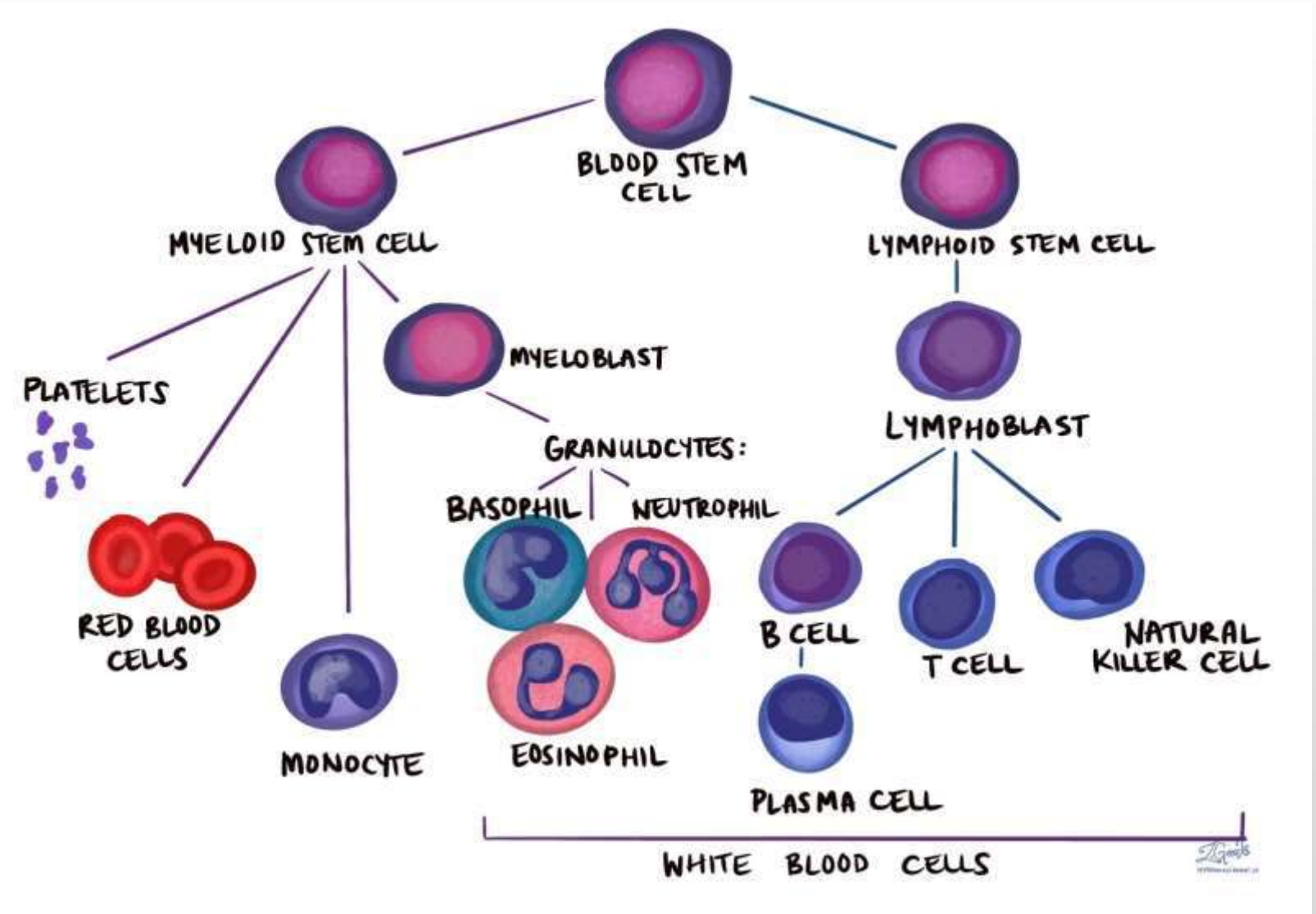
Leukopoiesis

Hematopoiesis

- The process of formation of blood cells.
  - Red blood cells (RBC)
  - White blood cells
  - platelets.
- It's a continuous process that begins before birth and continues throughout life.
- Hematopoietic stem cells produce all blood cells.
- In children, hematopoiesis happens in long bones like the thighbone.
- In adults, hematopoiesis happens in the spine, hips, ribs, skull, and breastbone.
- The body produces billions of new blood cells each day to maintain a steady supply

