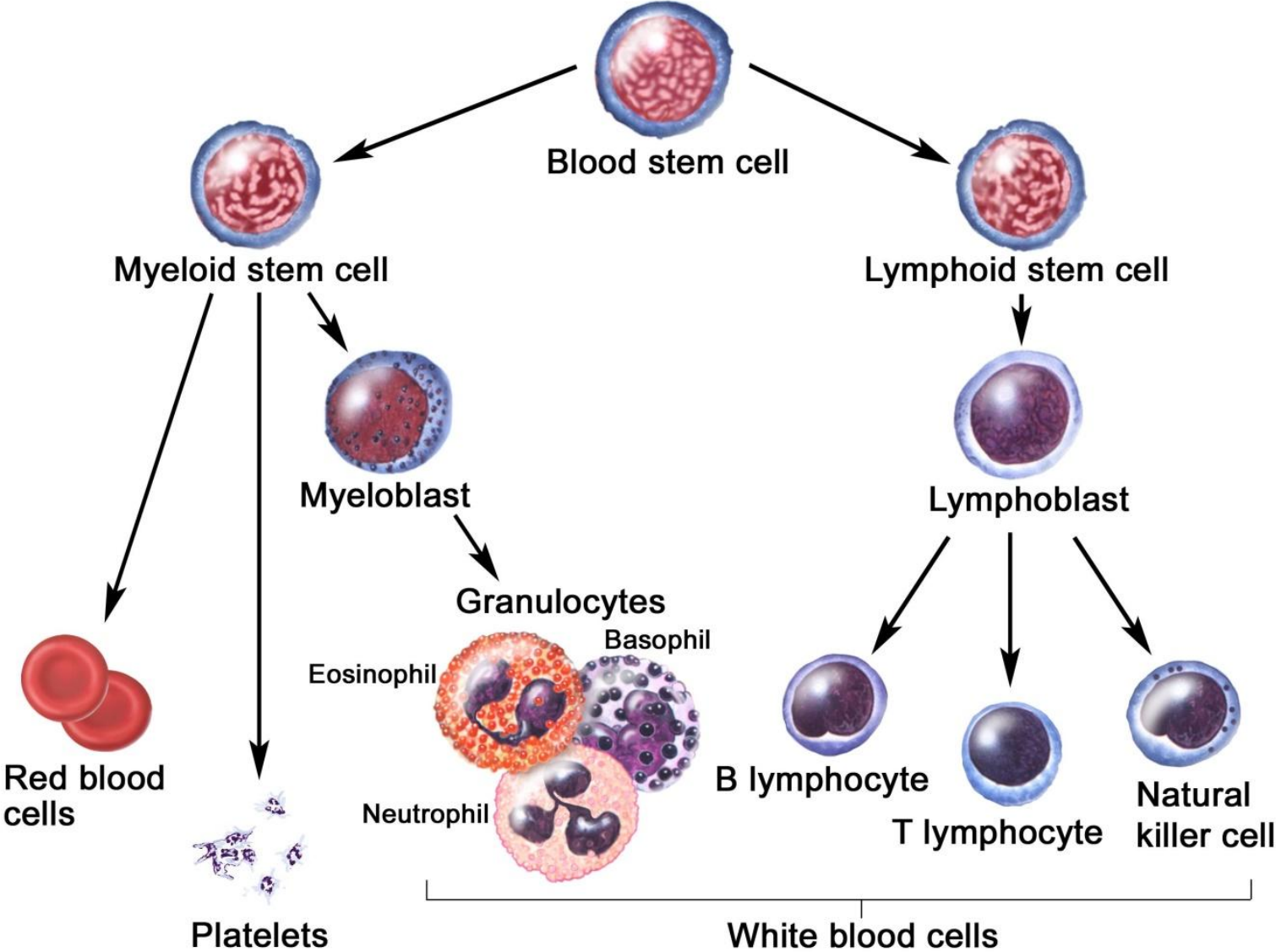


# Blood

# Formation of blood cells



**Blood** is fluid connective tissue that circulates through the cardiovascular system

### Components

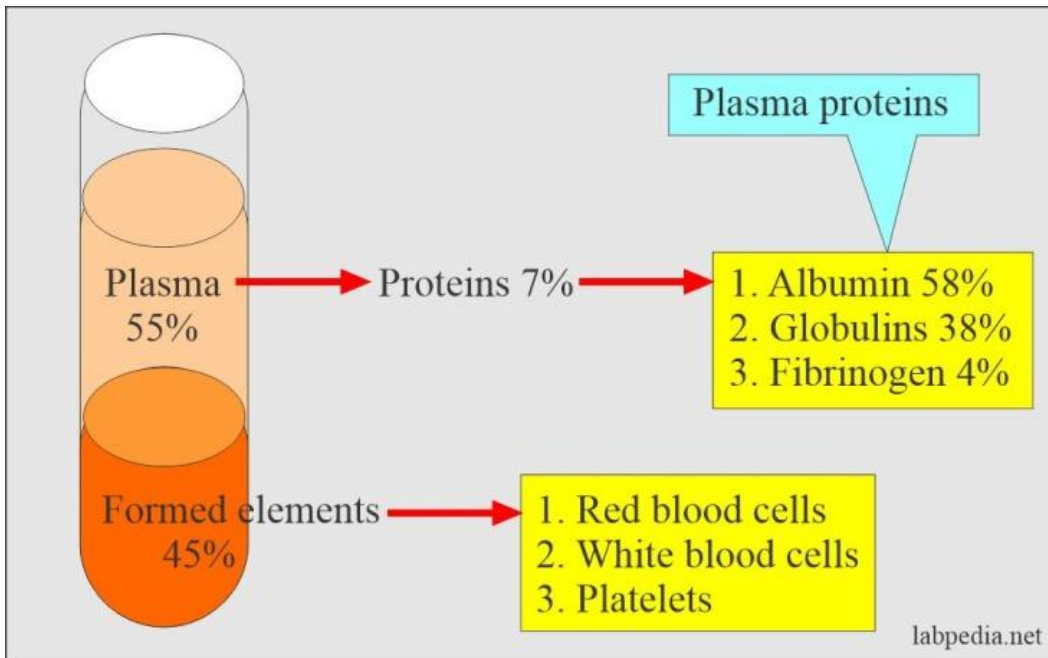
Cells

Extracellular matrix

water

proteins

non-organic substances



- **Plasma** is protein- containing fluid
- **Blood serum** is a plasma without fibrinogen

With anticoagulant



Whole blood

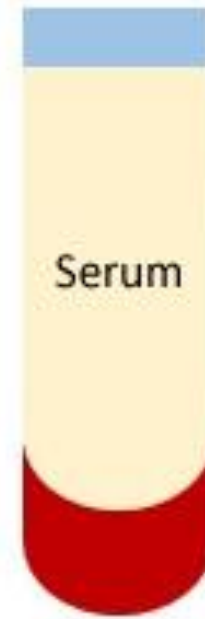
With anticoagulant



Red blood cell

With the blood cell etc.

