

# **Leucocytes**

**Leucocytes  
(WBCs)**

**By**

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# White Blood Cells (Leucocytes) (WBCs)



Neutrophils  
(50–70%)



Eosinophils  
(2–4%)



Basophils  
(<1%)



Lymphocytes  
(20–30%)



Monocytes (2–8%)

## **A. Granulocytes**

1. nucleus:  $>1$  lobe
2. granules
3. life span: few days
4. neutrophils, eosinophils, basophils

## **B. A granulocytes**

1. nucleus: round or horseshoe shape
2. no specific granules
3. lymphocytes & monocytes

# White Blood Cells (Leucocytes) (WBCs)

## Number

**4.000-11.000/mm<sup>3</sup> in adult man**

**increased in children**

## Origin

**The granulocytes and monocytes are formed from the bone marrow only (The WBCs formed in the bone marrow are stored within the marrow until they are needed in the circulatory system.**

**but the lymphocytes are formed**

**in the lymphatic tissues**

**(lymph node, spleen, thymus, tonsils, bone marrow and Peyer's patches of GIT)**

**Even 75% of the bone marrow form WBCs, its number is less than RBCs count because it has short life span.**

## ***\*Life span***

- ***In granulocytes***

**4-8 hours in the circulation**

**4-5 days in the tissue.**

**In infection there is rapid destruction.**

- ***In monocytes***

**10-20 hours in the circulation then enter the tissue to become tissue macrophages and can live for months.**

- ***In lymphocytes***

**variable according to the body need.**

**They circulate in between the lymphatic tissue and the blood (The lymphocytes have life spans of weeks or months, depending on the body's need for these cells)**

# **\*Differential leucocytic count**

- According to presence or absence of granules in their cytoplasm they are divided into :

## ***I- Granulocytes***

**(1) Neutrophils (both granules) 40-70%**

**(2) Eosinophils: (acidophil) 1-4%**

**(3) Basophils: (basic granules) 0-1%**

***II- Non-granulocytes*** (1) **Lymphocytes: 20-45%**

**(2) Monocytes: 2-8%**

**This typing can be done by staining the blood by Leishman stain or by specialized automatic machine**

# \* Types and Functions

- **(1) Neutrophils**

## **Characters:**

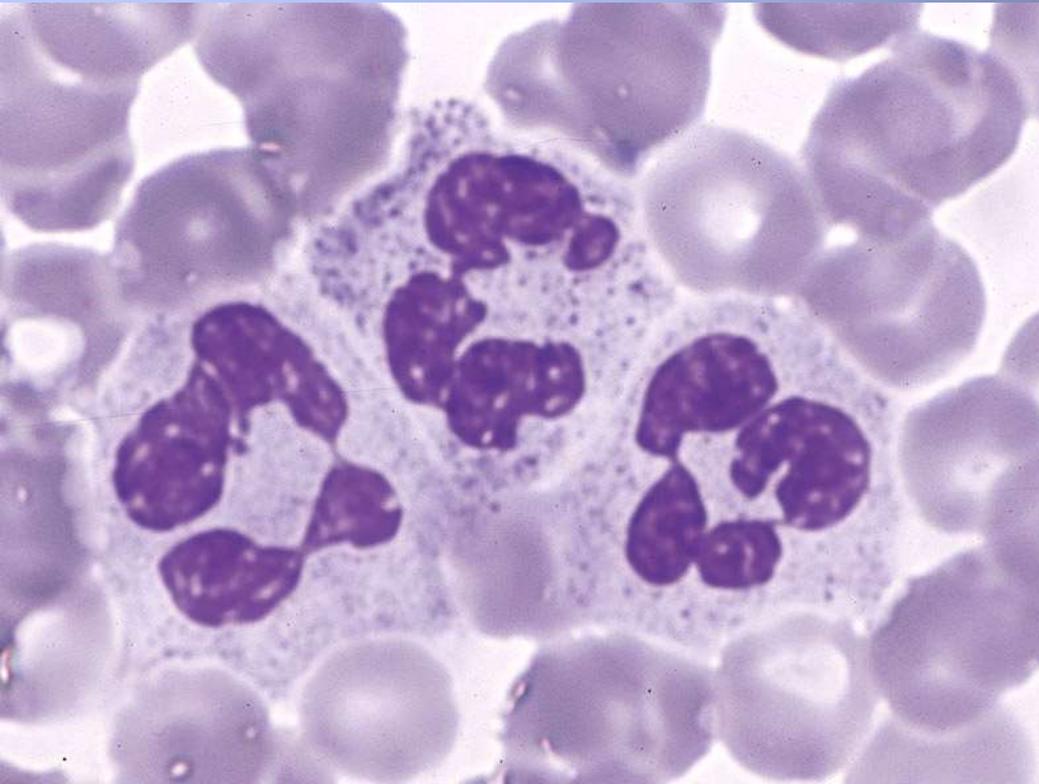
**40-70% of total number.**

**They contain small granules of both acidic and basic**

**Their nucleus are formed of 2-5 lobes connected by thin  
chromatin filaments**

# Neutrophils

1. 40-70% of leukocytes
2. nucleus: 2-5 lobes **connected by thin chromatin filaments**



