

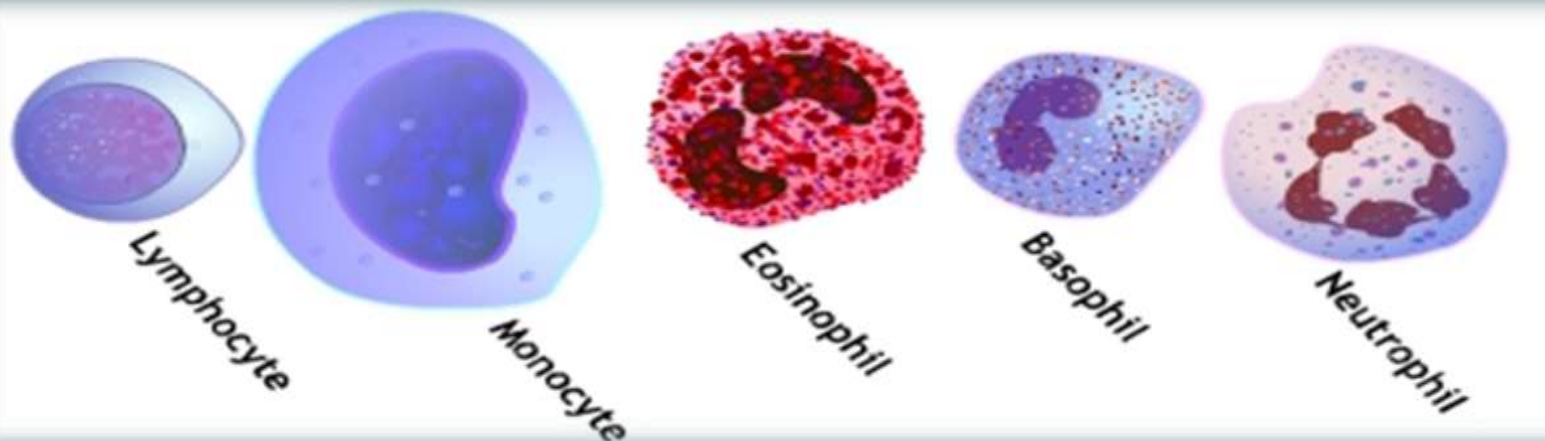


Al-Rasheed University College  
Pharmacy Department  
2<sup>nd</sup> Stage / 2<sup>nd</sup> Course  
(2019 – 2020)



Physiology Lab.  
2<sup>nd</sup> Stage / 2<sup>nd</sup> Semester  
Lab. (3)

# DIFFERENTIAL WBC COUNTING



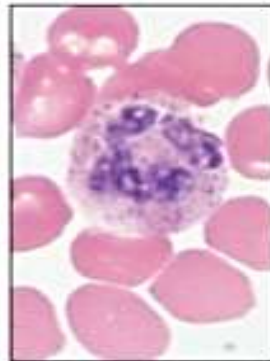
# INTRODUCTION:

- White blood cells (WBCs) are also called leukocytes
- They are the **first line of defense** against invading pathogens and diseases
- Leukocytes are originated in **bone marrow from stem cells (hemocytoblasts)** in response to certain hormones
- Once WBCs are fully mature, they enter the blood stream and then transported to the site of injury
- ***Two main types of WBCs are identified:***
  - ***Granulated WBCs*** (because of the presence of granules in cytoplasm)
    - Neutrophils
    - Eosinophils
    - Basophils
  - ***Agranulated WBCs*** (because they lack granules in cytoplasm)
    - Lymphocytes (T cell & B cells)
    - Monocytes

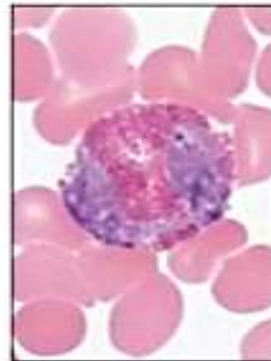
## CHARACTERISTIC DIFFERENCES:

**WBCs differ one from the other in:**

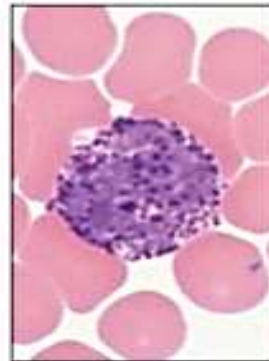
1. Cell size
2. Composition of the cytoplasm
3. Shape of the nucleus
4. Staining characteristics