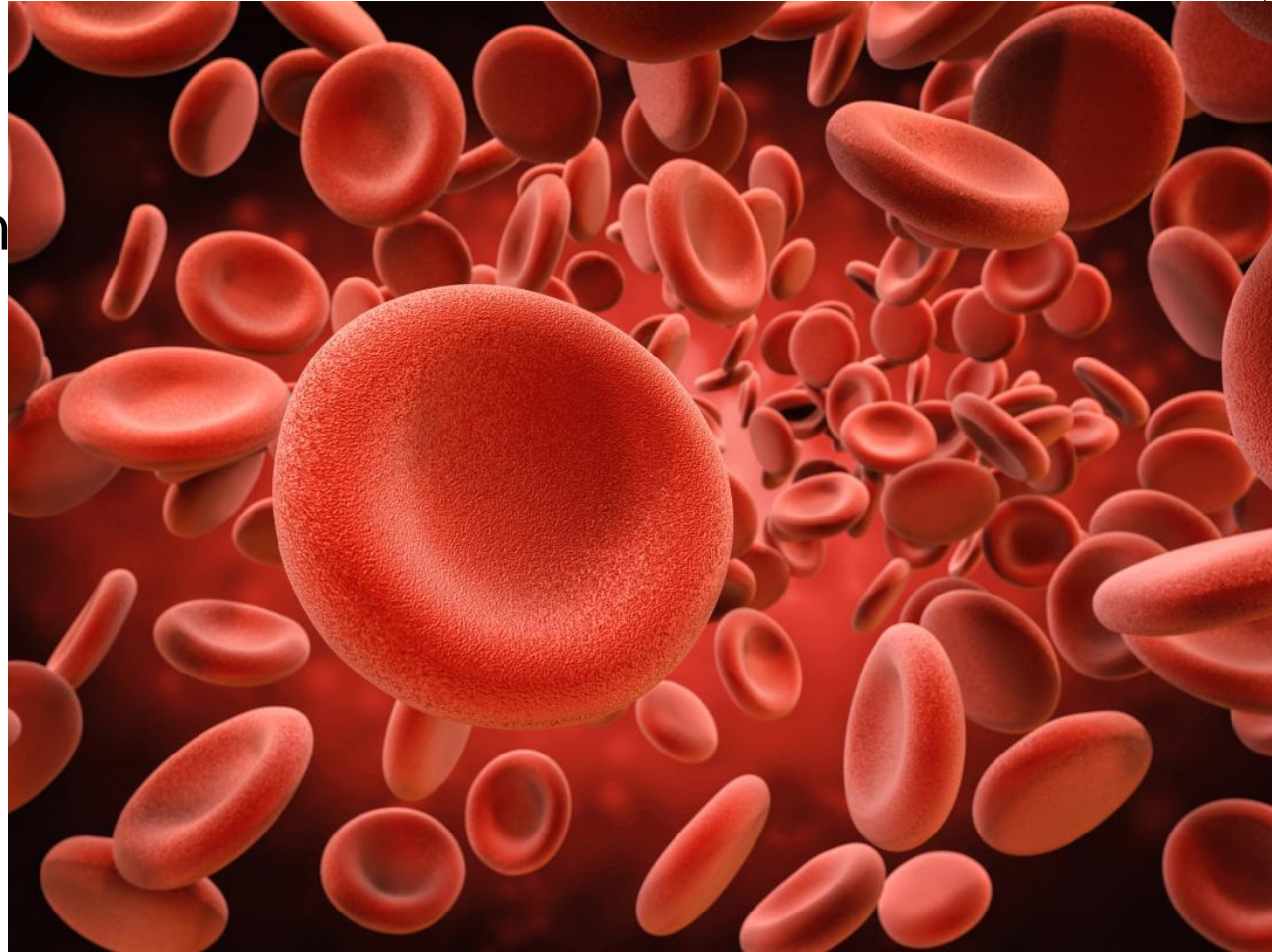
Without anticoagulant



Blood clot

# Functions of the blood

- Delivery of nutrients and oxygen
- Transport of wastes and carbon dioxide from cells
- Delivery of hormones and other chemicals
- Maintenance of homeostasis
- Participating in coagulation and thermoregulation
- Transport of humoral agents



# Plasma proteins

**Albumins**- the main protein of the plasma

## Functions:

- Maintain colloid osmotic pressure
- Binds and transport hormones, metabolites and drugs