**They contain small granules of both acidic and basic**

# Function

- The main function is the defensive function when bacteria invade the body

- ***(1) Margination***

**The Neutrophils aggregate and stick to the damaged capillary walls**

- ***(2) Chemotaxis***

**Some substances released at site of infection (degenerative products, bacterial toxins & complement system) lead to attraction of leucocytes from near capillary (<100  $\mu$  distance)**

**(because almost no tissue area is more than 50  $\mu$  away from a capillary) to migrate towards the inflammed area (positive chemotaxis )**

**(3) Diapedesis** WBCs can squeeze themselves through the pores of the capillaries to outside. In infected area these pores increase in size to facilitate diapedesis

**(4) Amoeboid movement** WBCs are motile cells and move by amoeboid motion by  $40 \mu/\text{min}$

### **(5) Phagocytosis**

This is the power of leucocytes to engulf foreign materials as bacteria, toxins and dead cells

Then ingest these material via proteolytic enzymes of lysosomes bactericidal agent as hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) can kill bacteria.

A neutrophil can phagocytize 5-20 bacteria before the neutrophils die and form pus

# (6) Opsonization

- which makes the foreign materials more susceptible for phagocytosis

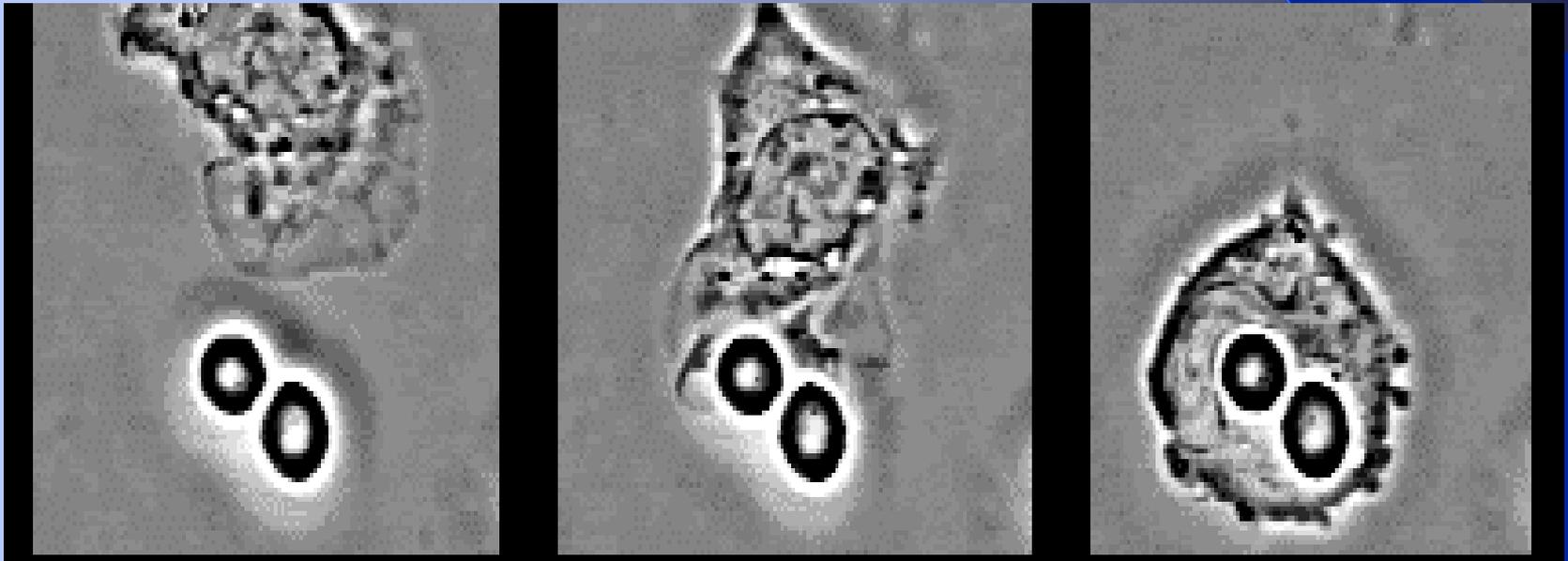
**First**, most natural structures in the tissues have smooth surfaces, which resist phagocytosis. However, if the surface is rough, phagocytosis is increased.

**Second**, most natural substances of the body have protective protein coats that repel the phagocytes. Conversely, most dead tissues and foreign particles have no protective coats, which makes them subject to phagocytosis.

**Third**, the immune system of the body develops antibodies against infectious agents such as bacteria. The antibodies then adhere to the bacterial membranes and thereby make the bacteria especially susceptible to phagocytosis.

# Phagocytosis

- ❖ Lysosomes contain enzymes = degrade biomolecules.
- ❖ E.g. acid hydrolases, lysozyme, neutral proteases, myeloperoxidase, lactoferrin, & phospholipase A.



