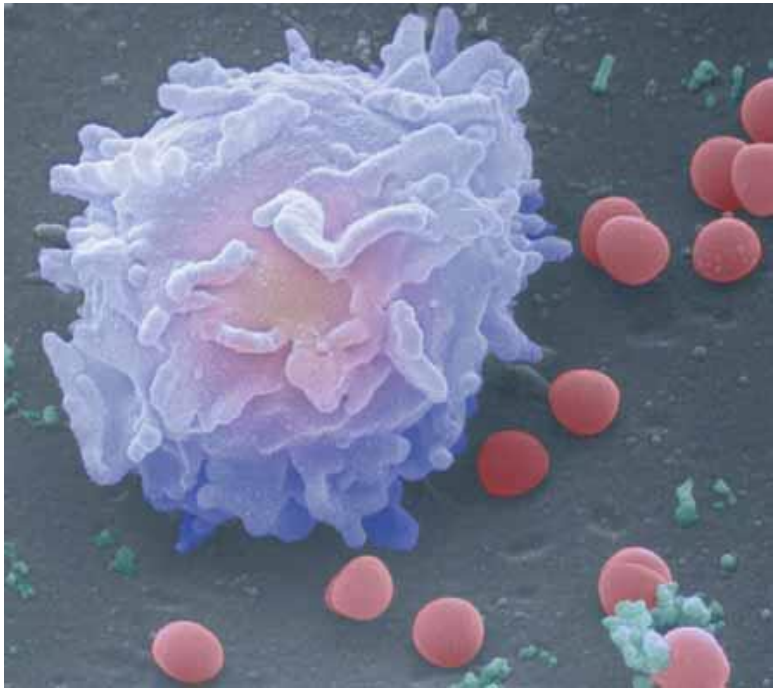
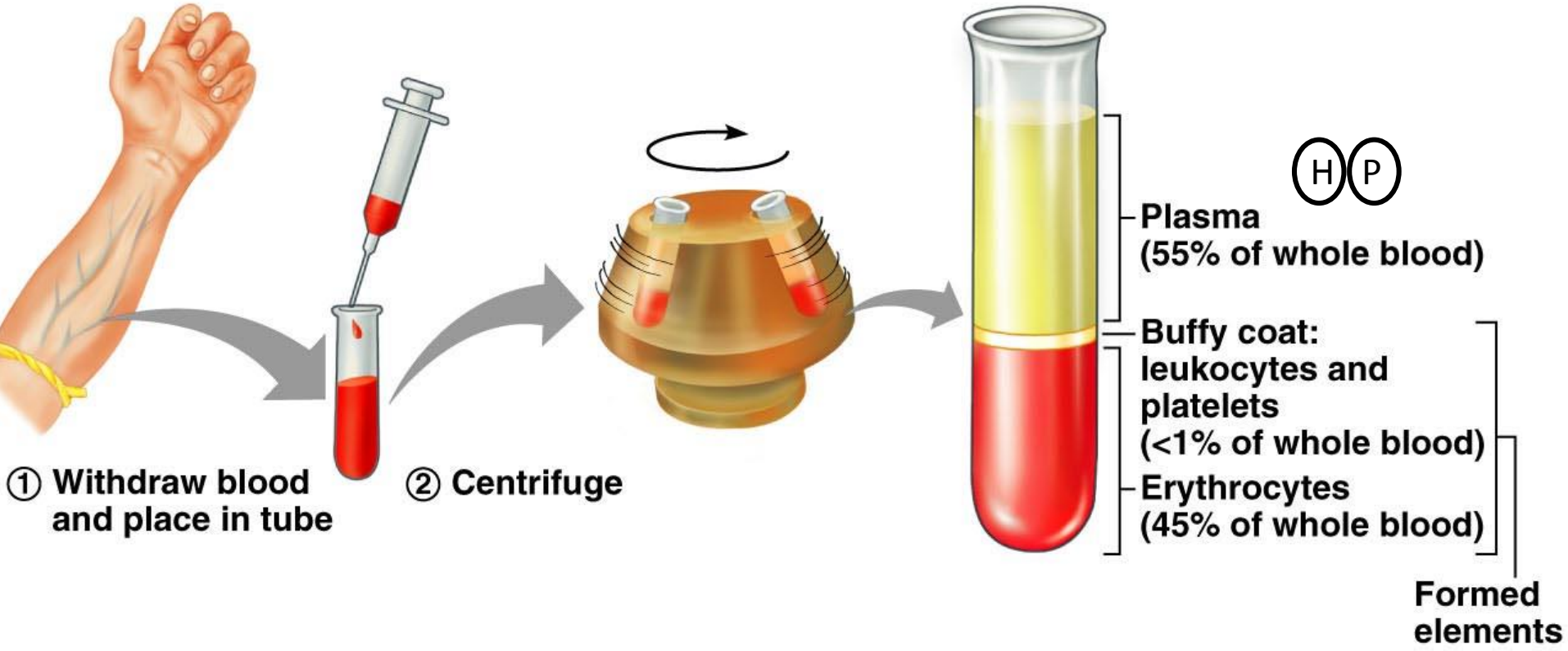
White blood cells / Leukocytes



Objectives

- Classify the white blood cells (WBCs).
- State the differences between WBCs.
- State differential WBC Count.
- Briefly describe the role of WBCs.

Blood



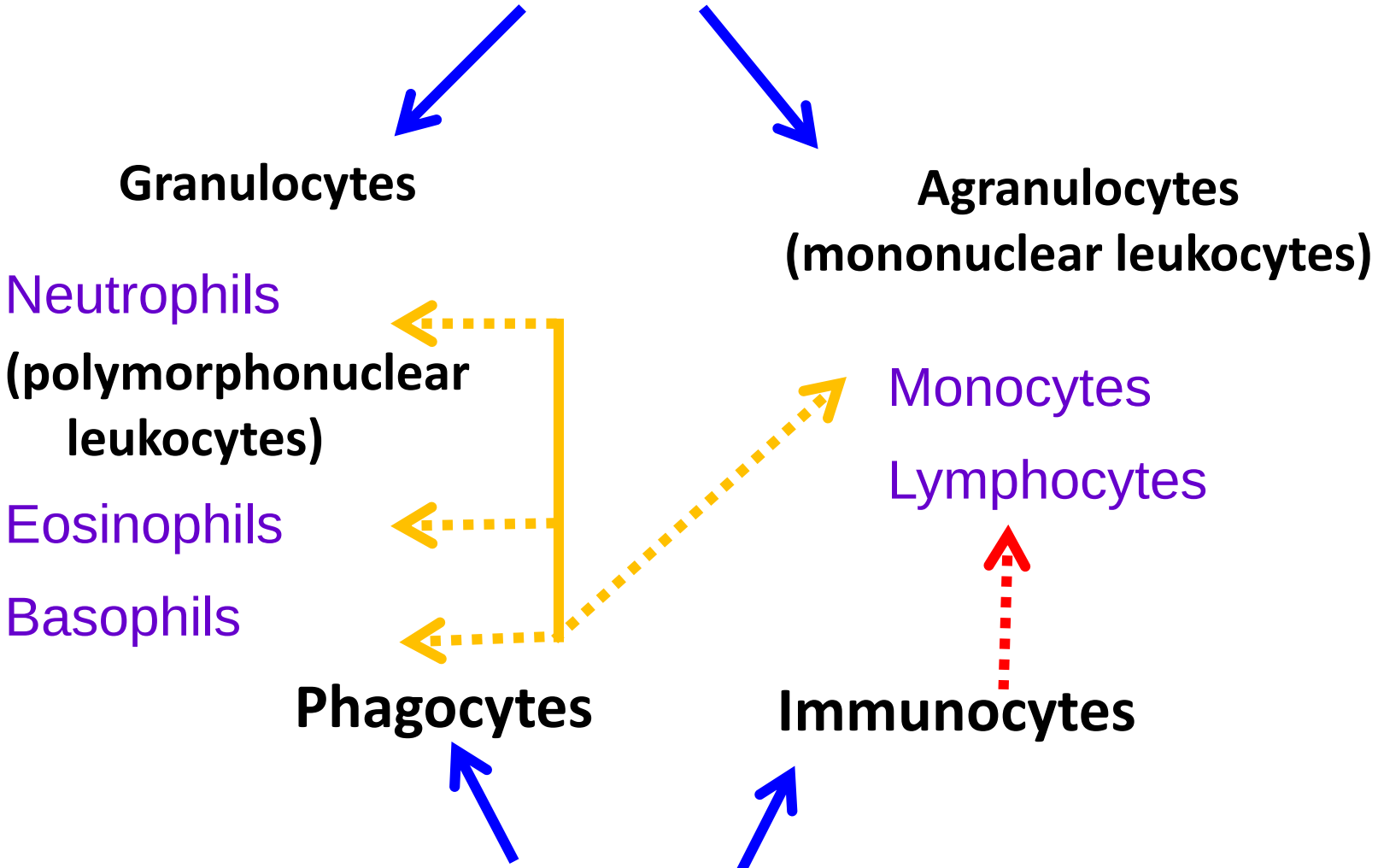
- **Leukocytes are less dense than erythrocytes**

Definition of WBC

The cells of the immune system which defend the body against both infectious disease and foreign materials, and repair of injured tissues.