## **Globulins:**

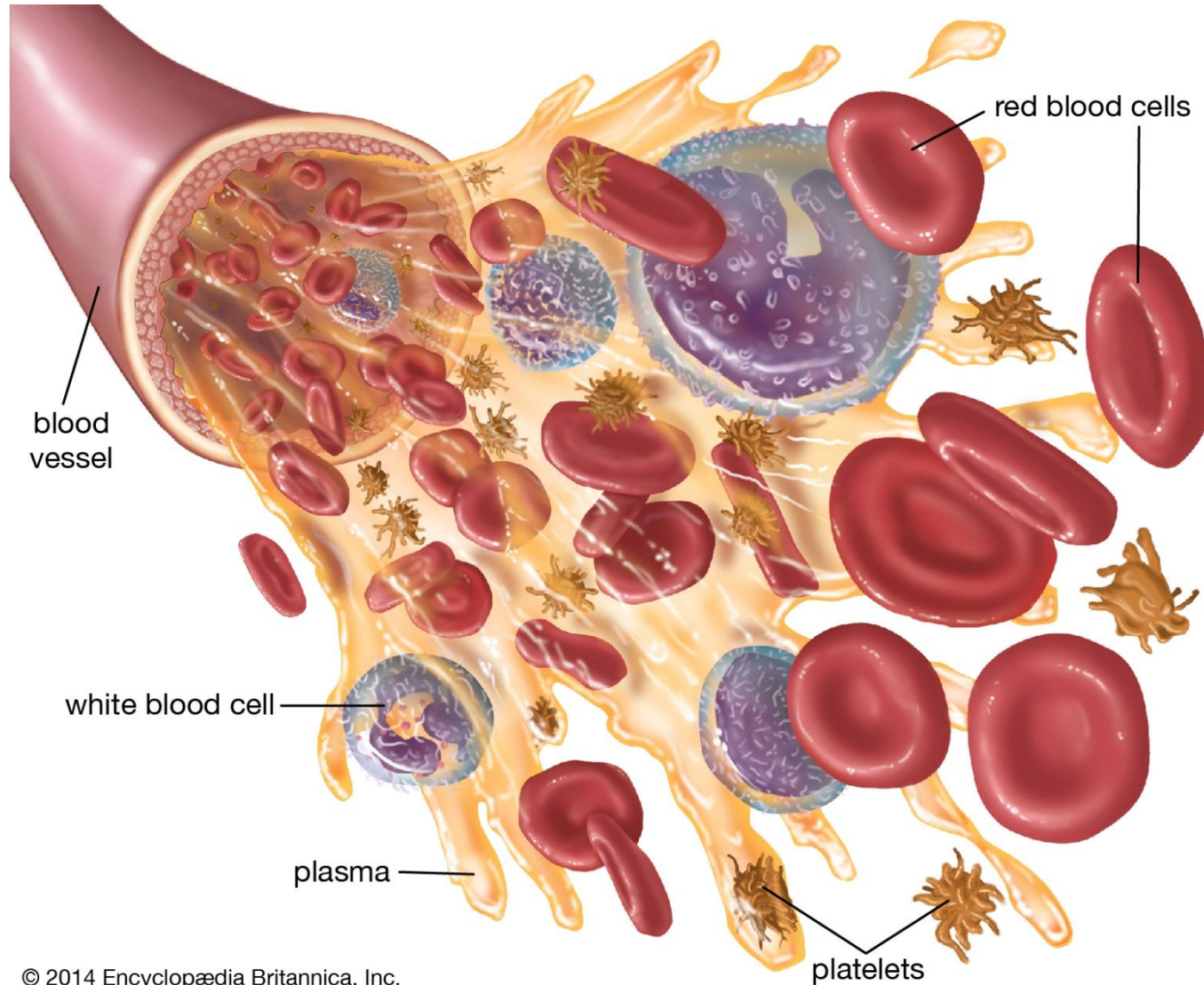
$\alpha$ - globulin- transports of hormones and lipids, inhibits the action of enzymes

$\beta$ - globulin- binds the ferrum

$\gamma$ -globulin- are antibodies

**Fibrinogen**- initiate the cascade reaction of coagulation

# Blood cells



**Erythrocytes-** anucleated post-cellular structure devoid of nucleus and typical organelles

**Functions:** bind and transport oxygen and carbon dioxide

**Number of erythrocytes per 1L**

Males-  $3.9-5.5 \times 10^{12}$

Females-  $3.7-4.9 \times 10^{12}$

Newborn –  $6.0-9.0 \times 10^{12}$

Elderly people- up to  $6.0 \times 10^{12}$



# Structure of erythrocyte

- Cell membrane
- Cytoplasm with numerous hemoglobin-containing granules

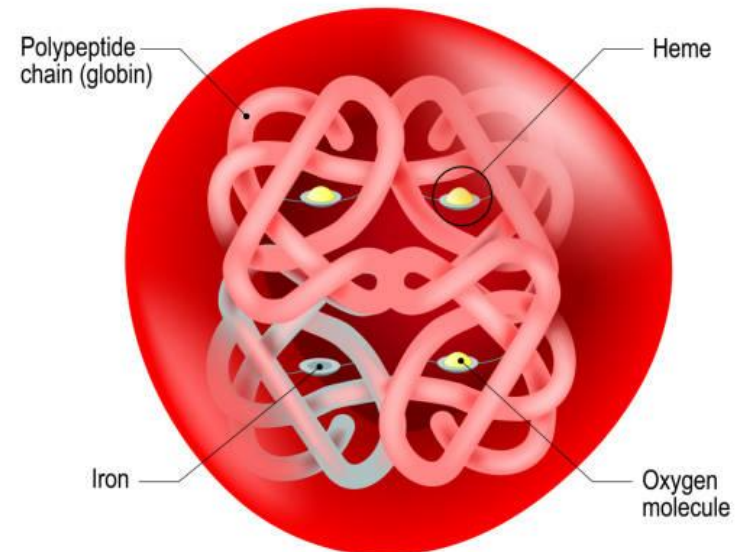
**Hemoglobin**- complex protein composing of four polypeptide chains of globin and iron-containing heme-group.

It can be bind with oxygen (oxygemoglobin), carbon dioxide (carbohemoglobin), carbon monoxide (carboxihemoglobin)