Human macrophage engulfing the fungus *Candida albicans*

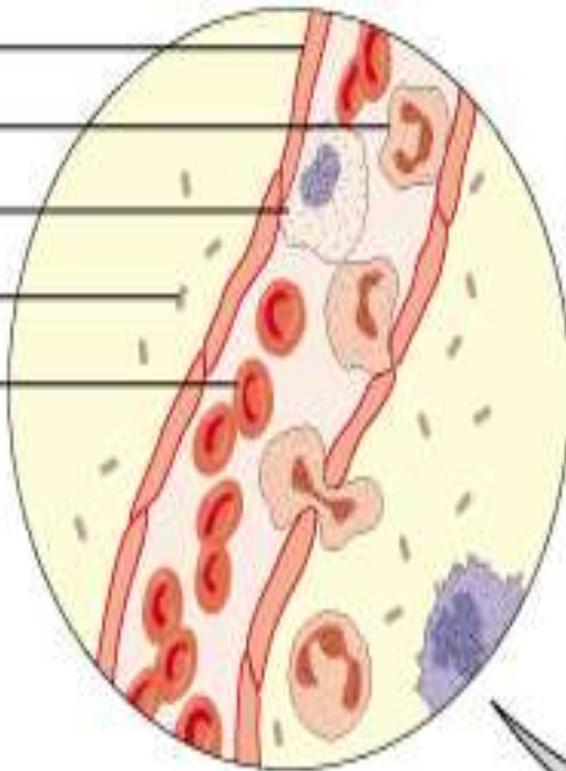
Blood vessel  
endothelium

Neutrophil

Monocyte

Bacterium

Erythrocyte

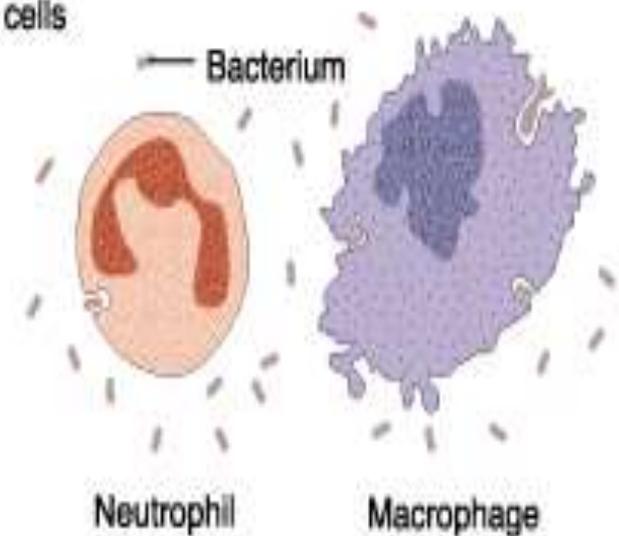


4 Margination—  
phagocytes  
stick to  
endothelium

5 Emigration—  
phagocytes  
squeeze between  
endothelial cells

6 Phagocytosis  
of invading  
bacteria

Bacterium



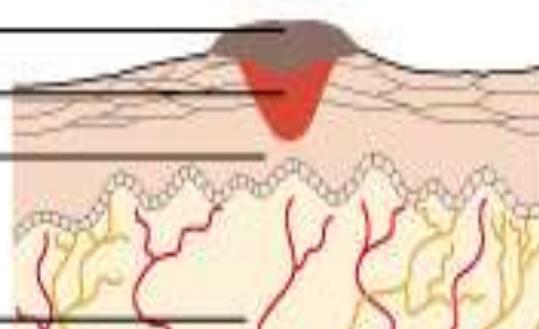
(c) Phagocyte migration and phagocytosis