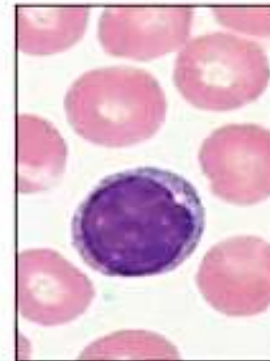
**(a) Neutrophil;**  
multilobed  
nucleus



**(b) Eosinophil;**  
bilobed nucleus,  
red cytoplasmic  
granules



**(c) Basophil;**  
bilobed nucleus,  
purplish-black  
cytoplasmic  
granules



**(d) Small  
lymphocyte;**  
large spherical  
nucleus



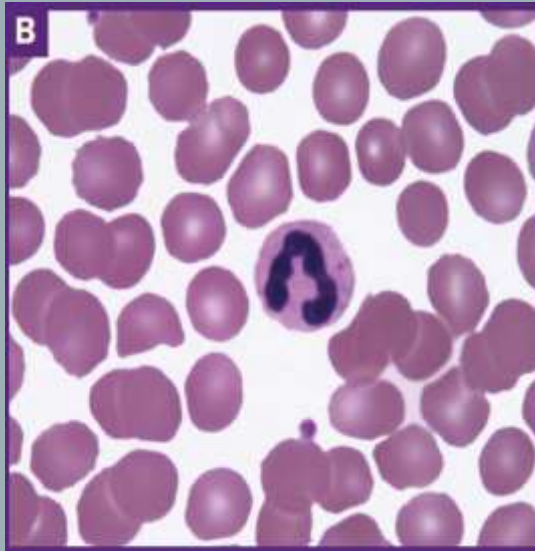
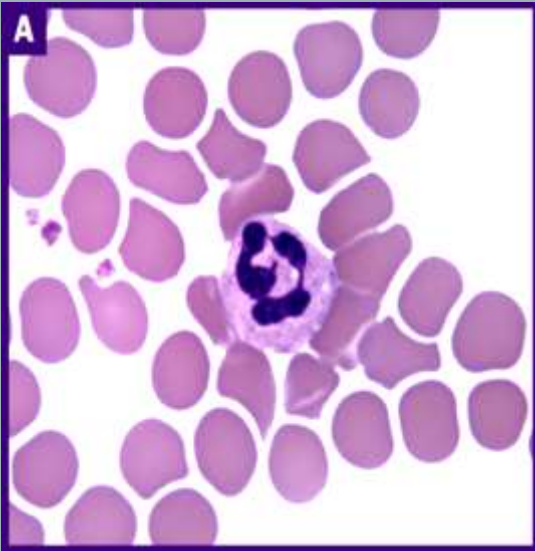
**(e) Monocyte;**  
kidney-shaped  
nucleus

# GRANULATED WBC:

**Neutrophils**

Eosinophils

Basophils



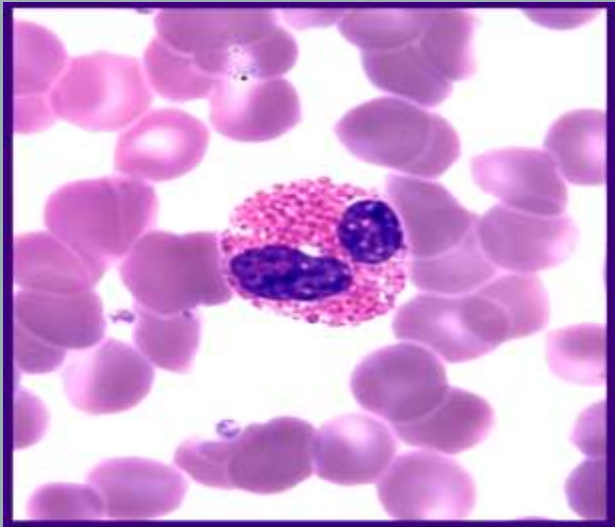
- Have fine granulated cytoplasm
- Mostly lobulated nucleus (2 – 5 lobes)
- Immature neutrophils, nucleus not lobulated
- Mature neutrophils, nucleus is lobulated (in this case the cells are called polymorphonuclear neutrophils PMNs)
- Granules stains purple in color with acid-base stain
- Most abundant type of WBCs (accounts for 55% - 65%)
- Mature and specialized neutrophils are called **microphages capable of phagocytosis**
- **First line of defense in acute bacterial infection or inflammation**
- Increased number of neutrophils called **(neutrophilia)** as in:
  - Acute inflammation (gouty arthritis)
  - Acute bacterial infection
- Decreased number of neutrophils called **(neutropenia)** as in:
  - Viral infection
  - Parasitic infection (malaria)