Types of WBC

Classified into 2 groups according to the **type of granules** and **shape of the nuclei**



Classified into 2 groups according to the perform of **function**

Granulocytes- 2 types of granules

Specific granules

- Bind neutral, acidic or basic components of the dye
- specific functions

Azurophilic granules

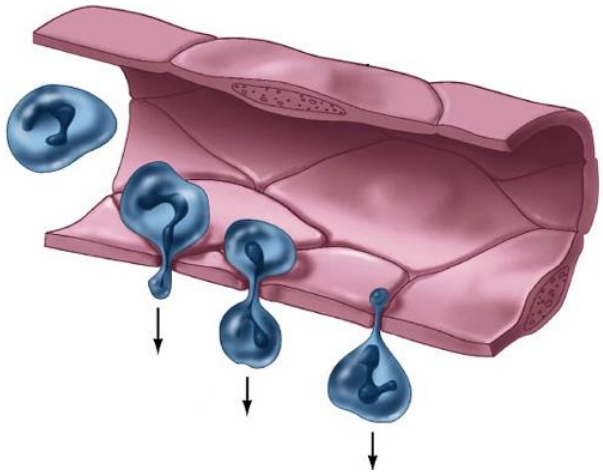
- Stain purple/blue
- Lysosomes

Agranulocytes

- **No specific granules**
- **Azurophilic granules / lysosomes – bind the azure dyes**

Leukocytes

- *Spherical shape & inactive state- in blood*
- *Cytokines in disease area stimulate adhesion of leukocytes to endothelium*
- *Migration through the vessel wall & pass through tissues (flattened & motile)*
- *Capable of amoeboid movements*
- *Neutrophils + monocytes = most active*
- *Lymphocytes = least power of movements*

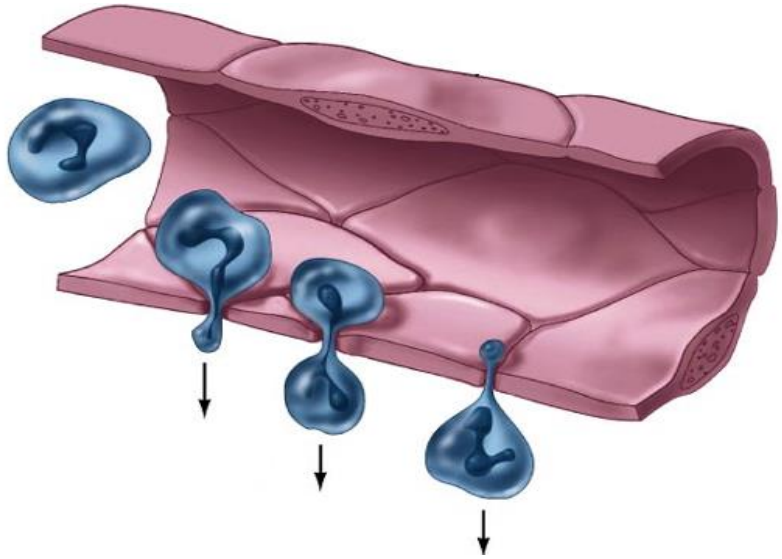


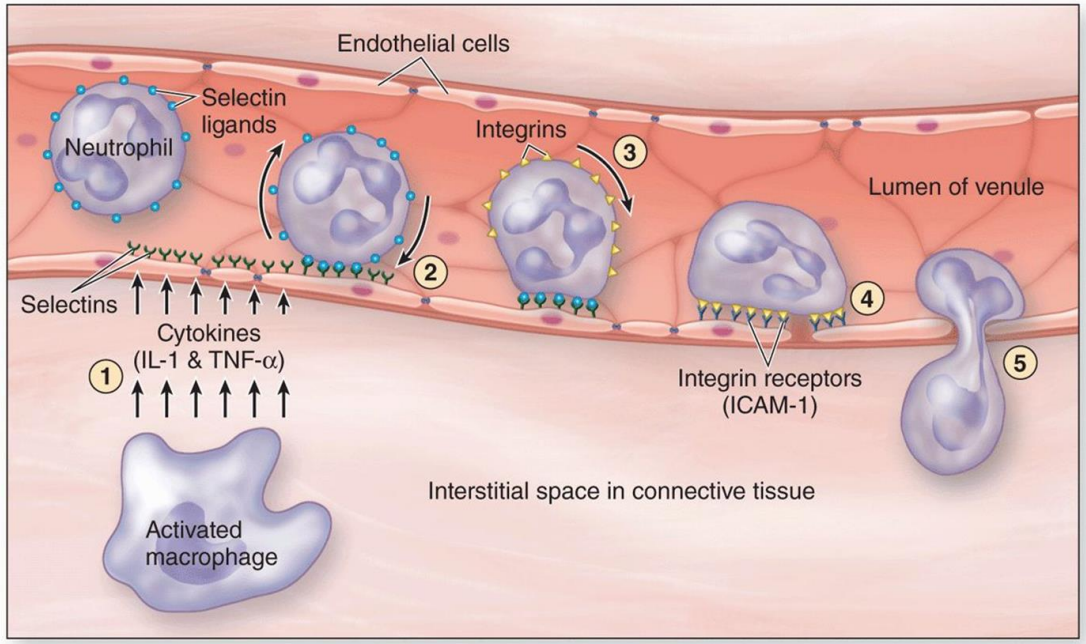
Diapedesis

Leukocytes

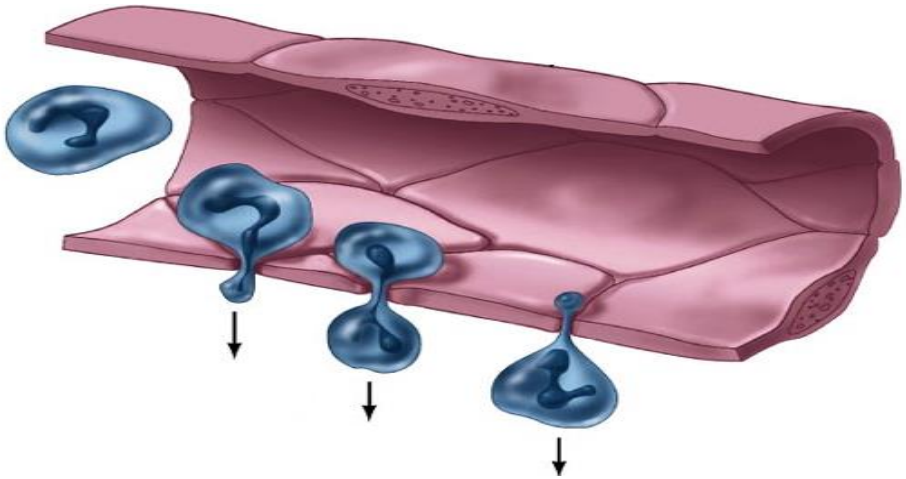
Diapedesis

A process that accounts for the unidirectional flow of granulocytes & monocytes





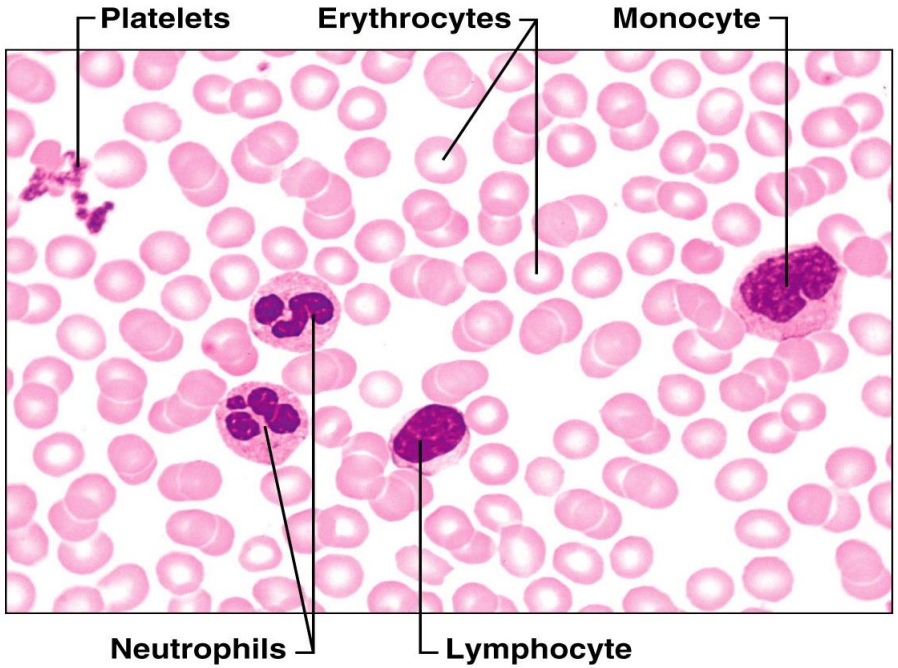
Granulocytes



- Nondividing terminal cells
- Less cellular organells – : less Ⓟ synthesis
- Less mt – low energy metabolism : glycolysis
- Contain glycogen : function in regions lack o_2
- Short life span & apoptosis

Blood Film

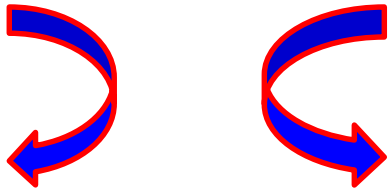
- Blood film – cell become flattened: appears large
- All granulocytes + monocytes = 12-15 / 20 μm in diameter
- Lymphocytes = 6-8 μm (small) / 12-18 μm (large)
- RBC ???