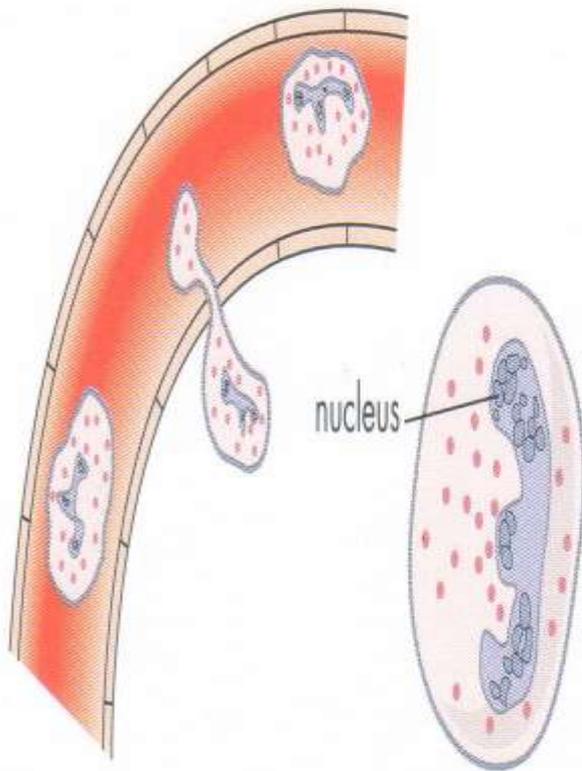
Scab

Blood clot

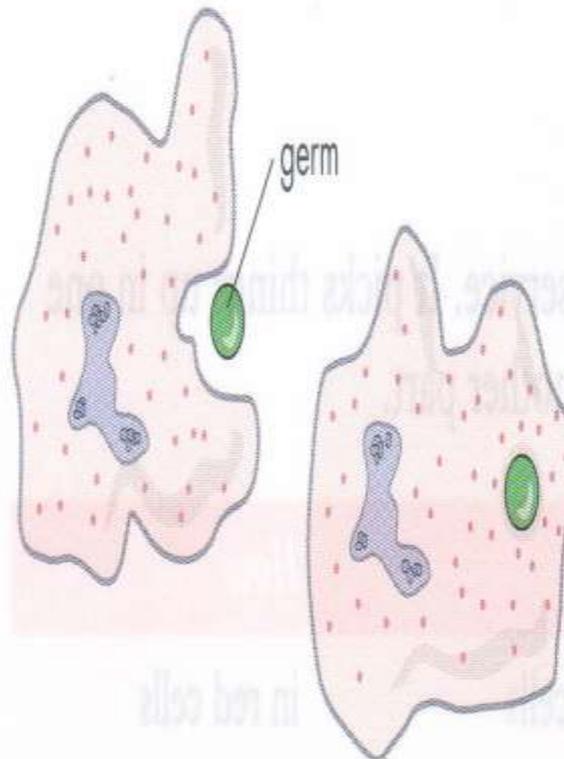
Regenerated  
epidermis  
(parenchyma)

Regenerated

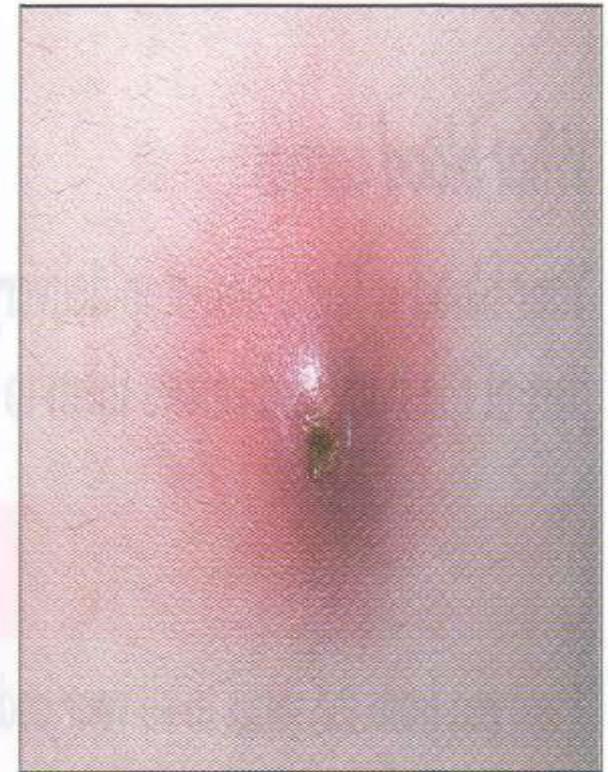