## Types of hemoglobin:

- HbA –adult-98%
- HbF- fetal- 2%

## HEMOGLOBIN



# Plasma membrane of erythrocyte-

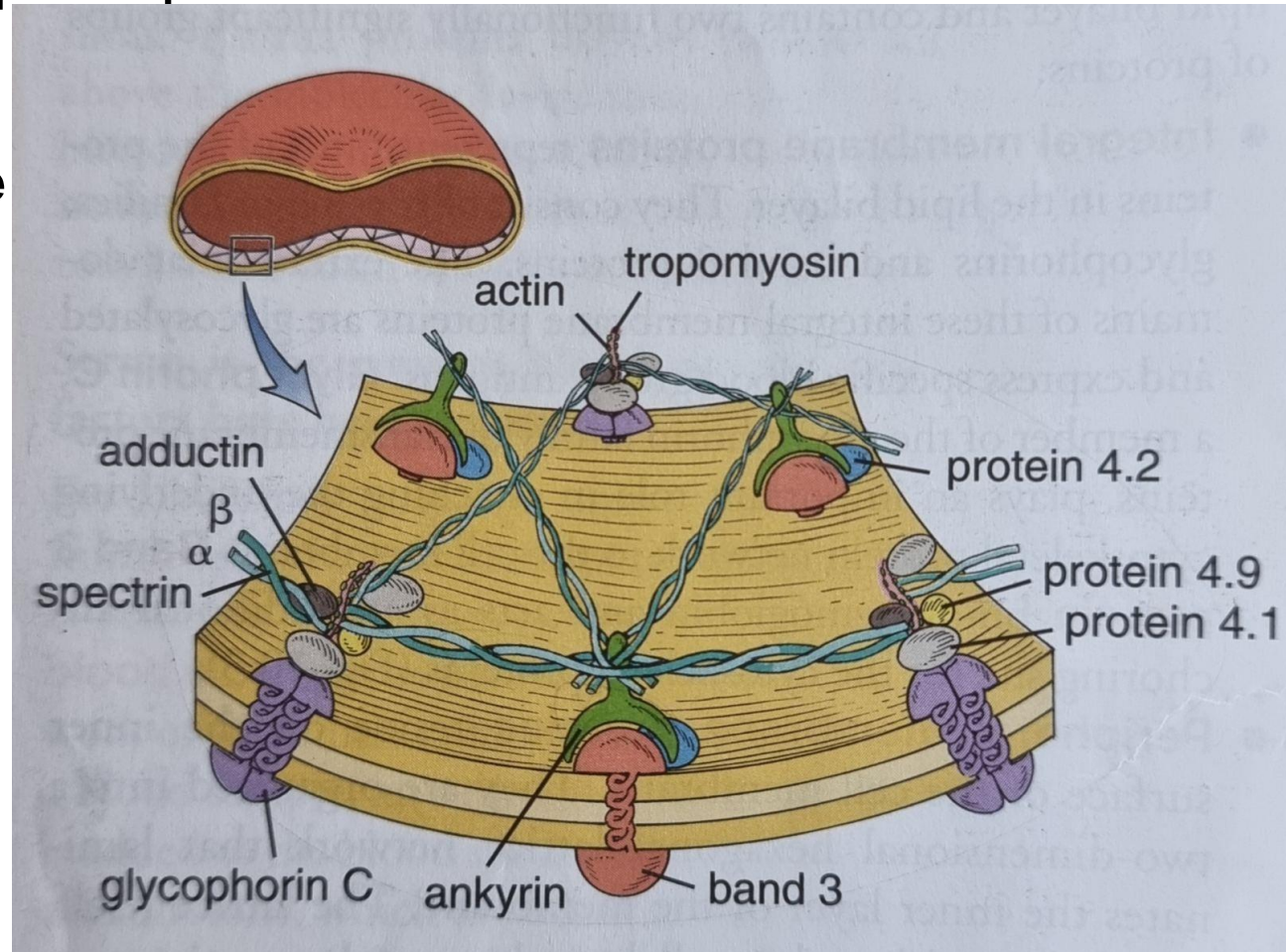
composed of typical lipid bilayer and contains two functionally groups of proteins

## 1. Integral membrane proteins:

- $\beta$ -sialoglycoprotein
- Glycophorin C
- Band 3

## 2. Peripheral membrane proteins:

- Ankyrin
- Spectrin



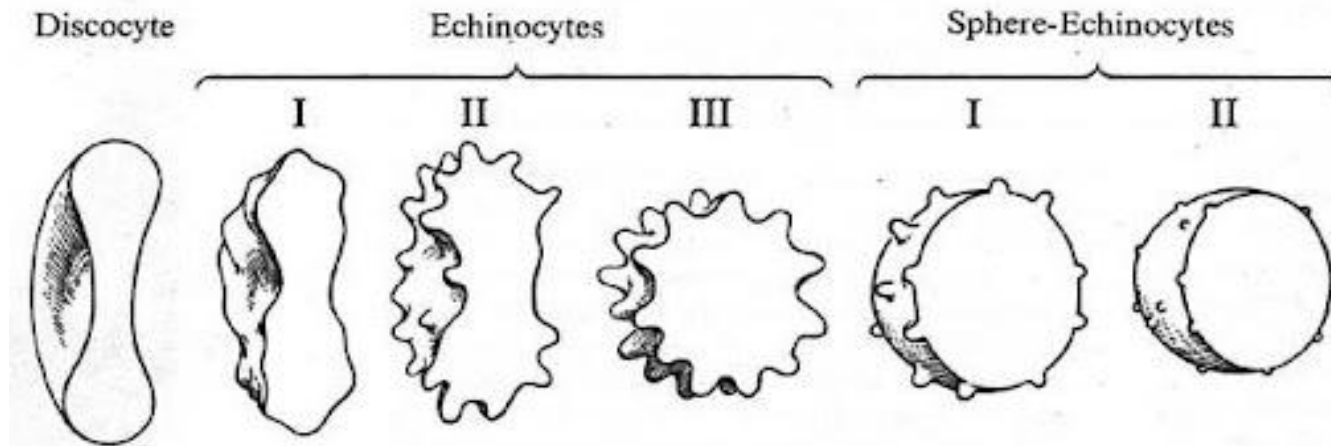
- **Shape of erythrocytes – discocytes**

**Other shapes:**

- Planocytes - flattened
- Stomatocytes - domed-chaped
- Saddle-shaped
- Spherocytes
- Echinocytes – spinous