(Wright's Stain)

Differential count (DC) (%)

6,000 - 10,000 cells/μl of blood



Granulocytes

Neutrophils- 40-70%

Eosinophils- 1-6%

Basophils- <1%

Agranulocytes

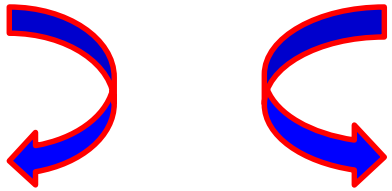
Monocytes- 4-8%

Lymphocytes- 20-45%

Reference : Oxford handbook of clinical medicine

Differential count (DC) (%)

6,000 - 10,000 cells/μl of blood



Granulocytes

Neutrophils- 57-67%

Eosinophils- 1-3%

Basophils - 0.75%

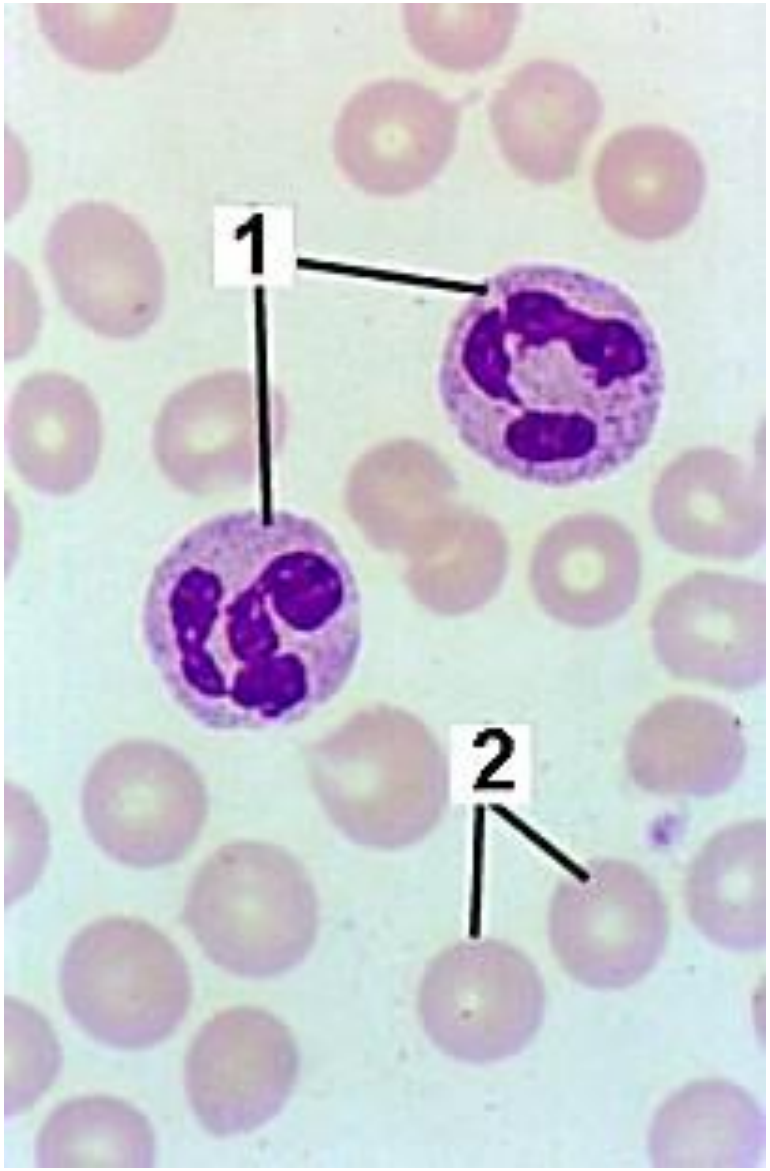
Agranulocytes

Monocytes- 3-7%

Lymphocytes- 25-33%

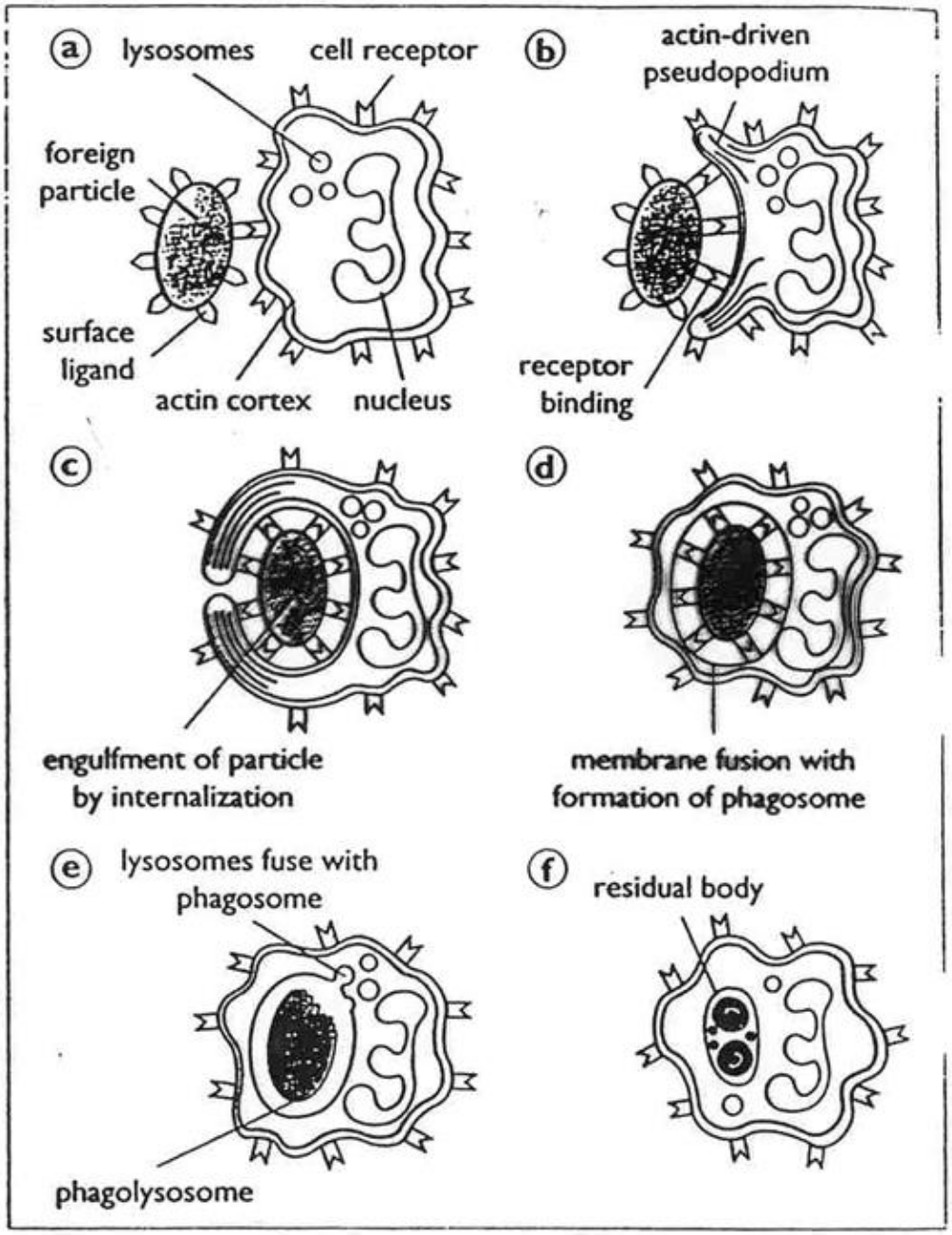
Reference : Junqueiras Basic Histology

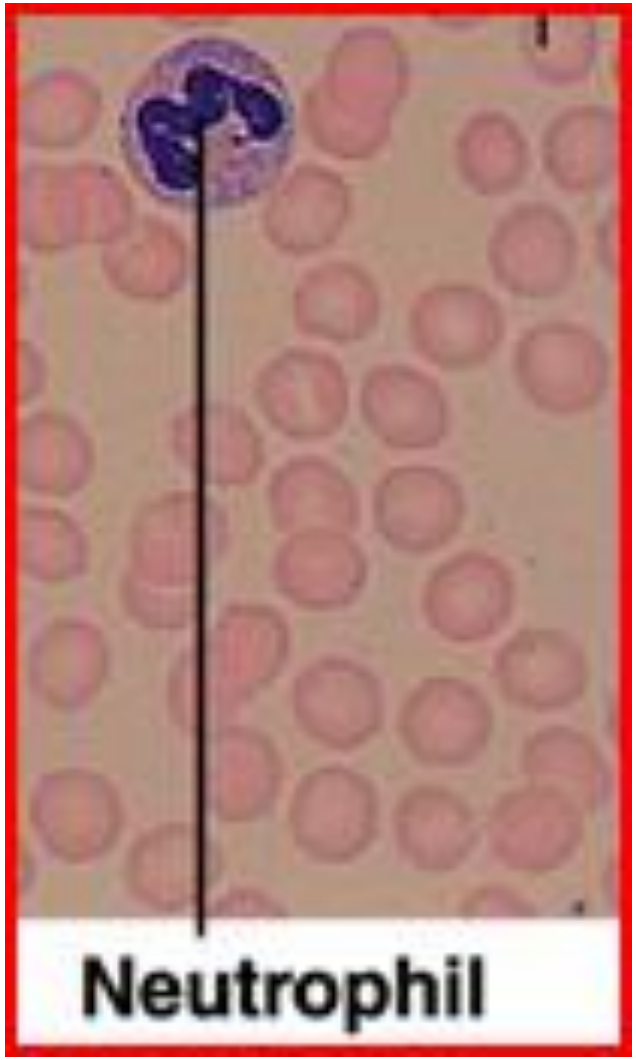
Neutrophils



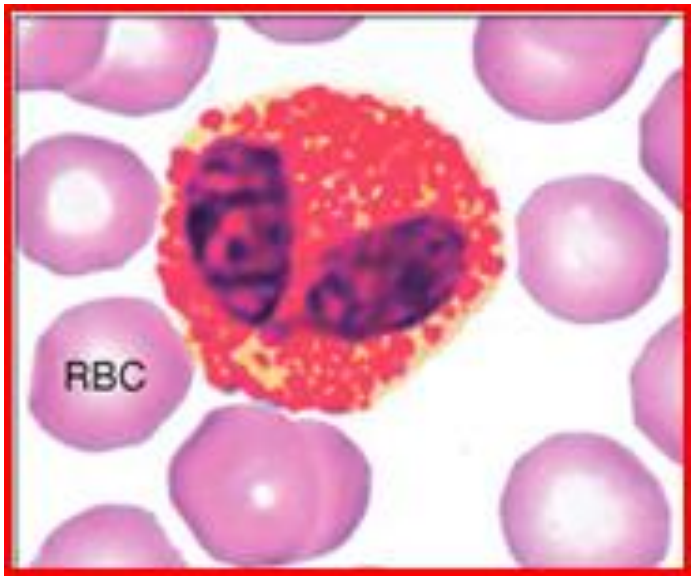
- *54-62% contribution & diameter = 12-15 μm*
- *2-5 lobes of nucleus (usually 3)*
- *♀ = drumstick appendage on one lobe (inactive x-chromosome)*
- *cytoplasm - 2 types of granules*
  - *Azurophilic primary (MPO, …)*
  - *Specific secondary (collagenase,..)*
- *Granules - small & numerous : purple*
- *Phagocytosis of bacteria*
- *Half-life : 6-8 hours- blood*
  1-4 days – connective tissue