1 The phagocytes pass out through capillary walls and into the infected tissue.



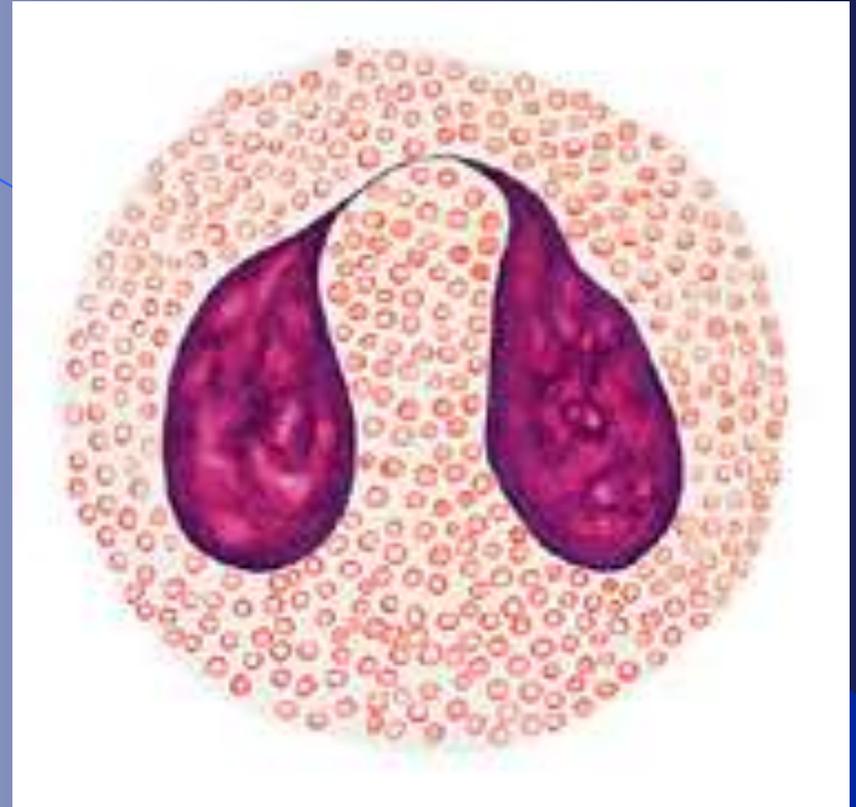
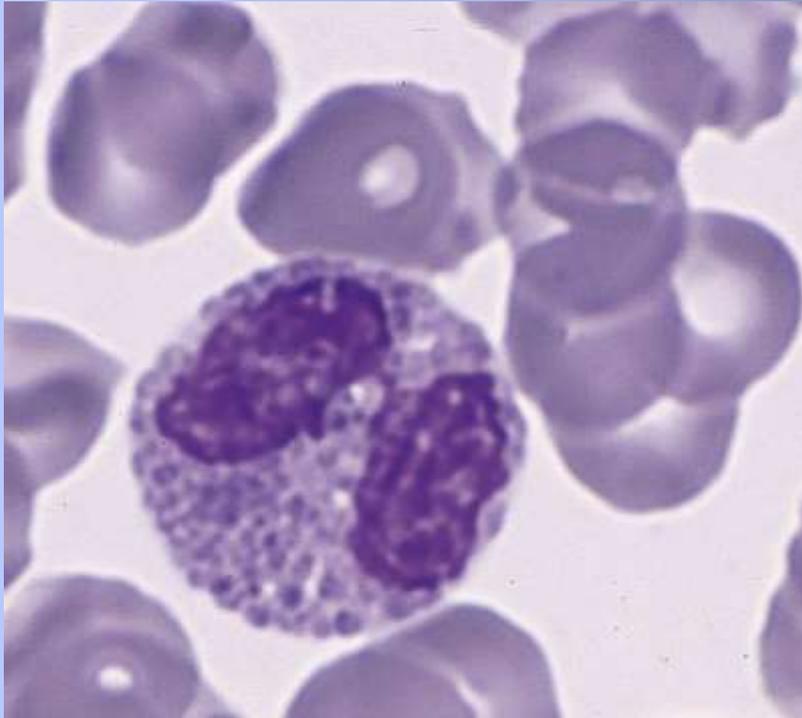
2 They change shape to surround the germs. They produce enzymes to kill and digest them.