**Physiological poikilocytosis** when the percentage of other shapes doesn't exceed 20%

**Pathological poikilocytosis** when the percentage of other shapes more than 20%



- **Size of erythrocytes:**

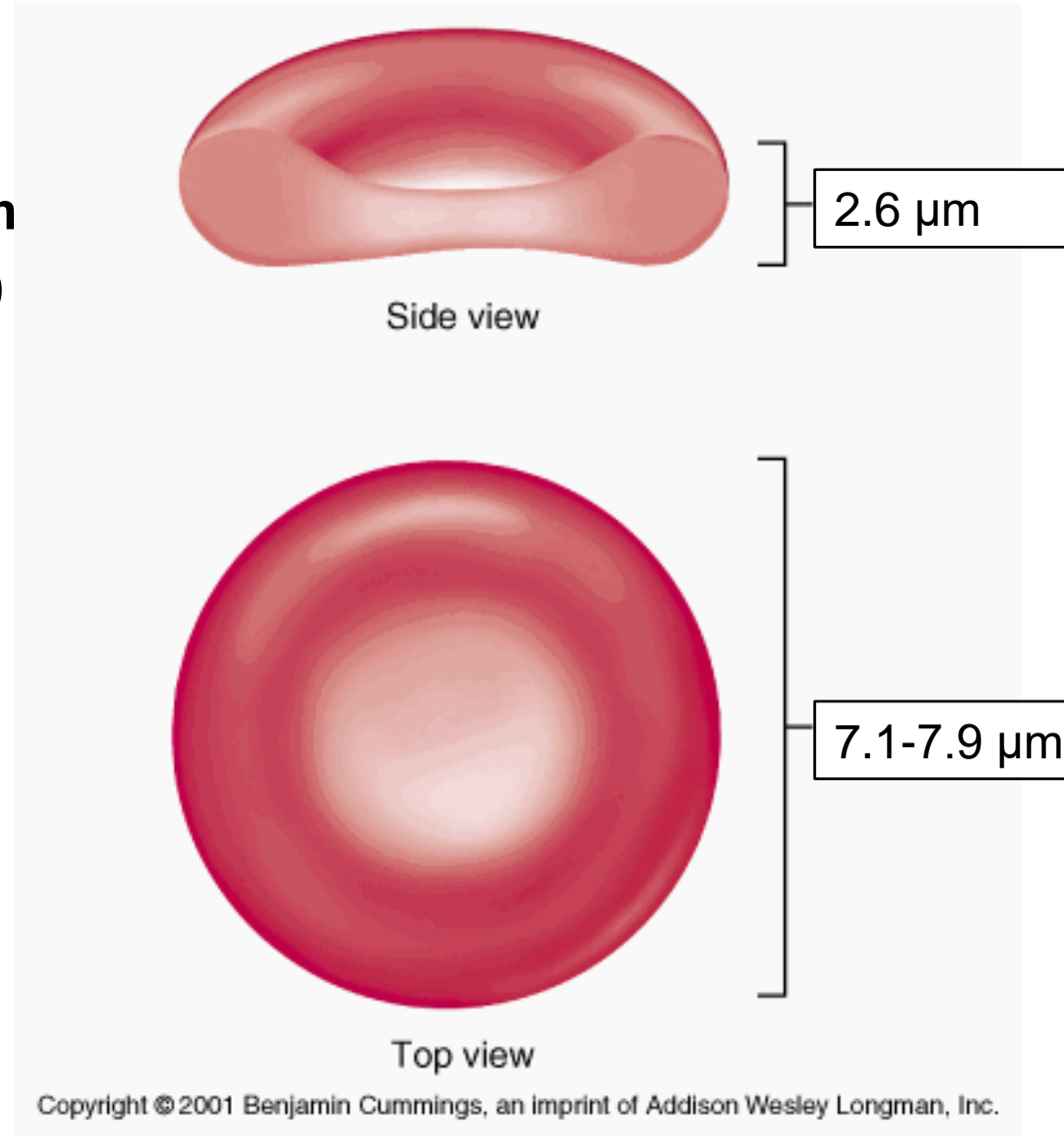
- **Normocytes** - 7.1-7.9  $\mu\text{m}$
- **Microcytes** - less than 6.0  $\mu\text{m}$
- **Macrocytes** – more than 8.0  $\mu\text{m}$