Phagocytosis Features





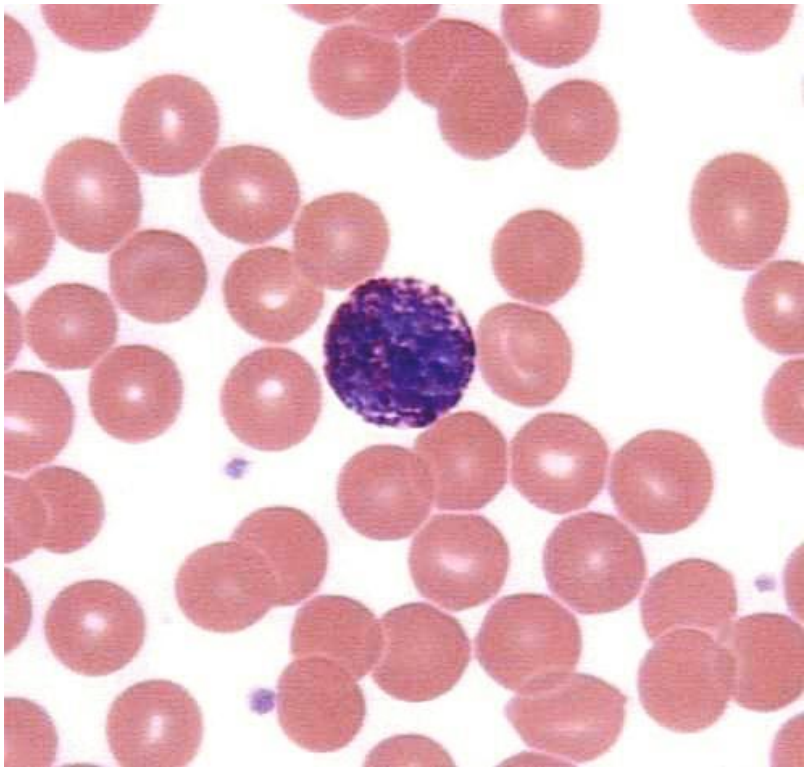
Eosinophils



- *1-3 % contribution & diameter = 12-15 μm*
- *Bilobed nucleus*
- *large elongated eosinophilic granules*
- *Coarse granules*
- *An increase number indicates parasitic worms/helmintthic infection and involvement in allergic reactions*
- *Phagocytose antigen-antibody complexes*

Basophils

- *>1% contribution & diameter = 12-15 μm*
- *irregular lobed- nucleus*
- *specific basic granules obscure the nucleus*
- *specific granules stain metachromatically (change the colour of stain)*
- *specific Granules have heparin & histamine*
- *may supplement the function of mast cells in hypersensitivity reactions.*



Strong allergen/Bee sting

Rapid degranulation /histamine release

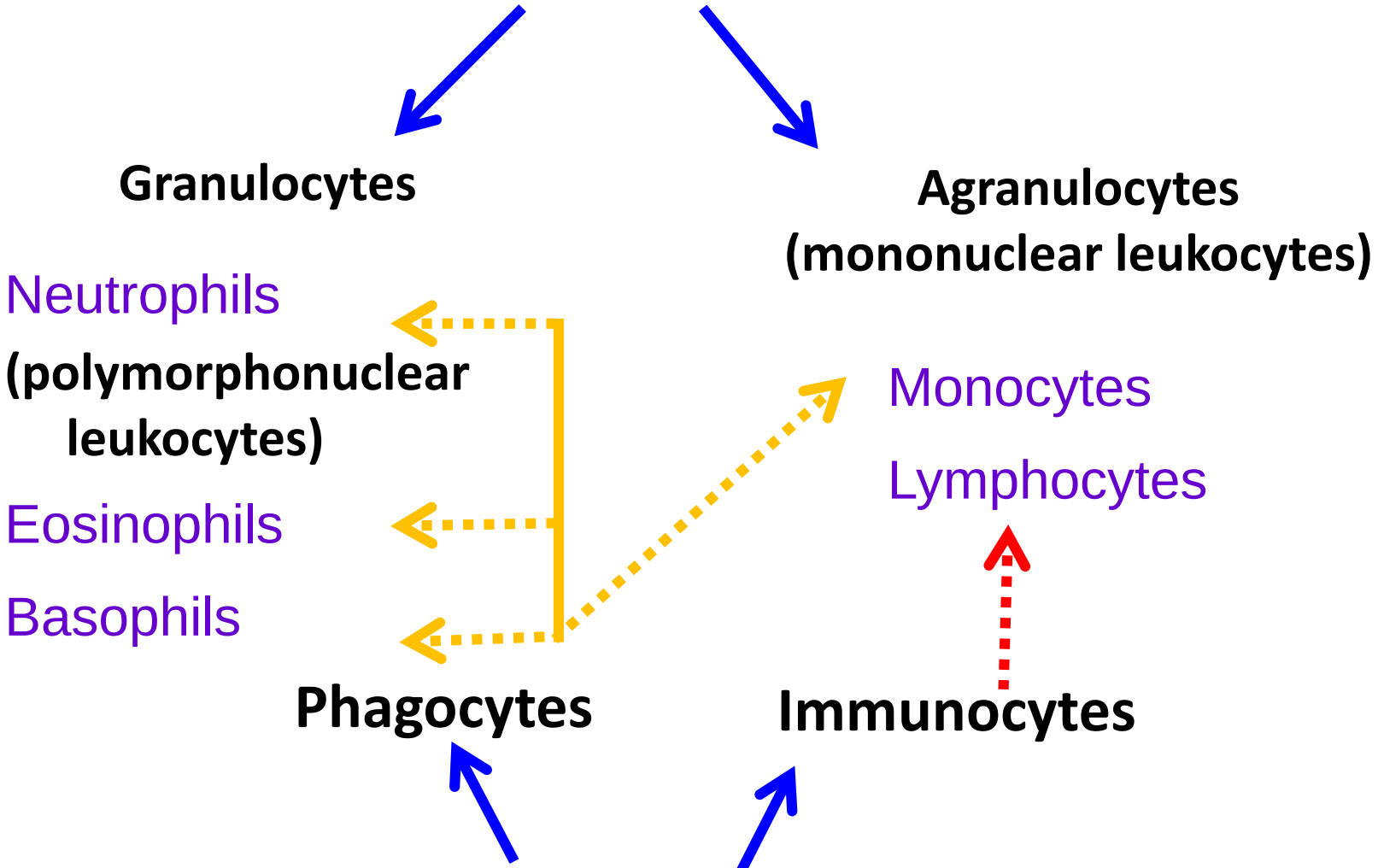
Vasodilatation in many organs

Sudden drop in blood pressure

Anaphylactic shock

Types of WBC

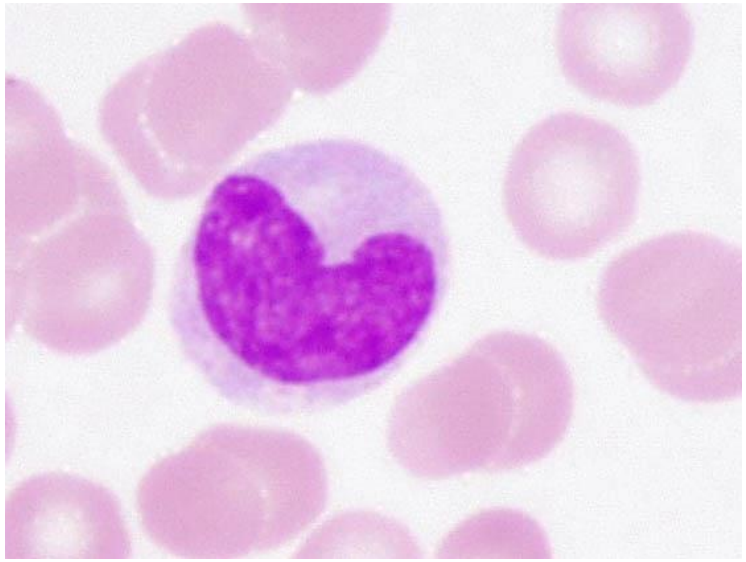
Classified into 2 groups according to the **type of granules** and **shape of the nuclei**



Classified into 2 groups according to the perform of **function**

Monocytes

- *3-7% contribution & largest diameter = 12- 20μm*
- *Dark kidney/ bean shaped nuclei*
- *less condensed chromatin than lymphocytes*
- *basophilic cytoplasm with fine azurophilic granules*
- *bluish gray colour cytoplasm*
- *not terminal cells : precursor of macrophages*
- *Highly phagocytic action*