3 Phagocytes live for only a short time. Dead phagocytes, dead germs and liquid form **pus** in the infected area.

# Eosinophils

- eosinophilic granules  
Anti parasitic & modulate  
inflammation



# (2) Eosinophils

- **Characters**

1-4% of total number

They contain red granules

They have bilobed nucleus

- **Function**

1- They are weak phagocytes

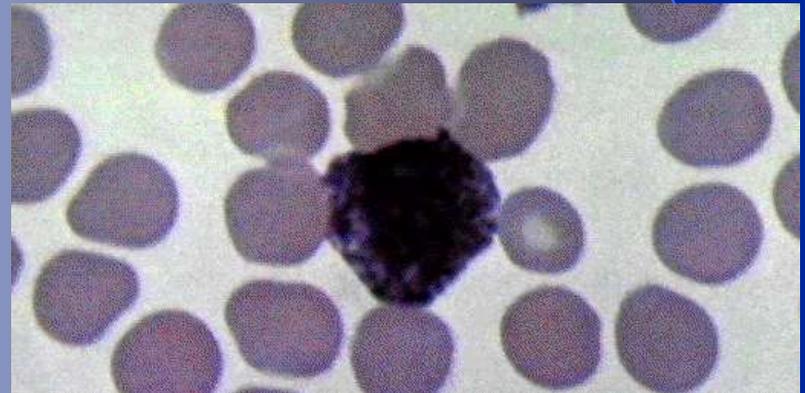
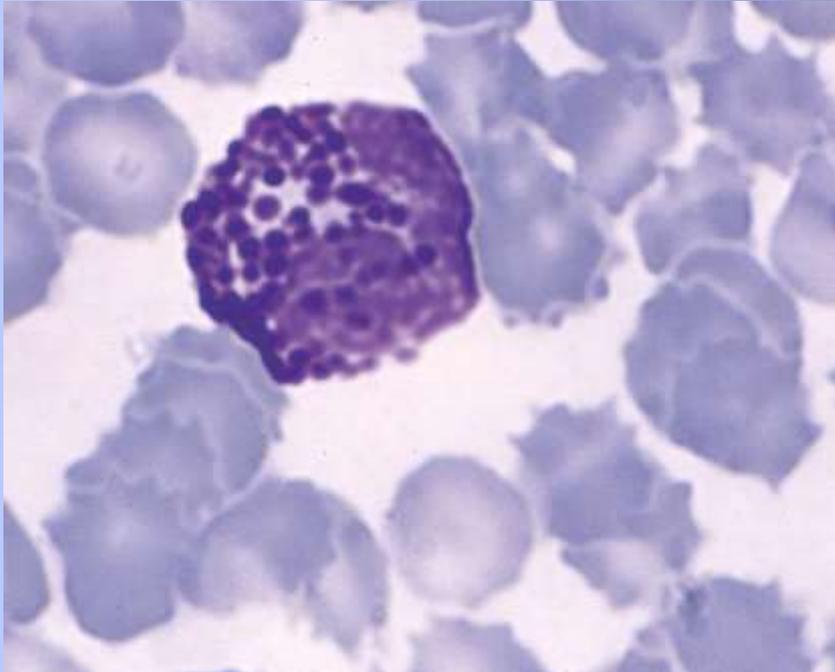
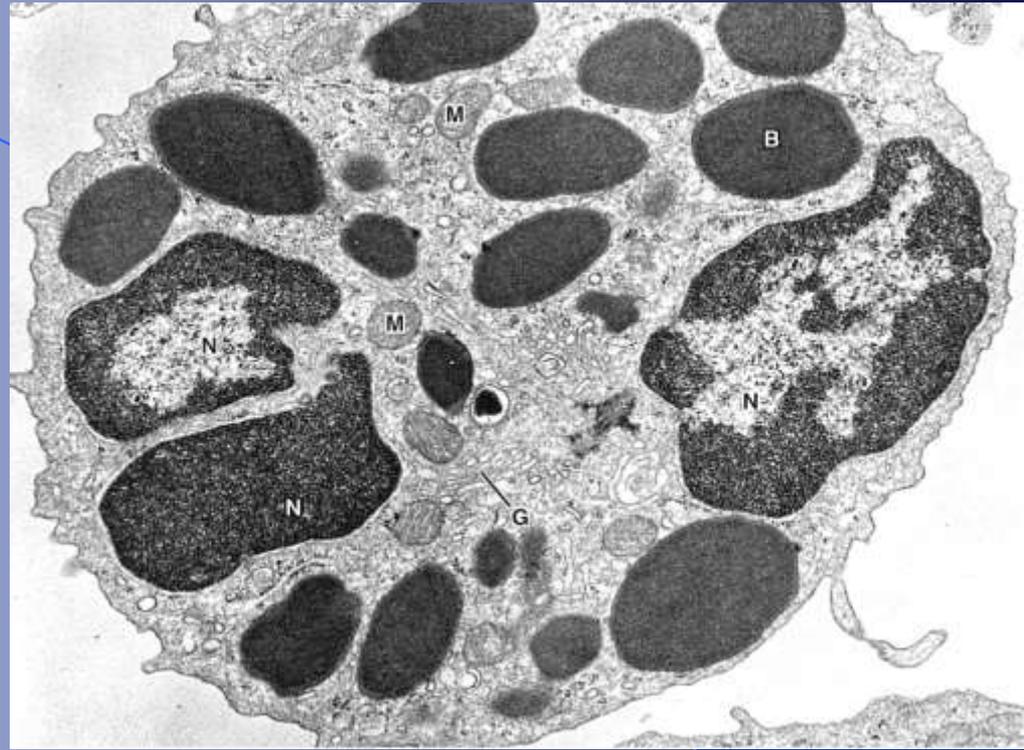
2- They increase in **parasitic infections** (ascaris) and by diapedesis, amoeboid movement and chemotaxis they attack the parasites (eosinophils attach themselves to the parasites by way of special surface molecules and release substances that kill many of the parasites.