**Physiological anisocytosis**

when the percentage of micro- and macrocytes doesn't exceed 25%

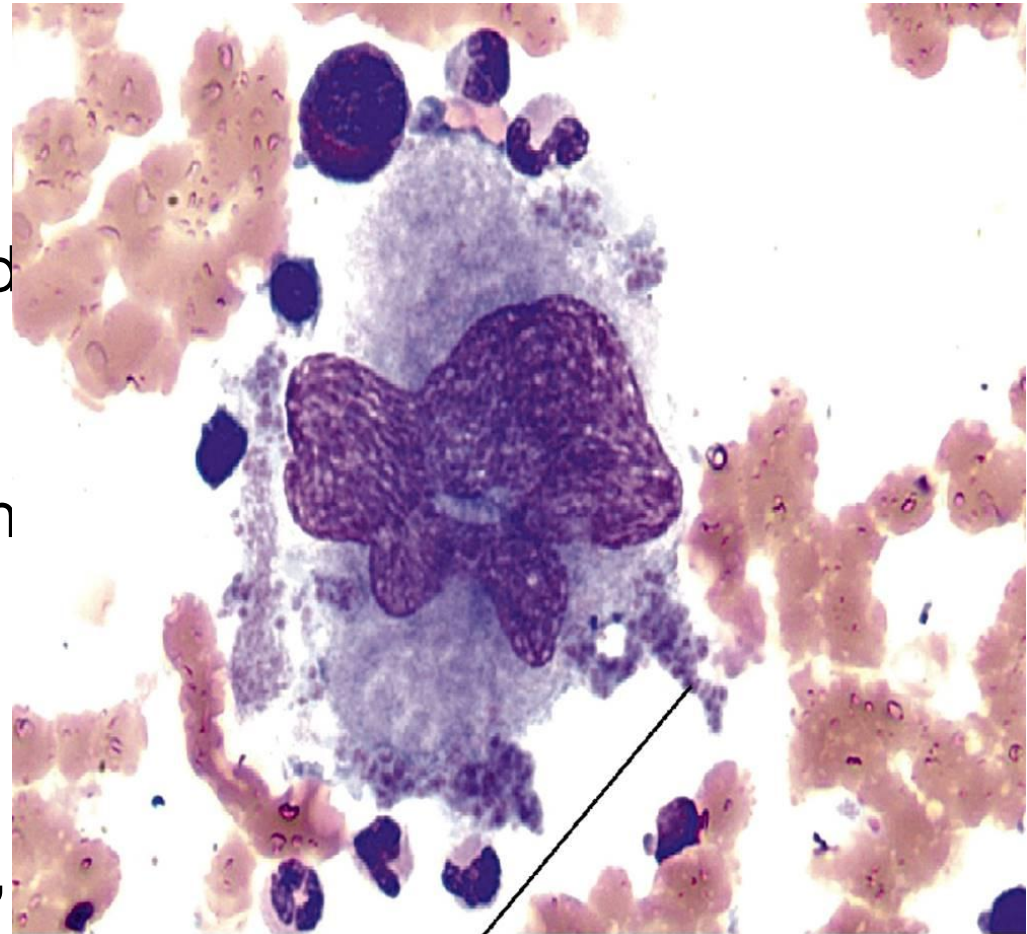
**Pathological anisocytosis**

when the percentage of micro- and macrocytes exceed 25%



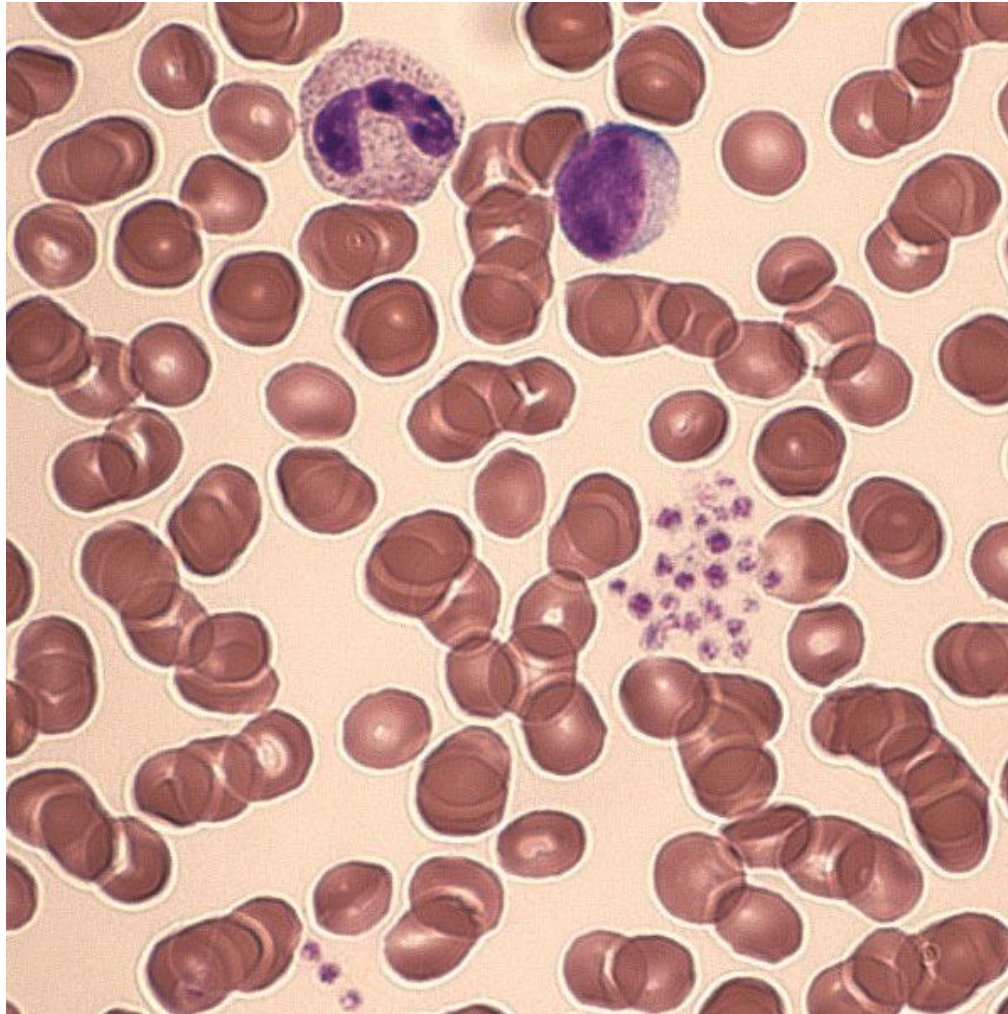
# Platelets (trombocytes)- enucleated fragment of megakaryocyte

- Number of platelets:  $180-320 \times 10^9$
- Functions: initiate the blood clotting discharging tromboplastin (enzyme) that catalyzes transformation of fibrinogen into fibrin
- Structure. Consists of:
  - Granulomere- dense dark granules, serotonin granules, lysosomes
  - Hyalomere- basis of thrombocyte containing microtubules