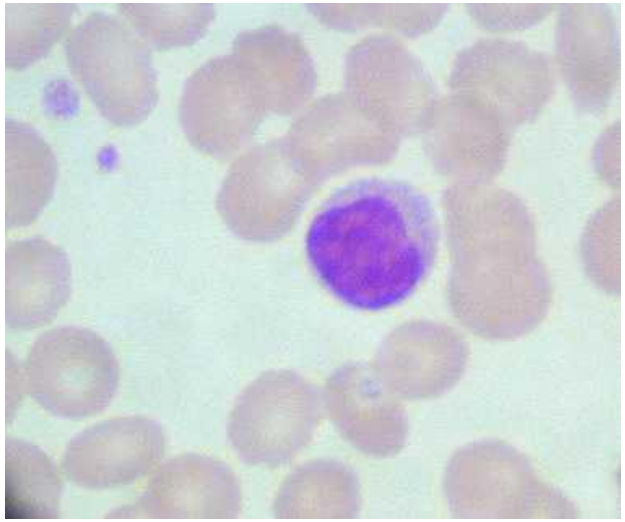
Mononucleosis

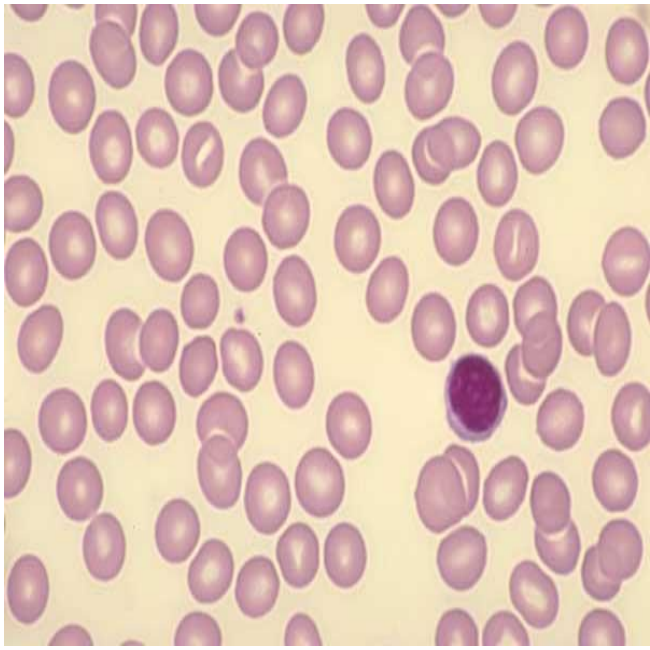
Highly contagious viral disease caused by Epstein-Barr virus; excessive number of agranulocytes;

fatigue
sore throat

Lymphocytes

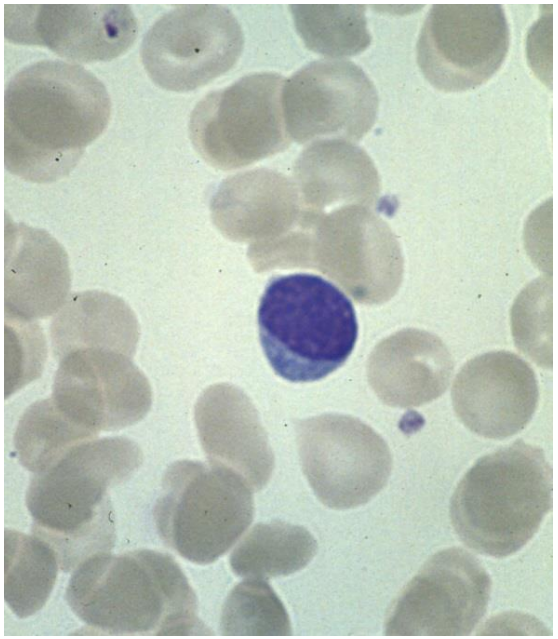
- *20-45% contribution & smallest diameter = 6-8/ 18 μm*
- *spherical nucleus, sometimes with an indentation*
- *condensed chromatin with blue scanty cytoplasm*
- *few azurophilic granules*
- *life span- few days to several years*
- *only cell type that return to blood after diapedesis*



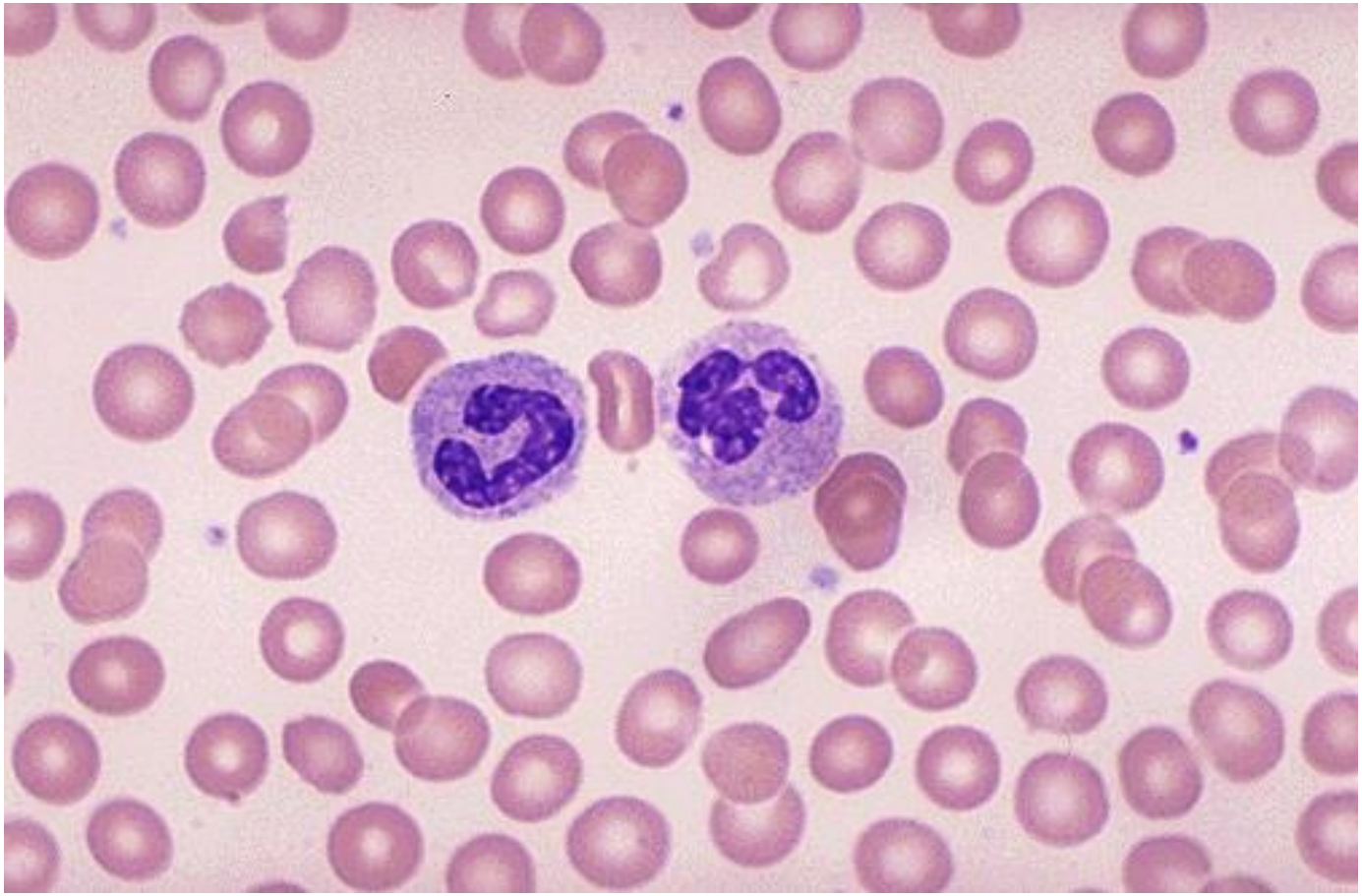


Lymphocytes

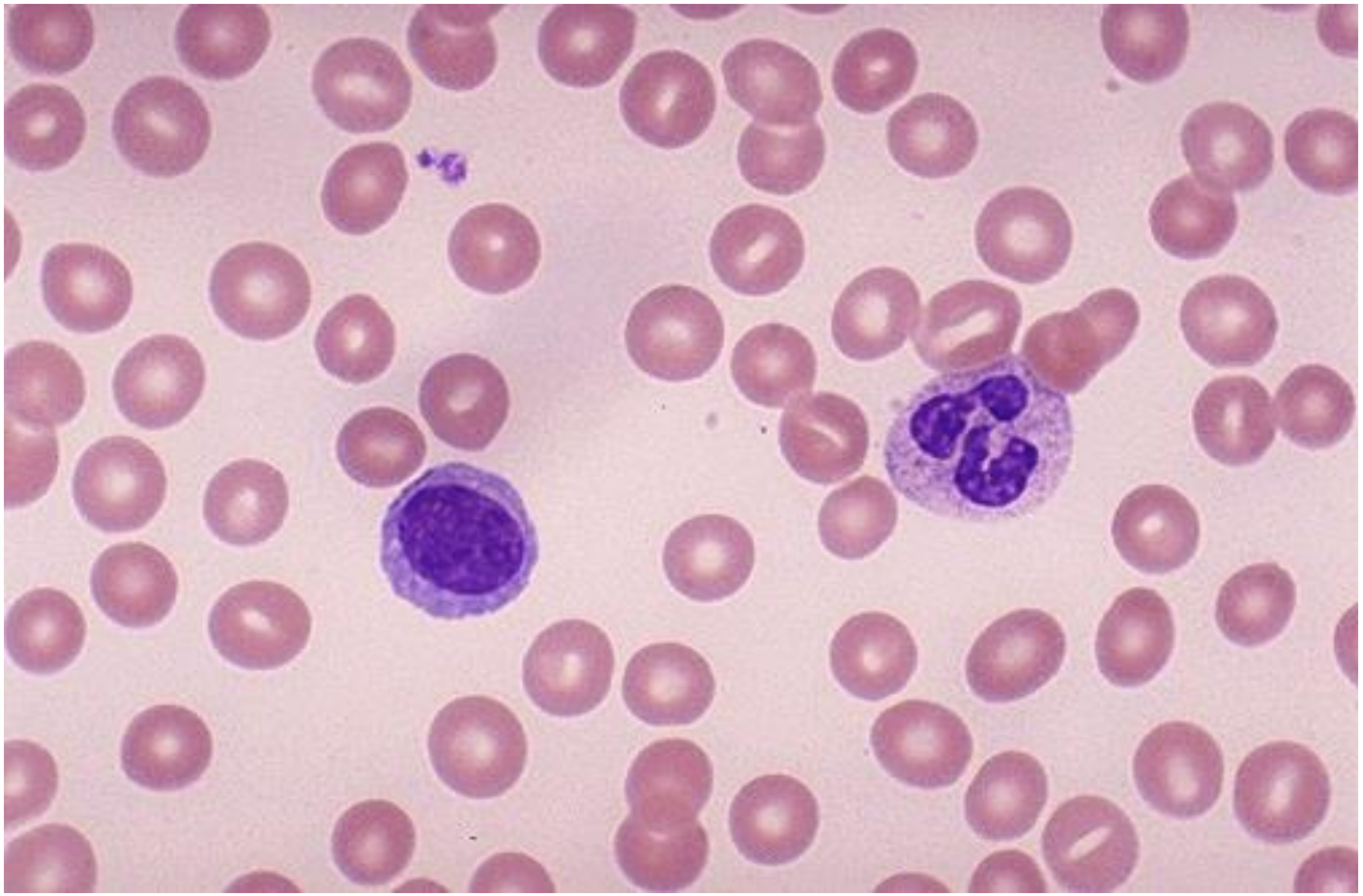
- *Two types*
  - *T lymphocytes—attack an infect or cancerous cell*
  - *B lymphocytes—produce antibodies against specific antigens (foreign body)*