# GRANULATED WBC

Neutrophils

**Eosinophils**

Basophils



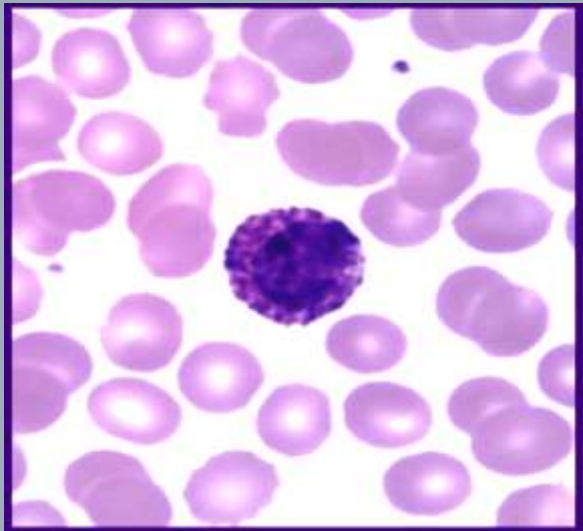
- Course granulated cytoplasm
- Lobulated nucleus (2 lobes)
- Granules stains bright red
- Accounts for about (1% - 3%) of WBCs
- **Release the histaminase enzyme** that combat the effect of histamine and other inflammatory mediators
- Active during moderate allergic reaction and parasitic worm infection. Capable of phagocytosis
- Increased number of eosinophils is called **(eosinophilia)**
  - Parasitic infection
  - Allergic reaction (hay fever)
- Decreased number of eosinophils is called **(eosinopenia)**
  - Cushing syndrome
  - Acromegaly

# GRANULATED WBC

Neutrophils

Eosinophils

**Basophils**

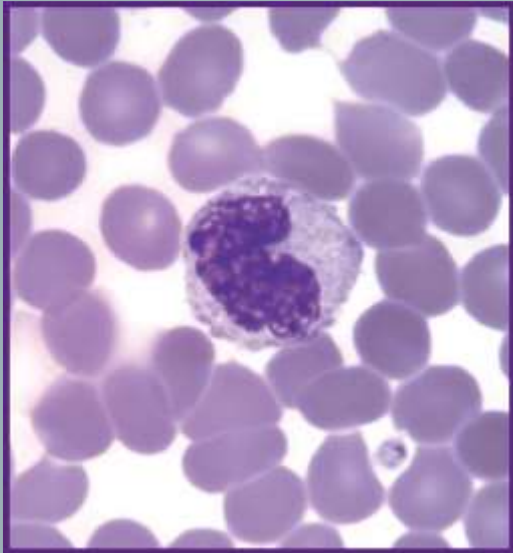


- Very coarse granulated cytoplasm
- Lobulated nucleus (2 lobes), usually obscured by the large granules
- Granules stain deep blue
- Least abundant type of WBCs, accounts for (1% or less)
- They release **histamine** to promote inflammation and **heparin** to prevent blood clotting and intracellular coagulation
- Increased number of basophils is called **(basophilia)**
  - TB infection
  - Hypothyroidism
- Decreased number of basophils is called **(basopenia)**
  - Hyperthyroidism
  - Cushing syndrome

# AGRANULATED WBC

Monocytes

Lymphocytes



- Cytoplasm lacks granules, stains light blue
- Single nucleus, not lobulated (kidney-shaped or horse shoe-shaped), nucleus stains purple
- The largest cells of WBCs
- Accounts for 3% - 7% of all WBCs
- **Specialized monocytes** leave the blood stream and localize in different organs, then they are **called macrophages**
- They are the **first line of defense** in **chronic infection**, and they are capable of phagocytosis.
- They secrete anti-viral substance called interferon and inflammatory substance called interleukin I
- Increased in number of monocytes is called **(monocytosis)**
  - Ulcerative colitis
  - Tuberculosis (TB)
- Decreased number of monocytes is called **(monocytopenia)**
  - Hairy cell leukemia
  - Steroid treatment