Platelets

# Platelets



# Leucocytes

## Classification

### 1. Granulocytes

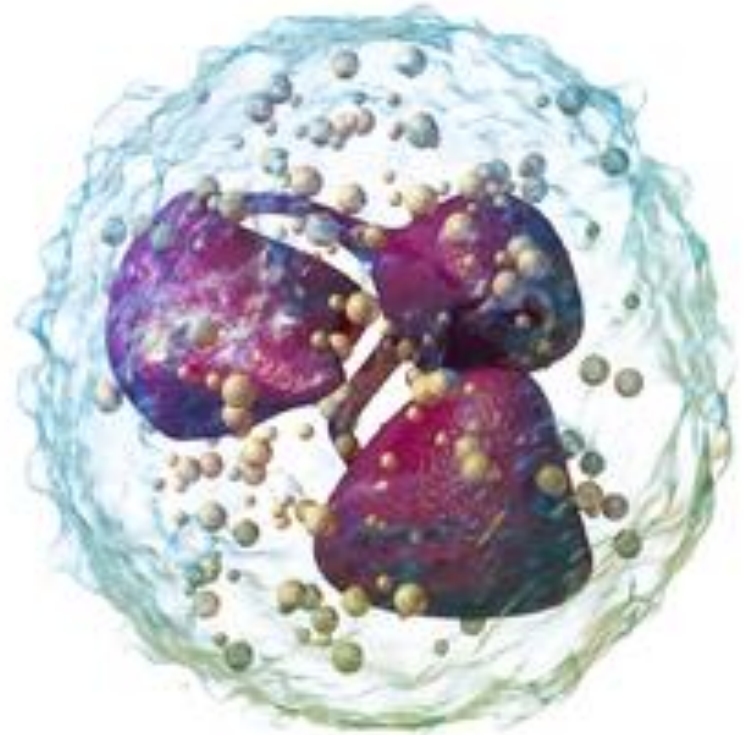
- Neutrophils
- Eosinophils
- Basophils

### 2. Agranulocytes

- Lymphocytes
- Monocytes

# Neutrophils

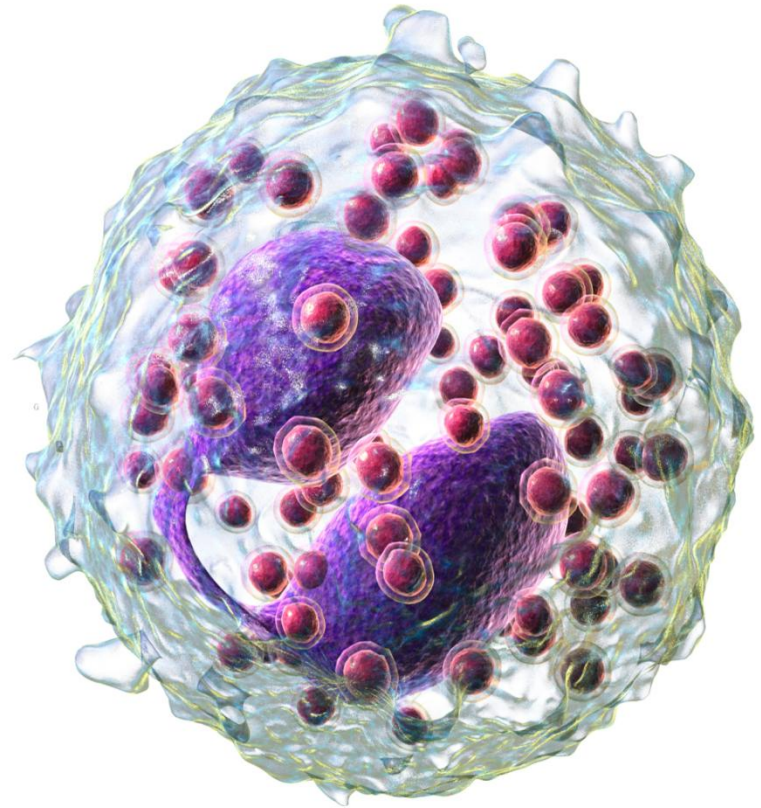
- **65-70% of total number of leukocytes**
- **Types of granules:**
  - Primary (azurophilic)-acid hydrolase
  - Secondary (neutrophilic)- acidic phosphatase
- **Types of neutrophils:**
  - Young (metamyelocytes)-0-05%
  - Band-1-6%
  - Segmented-49-72%
- **Function-** phagocytosis





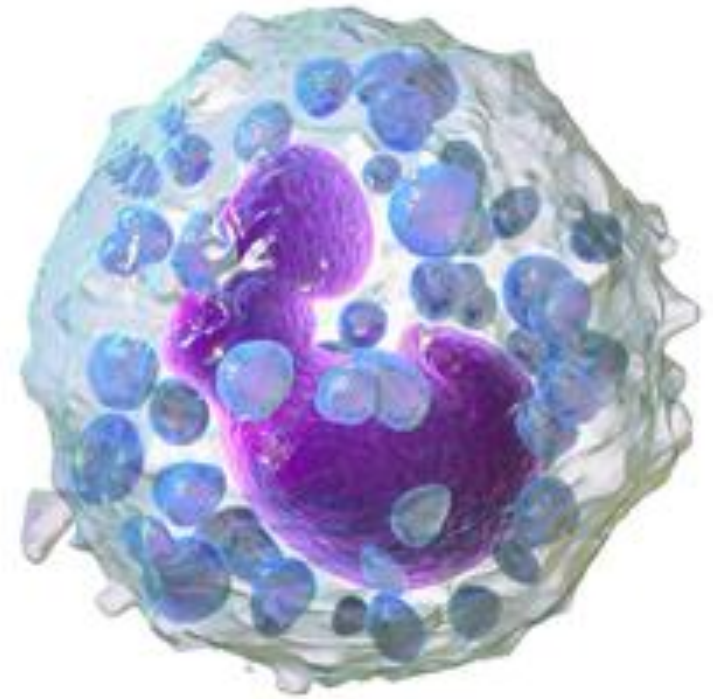
# Eosinophils

- 1-5 % of total number of leukocytes
- **Types of granules:**
  - Primary (azurophilic)-acid hydrolase
  - Secondary (eosinophilic)- **arginin-prot** histaminase, arylsulfatase, collagenase
- **Types of eosinophils** :Young,Band, Segmented
- **Functions**
  - Are less capable to phagocytosis
  - Break down the histaminedischarging by basophil
  - React on parasites causing allergic reaction



# Basophils

- **0.5-1 % of total number of leukocytes**
- **Types of granules:**
  - Primary (azurophilic)-acid hydrolase
  - Secondary (basophilic)- **heparin, histamine**
- **Functions**
  - Regulation of blood clotting by activity of heparin
  - Regulation of permeability of blood vessels by action of histamine causing allergic symptoms (itch, redness, edema)
  - Production of eosinophil-chemotaxis factors