IgG-infection
IgM-microbes
IgE- Alergy
IgD-immune response
IgA-Resp & GI

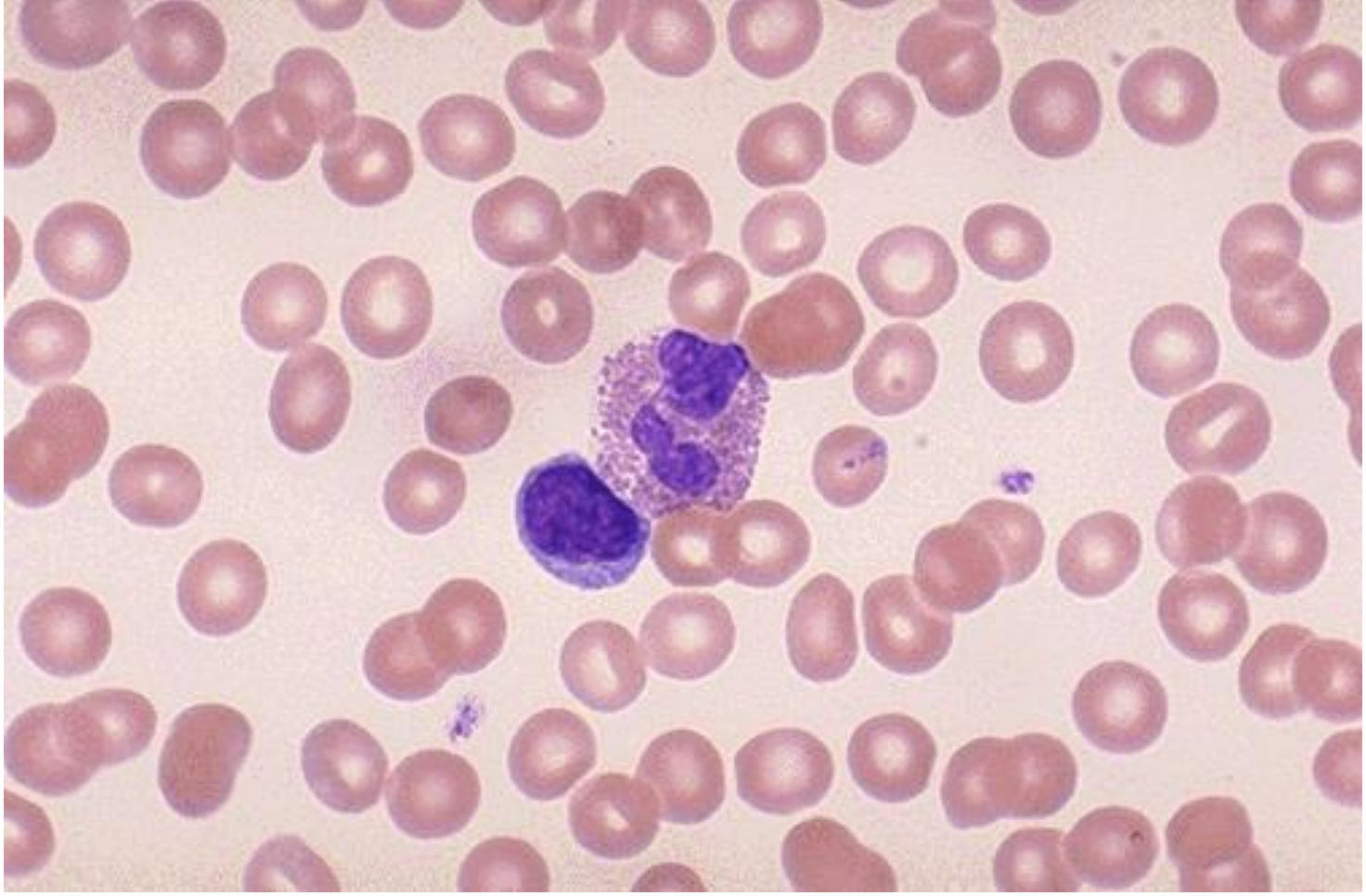


This normal peripheral smear demonstrates a segmented neutrophil and a band neutrophil.

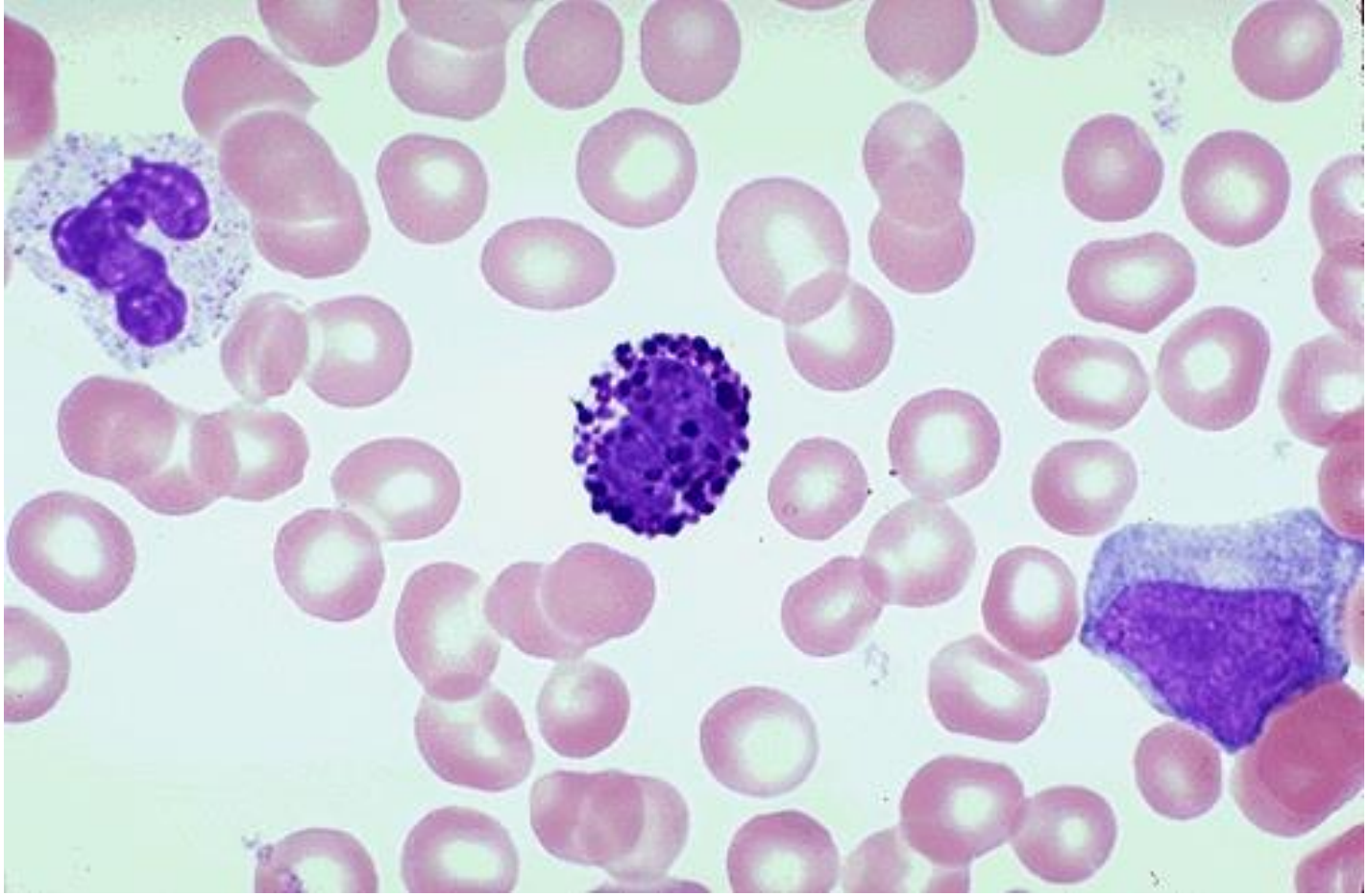


This normal peripheral smear demonstrates a segmented neutrophil and a lymphocyte.