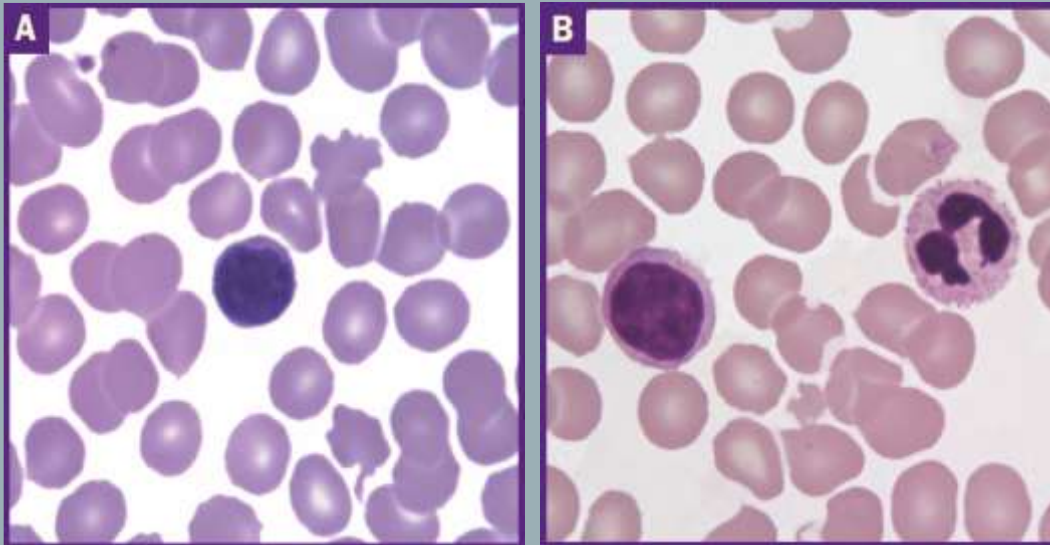
## LOCALIZATION OF SPECIALIZED MONOCYTES (MACROPHAGES):

- As mentioned previously, mature monocytes are specialized and tend to localize in different organs and they are called (macrophages), these include:
  - **Histiocytes** in connective tissue
  - **Microglia** in the brain
  - **Kupffer cells** in the liver
  - **Alveolar macrophages** in the lungs
  - **Sinus – lining macrophages (reticular cells)** in the spleen, lymph nodes and thymus gland
  - **Mesangial cells** in the glomerulus of nephrons in the kidney
  - **Osteoclasts** in bones