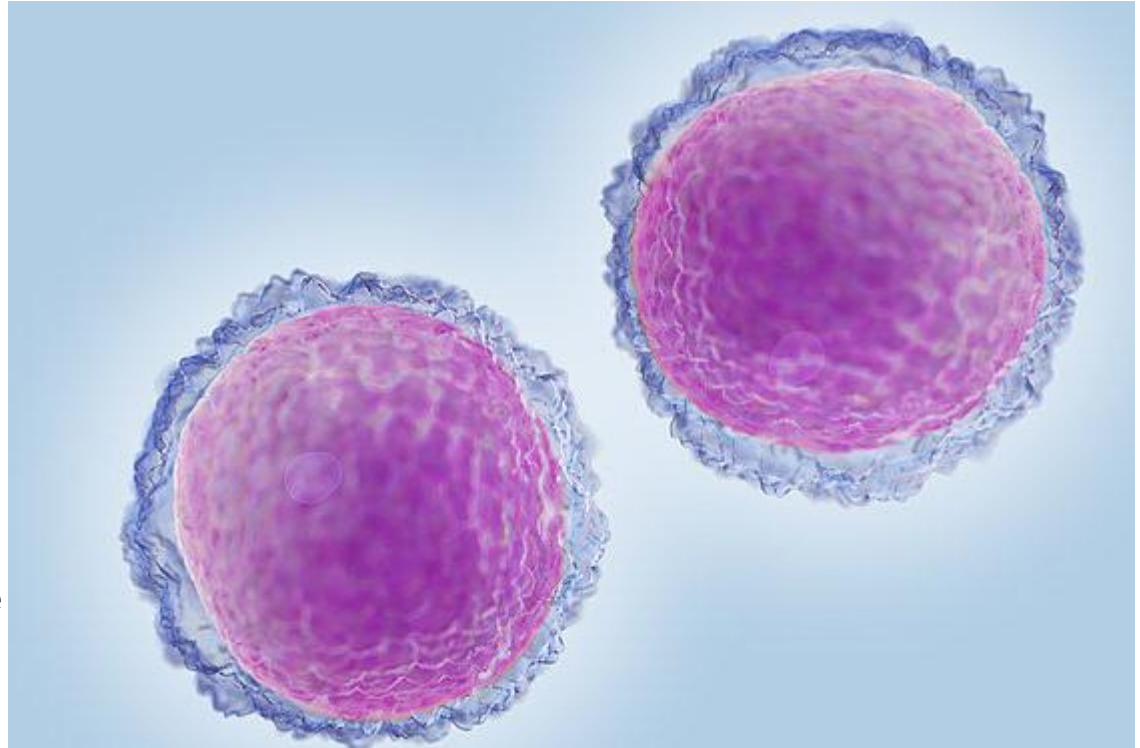
# Lymphocytes

- **19-37% of total number of leukocytes (T and B-lymphocytes)**
- **Types basis on their size:**
  - Small-4,5-6,0  $\mu\text{m}$
  - Medium-7,0-10,0  $\mu\text{m}$
  - Large – more than 10,0  $\mu\text{m}$
- **Functional types:**
  - T- lymphocytes
  - B-lymphocytes
  - NK- cells

# T-lymphocytes

- provide cell-mediated immunity and regulation of humoral immunity

- Arise from the hemopoietic stem cell of the red bone marrow
- **Functional types:**
  - T-killer- elimination of tumor cells and rejection of allografts
  - T-suppressor-inhibit the production of antibodies by B-lymphocytes
  - T-helper-initiate the production of antibodies by B-lymphocytes



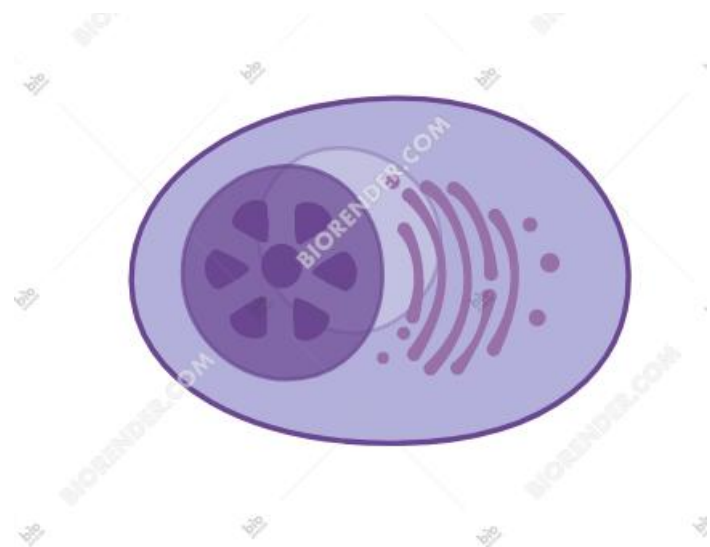
# B-lymphocytes - provide humoral immunity

- Arise from the hemopoietic stem cell of the red bone marrow

- The definitive form is **plasma cell**

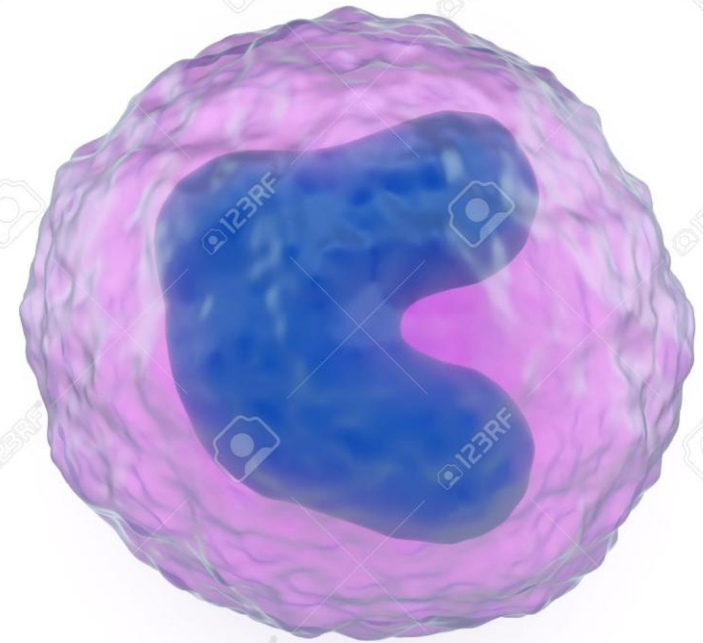
**Structure:** light perinuclear space with well-developed RER, and nucleus as a wheel with light and dark areas

- **Function:** production of immunoglobulins (antibodies)
- **NK-killer (natural killer) -** programmed to kill specific viruses cells



# Monocytes - macrophatic system cells

- **3-11 % of total number of leukocytes**
- **Structure:** nucleus is variable in shape, in the cytoplasm numerous lysosomes, small mitochondria, RER, pinocytotic vesicles.
- **Function:** migrate to the connective tissue and provide phagocytosis



# Blood Cells



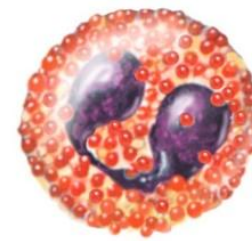
Monocyte



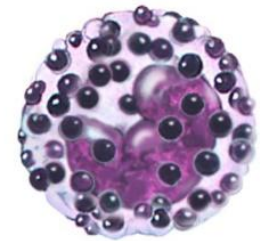
Lymphocyte



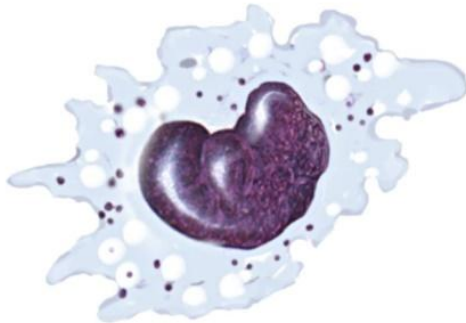
Neutrophil



Eosinophil



Basophil



Macrophage



Erythrocyte



Platelets

# Blood smear