This normal peripheral smear demonstrates a monocyte.



This normal peripheral smear demonstrates an eosinophil and a lymphocyte.



This normal peripheral smear demonstrates a basophil, a segmented neutrophil, and a lymphocyte.

Medical implication

- ***Leukocytosis - Elevated WBC count***

  Bacterial infection such as appendicitis, tonsillitis, ulcers & urinary tract infection
  Leukemia / hemolytic disease of new born/bone tumors
  Following strenuous exercise / emotional stress

- ***Leukopenia -Abnormally low WBC count***

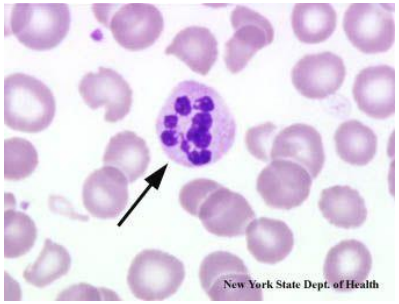
  *Drug (*radio therapy and chemotherapy)
  Rheumatoid arthritis / SLE (autoimmune disease)
  Viral disease such as measles & infectious hepatitis

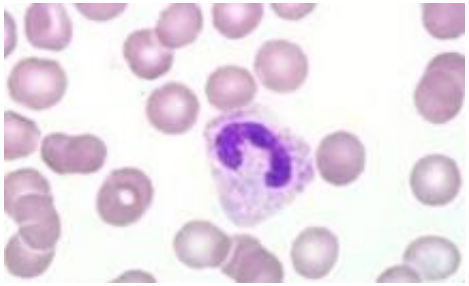
- ***Nonsegmented nucleus – band forms***

  Indicates higher production of neutrophils in response to bacterial infection

- ***Hypersegmented nucleus***

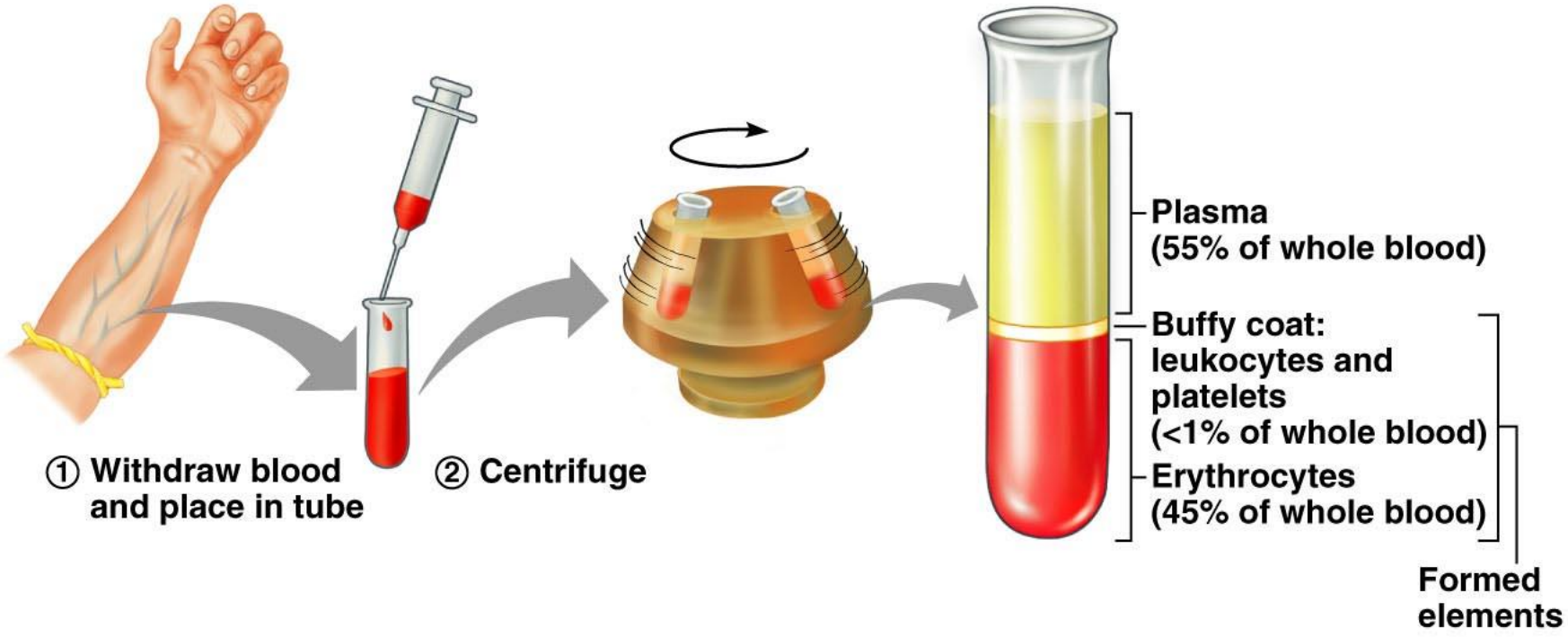
  More than 5 segments
  typically old cells

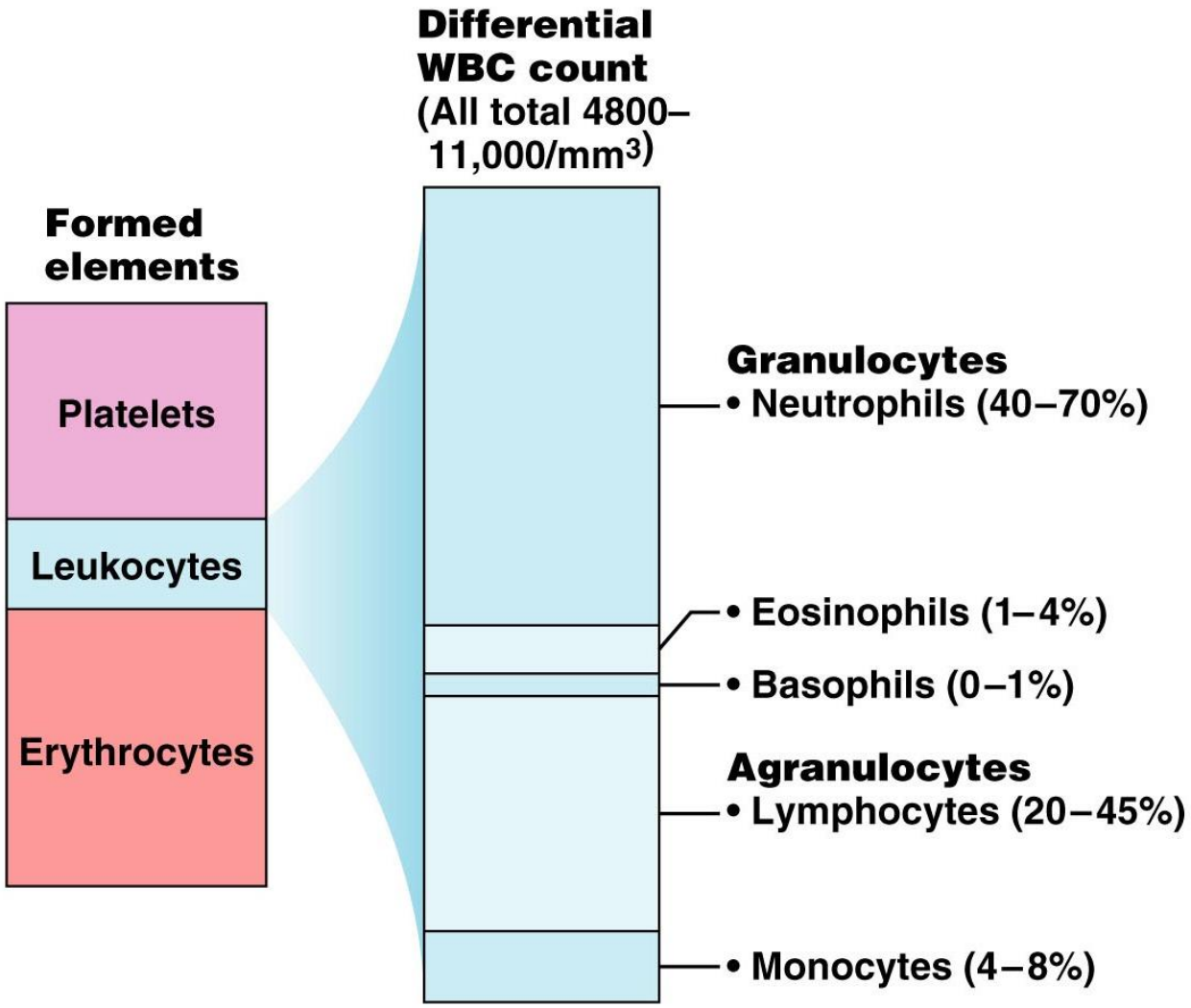




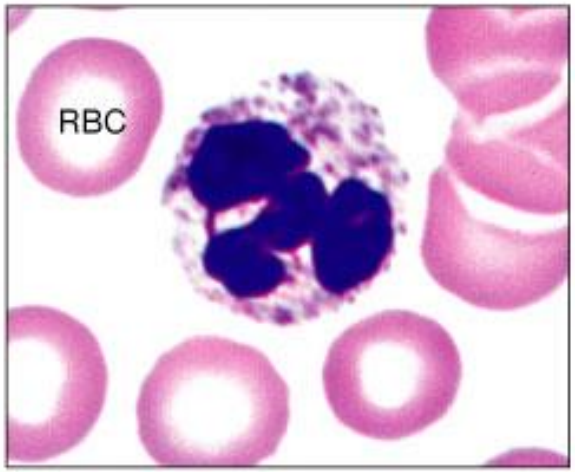
Differences between RBCs & WBCs

Summary

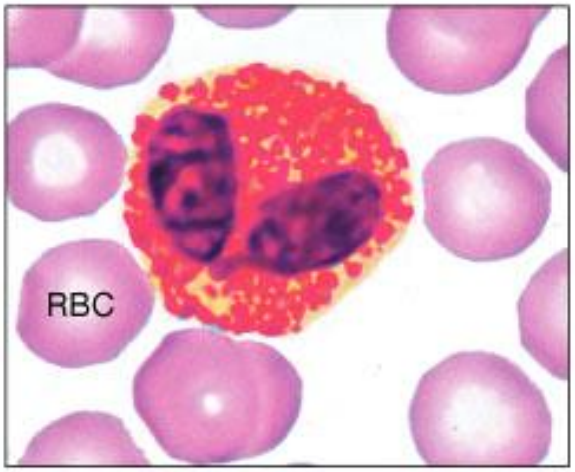

① Withdraw blood and place in tube
② Centrifuge
Plasma (55% of whole blood)
Buffy coat: leukocytes and platelets (<1% of whole blood)
Erythrocytes (45% of whole blood)
Formed elements