# AGRANULATED WBC

Monocytes

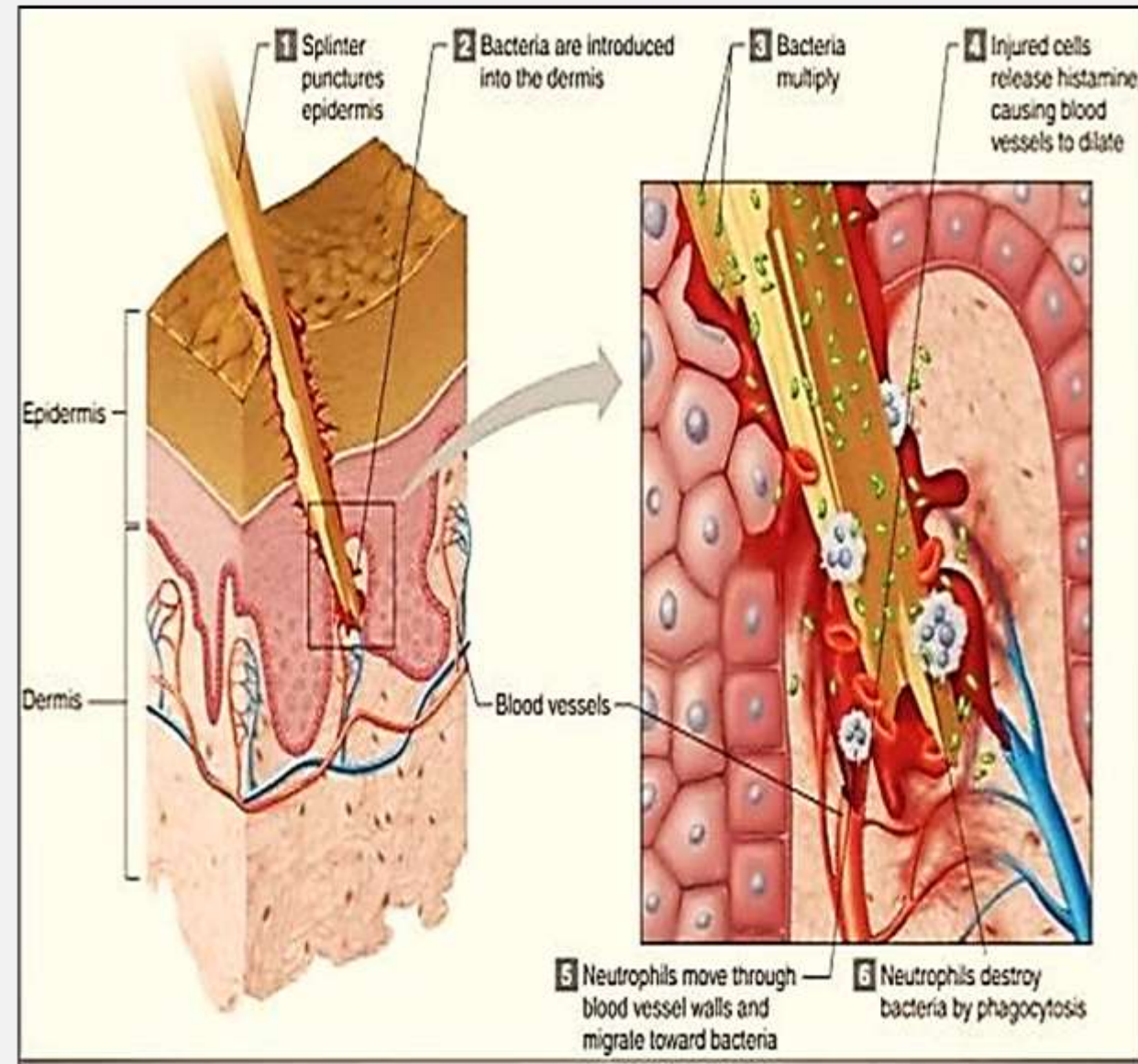
Lymphocytes



- Cytoplasm lacks granules, stains light blue
- Single nucleus, not lobulated. The nucleus is round and takes up most of the cell leaving a small amount of cytoplasm surrounding the nucleus, stains purple
- Smallest cells among WBCs
- Accounts for 25% - 33% of all WBCs
- **There are 2 types of lymphocytes:**
  - **T lymphocytes:** originate from bone marrow and mature in the thymus and important for cellular immunity
  - **B lymphocytes:** originates from bone marrow and mature in bone marrow and they secrete antibodies
- **Important in cellular immunity and antibodies production**
- Increased number of lymphocytes is called **(lymphocytosis)**
  - Viral infection
  - Chron disease
- Decreased number of lymphocytes is called **(lymphocytopenia)**
  - Malignancies
  - Aplastic anemia

## HOW DO LEUKOCYTES FIGHT THE INFECTION?

- Splinter puncture the epidermis
- Bacteria are introduced into the dermis
- Bacteria multiply
- Injured cells release histamine, causing blood vessels to dilate
- Neutrophils move through blood vessel wall and migrate toward bacteria
- Neutrophils destroy bacteria by phagocytosis



## SUMMARY TABLE:

T A B L E O F R E S U L T S					
Cell	Abundance in Blood (%)	Diameter ( $\mu\text{m}$ )	Nucleus	Cytoplasmic Granules (Wright's or Giemsa Stain)	Functions
<b>Granulocyte</b>					
Neutrophil	55–65	12–15	2–5 lobes	Present, but stain poorly; contain antimicrobial chemicals	Phagocytosis and digestion of (usually) bacteria
Eosinophil	1–3	12–15	2 lobes	Present and stain red; contain antimicrobial chemicals and histaminase	Present in inflammatory reactions and immune response against some multicellular parasites (worms)
Basophil	0.5–1	12–15	Unlobed or 2 lobes	Present and stain dark purple; contain histamine and other chemicals	Participate in inflammatory response
<b>Agranulocyte</b>					
Lymphocyte	25–33	7–18 (rare)	Spherical (leaving little visible cytoplasm)	Absent	Active in specific acquired immunity (as T and B cells)
Monocyte	3–7	12–20	Horseshoe-shaped (cytoplasm is prominent)	Absent	Phagocytosis (as macrophages)

**SEE YOU  
NEXT WEEK**

**To Be Continued Next Week  
With The Details of The Experiment  
(Part 2)**



**LOADING**  
PLEASE WAIT...