3- They increased in **allergic conditions** by the release of eosinophil chemotactic factor released from the mast cells and basophiles. Eosinophils phagocytose the antigen-antibody complexes and release substances to neutralize the histamine

4- They may produce profibrinolysin → fibrinolysin which digest fibrin clot

# Basophils

1. < 1% of leukocytes
2. basophilic granules



# (3) Basophils

## ● Characters:

**0-1% of total number**

**They contain deep blue granules with staining**

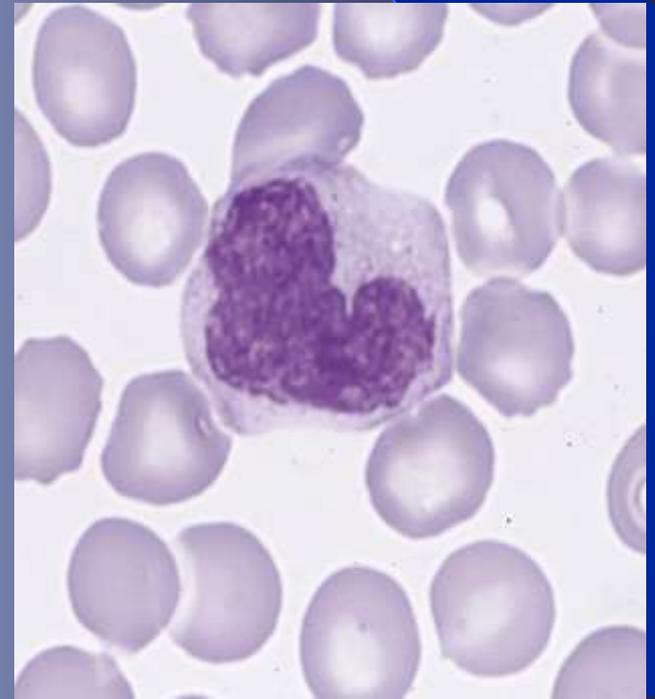
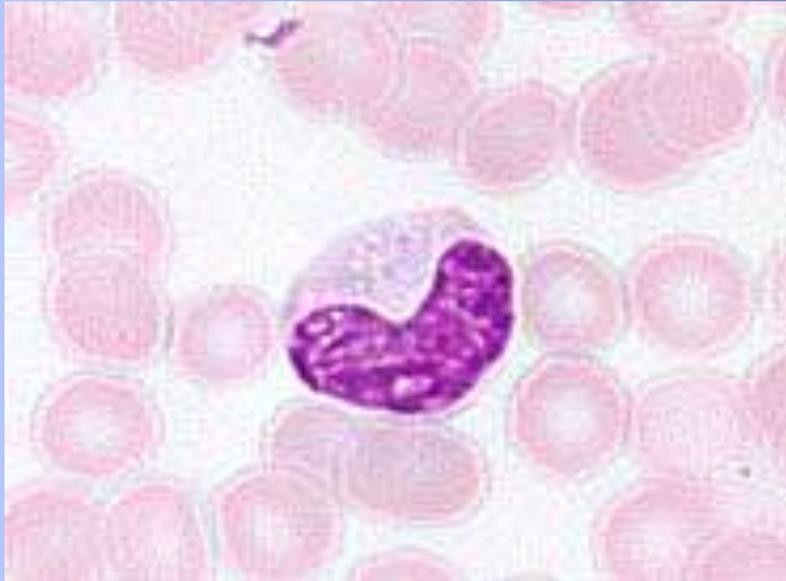
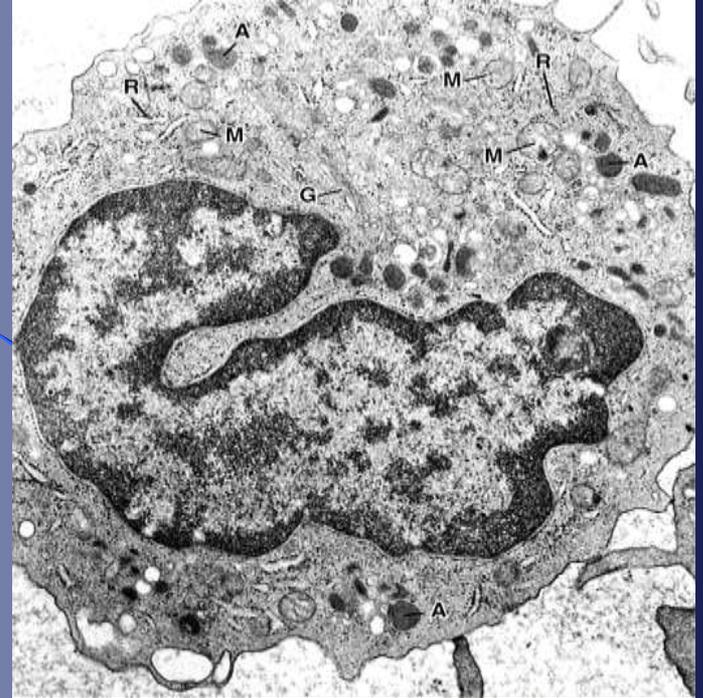
**In the connective tissue, they are called the mast cells**

## ● Function

- **They form heparin as anticoagulant**
- **The immunoglobulin E (IgE) type, has a special tendency to become attached to mast cells and basophils. Then, when the specific antigen for the specific IgE antibody subsequently reacts with the antibody, the resulting attachment of antigen to antibody causes the mast cell or basophil to rupture and release large quantities of histamine and other allergic mediators as serotonin, bradykinin and lysosomal enzymes to mediate allergic manifestation as vasodilatation and tissue reaction**

# Monocytes

1. nucleus: oval, horseshoe/kidney shaped, eccentric
2. become wandering macrophages after diapedesis



# **(4) Monocytes**

## **Characters**

**2-8% of total number**

**They contain a granular cytoplasm but when they enter the tissues they swell and their cytoplasm become filled by large number of lysosomes and then they are called macrophages**

