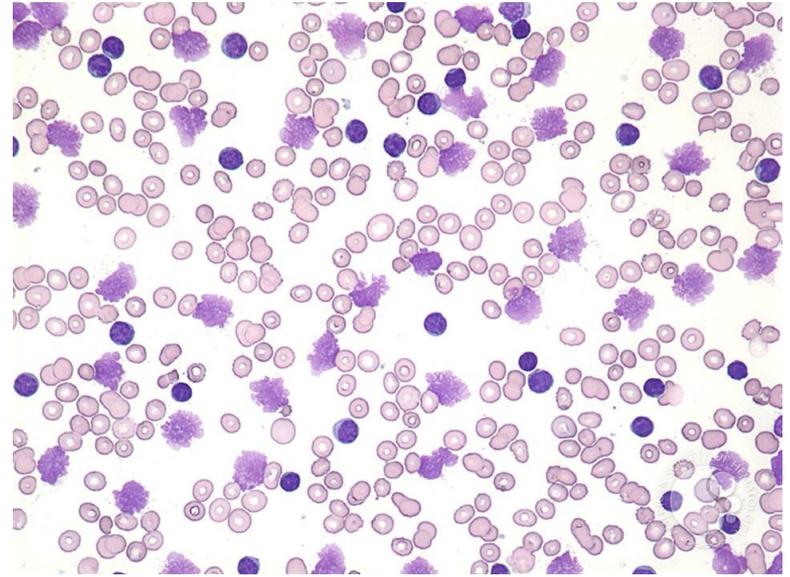
### Causes:

**Physiological:** in children

**Pathological:**

1-chronic infections tuberculosis,  
syphilis,

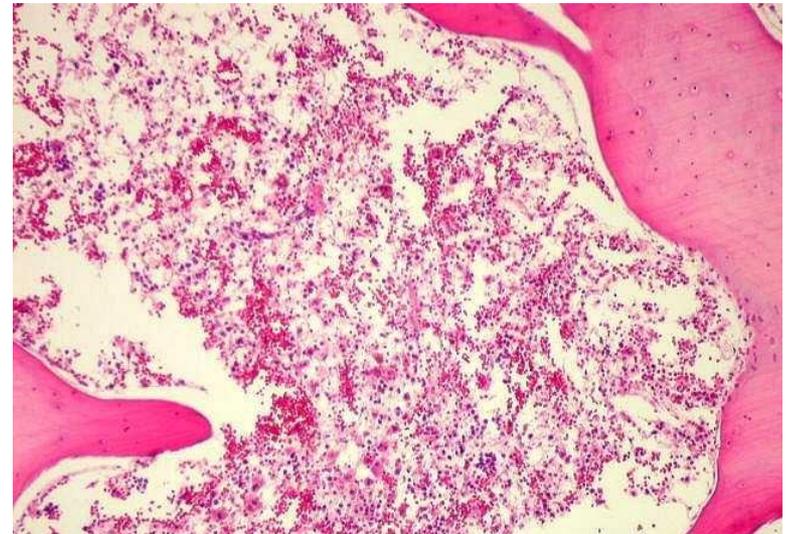
2-leukemia, Lymphoma.



## 2-Lymphopenia:

Bone marrow depression.

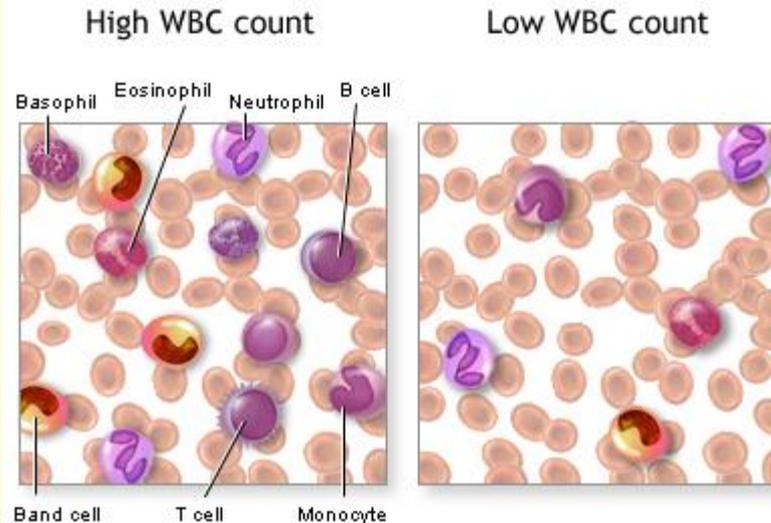
- ❖ drugs
- ❖ Irradiation
- ❖ Severe chronic diseases



# Abnormalities in leukocytic count

## leukocytosis

- Infection
- Or Inflammations
- Allergic reaction
- Leukaemia



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

## Leukopenia

# Acquired Causes of decrease in number

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

# Monocyte

# Lymphocyte

Subsets T, B, natural killer

Number	3-8% of WBCs	20-30 % of WBCs Next most common after neutrophils
Size	12-20 $\mu\text{m}$ diameter	9-11 $\mu\text{m}$ 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>B Cells</b> involved in humoral immunity <b>T Cells</b> involved in cell-mediated immunity <ul style="list-style-type: none"> <li>• T helper cells,</li> <li>• T suppressor cells,</li> <li>• cytotoxic T c &amp; memory cell</li> </ul>
Abnormality	Monocytosis: is an abnormal increase in the number of blood monocytes. It occurs in diseases like malaria, typhus, viral infections	Lymphocytosis: It is an abnormal increase in the number of lymphocytes as in: lymphatic, leukaemia