Differential
WBC count
(All total 4800–
11,000/mm3)
Formed
elements
Platelets
Leukocytes
Erythrocytes
Granulocytes
• Neutrophils (40–70%)
• Eosinophils (1–4%)
• Basophils (0–1%)
Agranulocytes
• Lymphocytes (20–45%)
• Monocytes (4–8%)

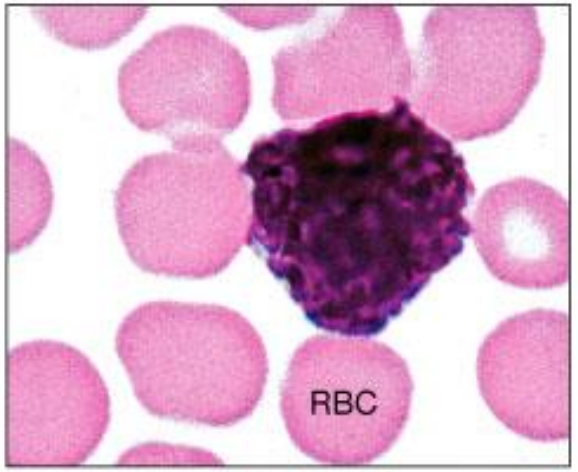
White Blood Cells



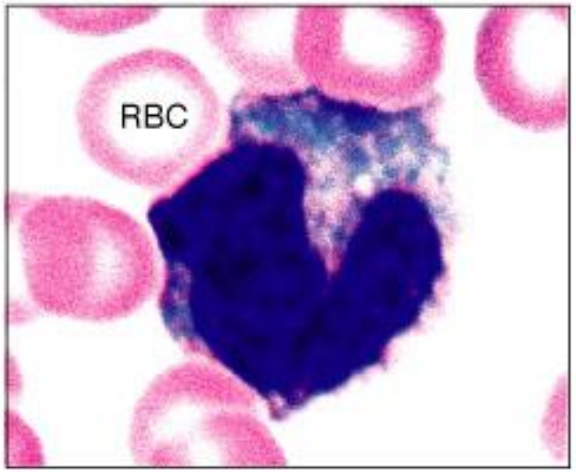
(a) Neutrophil



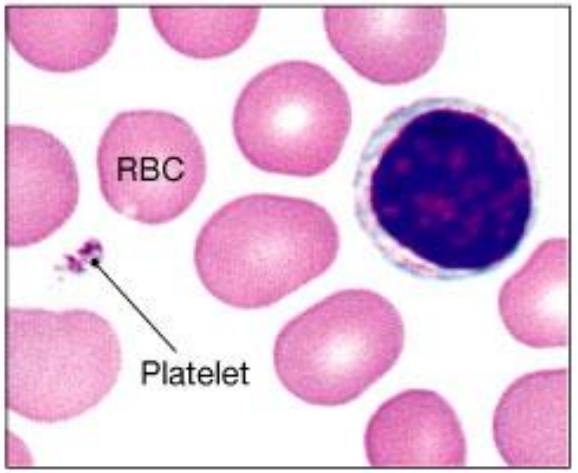
(b) Eosinophil



(c) Basophil

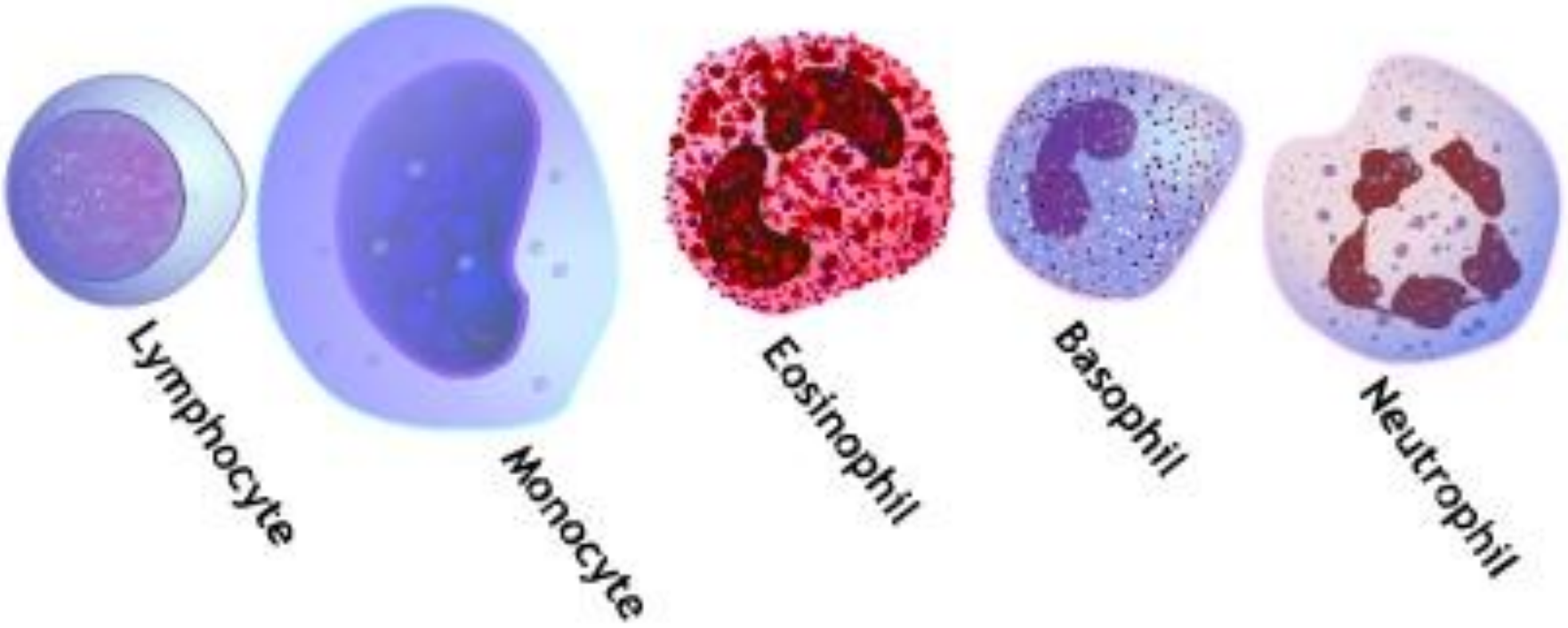


(d) Monocyte



(e) Lymphocyte

Figure 19.11


Lymphocyte
Monocyte
Eosinophil
Basophil
Neutrophil

TABLE

17.1 Summary of Formed Elements of the Blood

Cell Type	Illustration	Description*	Number of Cell per mm^3 (μl) of Blood	Duration of Development (D) and Life Span (LS)	Function
Erythrocytes (red blood cells; RBCs)		Biconcave, anucleate disc; salmon-colored; diameter 7–8 μm	4–6 million	D: 5–9 days LS: 100–120 days	Transport oxygen and carbon dioxide
Leukocytes (white blood cells, WBCs)		Spherical, nucleated cells	4800–11,000		
Granulocytes					
• Neutrophils		Nucleus multilobed; inconspicuous cytoplasmic granules; diameter 12–14 μm	3000–7000	D: 7–11 days LS: 6 hours to a few days	Destroy bacteria by phagocytosis
• Eosinophils		Nucleus bilobed; red cytoplasmic granules; diameter 12–15 μm	100–400	D: 7–11 days LS: about 5 days	Turn off allergic responses and kill parasites
• Basophils		Nucleus bilobed; large blue-purple cytoplasmic granules; diameter 10–14 μm	20–50	D: 3–7 days LS: a few hours to a few days	Release histamine and other mediators of inflammation
Agranulocytes					
• Lymphocytes		Nucleus spherical or indented; pale blue cytoplasm; diameter 5–17 μm	1500–3000	D: days to weeks LS: hours to years	Mount immune response by direct cell attack (T cells) or via antibodies (B cells)
• Monocytes		Nucleus U- or kidney-shaped; gray-blue cytoplasm; diameter 14–24 μm	100–700	D: 2–3 days LS: months	Phagocytosis; develop into macrophages in tissues
Platelets		Discoid cytoplasmic fragments containing granules; stain deep purple; diameter 2–4 μm	150,000–500,000	D: 4–5 days LS: 5–10 days	Seal small tears in blood vessels; instrumental in blood clotting

*Appearance when stained with Wright's stain.

REFFERENCES

- **Junqueira**, L.C., Carneiro (1998). **Basic histology**. 9 th ed., stamford: Appleton & lange

- Burkit, H.G, young, B. (1993). **Wheaters functional histology**. 4 th ed., london:Churchill livingstone