**They have oval or kidney shaped nucleus**

## **Function**

**Phagocytosis as in neutrophils but with more powerful effect**

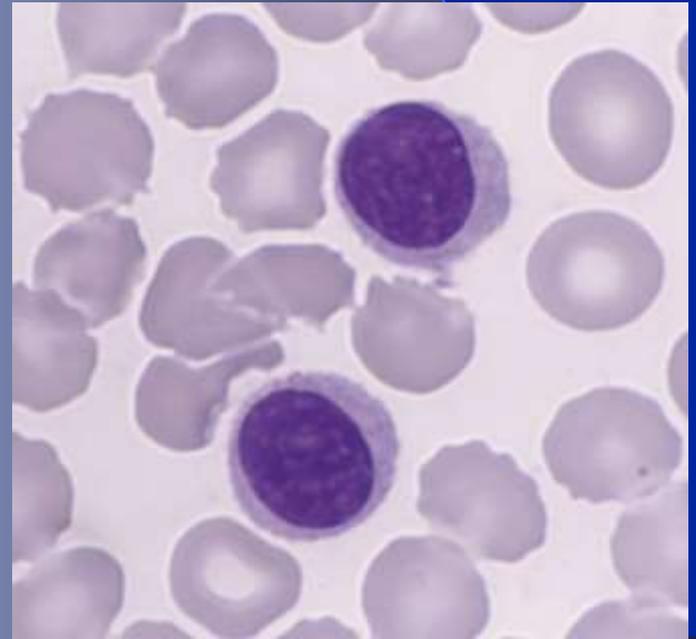
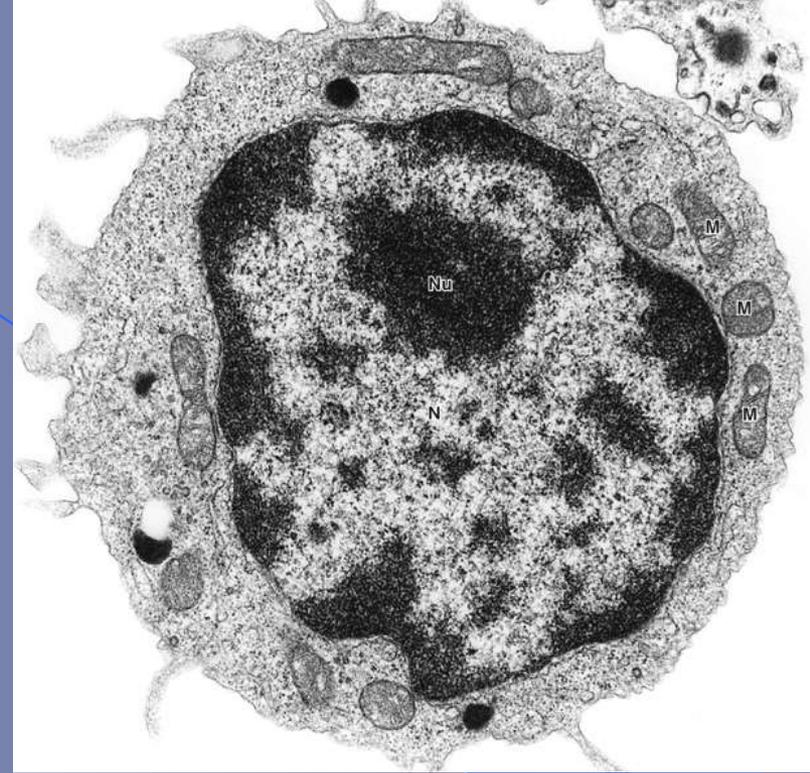
**Macrophages help the function of T-and B-lymphocytes by presenting the antigen to these cells**

**Macrophages release many chemical substances to increase the inflammatory and allergic reactions against organisms**



# Lymphocytes

1. nucleus: spherical, intensely stained
2. cytoplasm: scanty



# (5) Lymphocytes

## ● Characters

20-45% of total number

They are the smallest type of W.B.Cs and contain large rounded nucleus

## ● Function

There are two types of lymphocytes

### 1) *B-lymphocytes:*

They are changed to plasma cells and are responsible for humeral immunity or antibody- mediated immunity

### 2) *T-lymphocytes*

They complete their development in the thymus gland and are responsible for cellular immunity or cell-mediated immunity

# Leukocytosis

- **A- Physiological Leukocytosis**

- Increase in number of leucocytes above 11.000/mm<sup>3</sup>. It occurs in muscular exercise, emotions, cold bath, cold or hot weather, pregnancy, labor, and after meals.

- **B- Pathological Leukocytosis**

- Neutrophilia**

- Increase number of neutrophils as in cases of:

- Infections**

- of all types as acute or chronic, bacterial, viral or fungal.

- Inflammation**

- as rheumatic fever

- Tissue damage**

- as trauma, burn

- Malignant tumors**

- Smoking**

## **Eosinophilia**

● ↑ eosinophils due to

- Allergic conditions as asthma, hay fever, skin allergy
- Parasites
- Leukemia

## **Basophilia**

● ↑ basophils as in allergy or leukemia

## **Monocytosis**

As in chronic infections as tuberculosis or in leukemia.

## **Lymphocytosis**

As in chronic viral and bacterial infections and in leukemia.

# Leukemia

It is a malignant disease of bone marrow causing marked increase in WBCs may reach 500.000/mm<sup>3</sup>

However, the leukemia cells are **bizarre and undifferentiated** and not identical to any of the normal WBCs.

Usually, the **more undifferentiated** the cell, the **more acute** is the leukemia, often leading to death within a few months if untreated.

**Leukemic cells**, especially the very undifferentiated cells, are usually nonfunctional for providing normal protection against infection.

**Leukemia** is associated with **anemia** and **bleeding tendency** due to **decrease in bone marrow area** responsible for RBCs and **platelet synthesis respectively**

# Leucopenia

- It means a decrease in the total leucocytic count below 4.000/mm<sup>3</sup>
- In this condition the body is not protected against many bacteria and other agents that might invade the tissues, and death may occur
- **It is caused by**
  - 1- Bone marrow depression by radiation, drugs as cancer chemotherapy**
  - 2- Some bacterial infections as typhoid fever, brucellosis**
  - 3- Some viral infections as AIDS, influenza, hepatitis**

- Within **2 days** after the bone marrow stops producing WBCs, ulcers may appear in the mouth and colon, or some form of severe respiratory infection might develop. **Bacteria** from the ulcers rapidly invade surrounding tissues and the blood.
- Without treatment, death often follow in less than a week after acute total leukopenia begins.

A vibrant sunset scene with a body of water in the foreground and dark hills in the distance. The sky is filled with warm colors of orange, red, and purple, with some clouds catching the light. The text 'THank you' is overlaid in a large, blue, bold font with a white outline. The 'T' is all caps, while 'Hank you' is in title case. The entire image is framed by a white border, which is itself set against a dark blue background.

**THank you**