Hematopoiesis



Leukopoiesis

- White blood cells (EBC) production

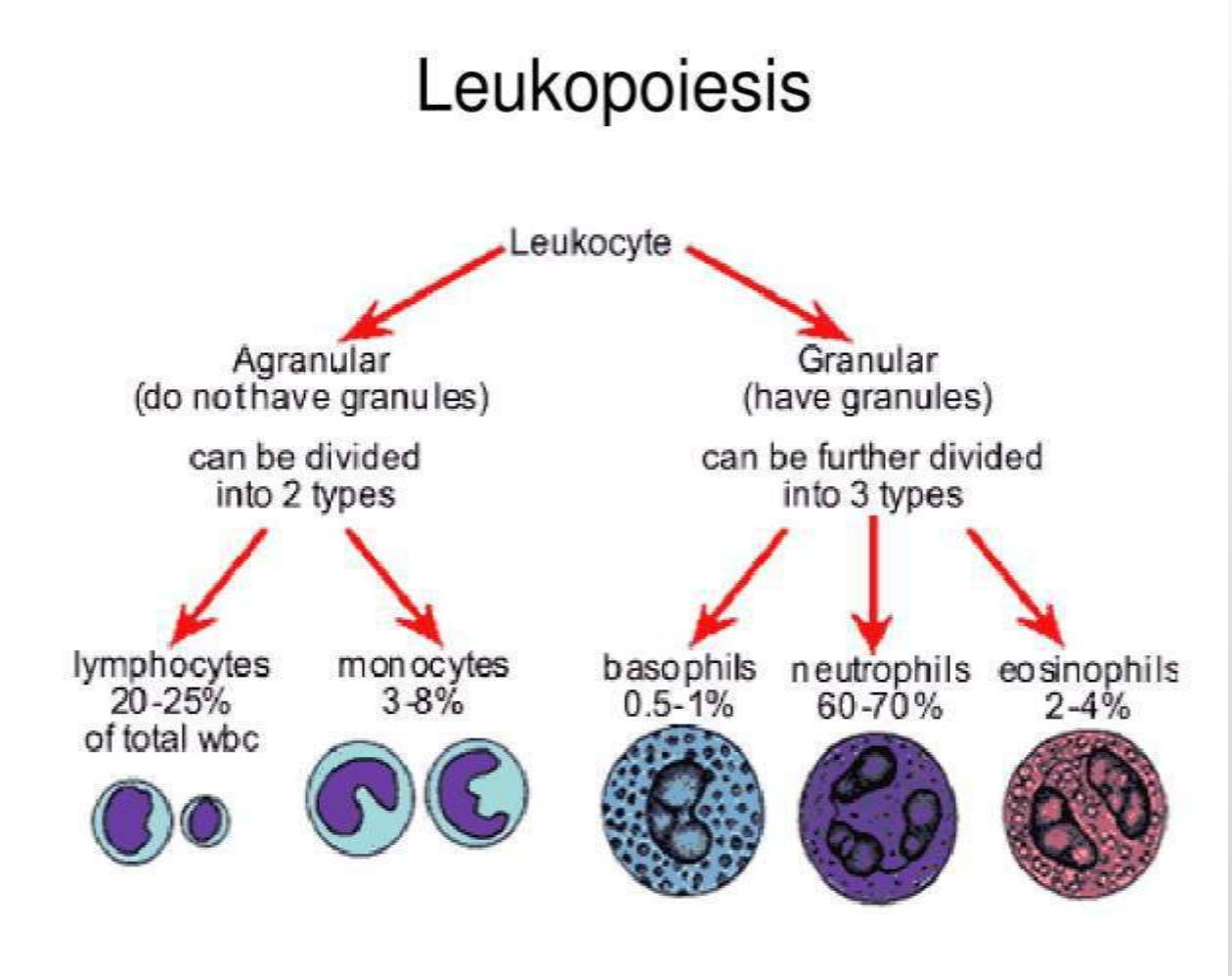
All blood cells originate from hemocytoblasts, which produce:

1. Myeloid Stem Cells

- Differentiate into progenitor cells, which produce all WBCs except lymphocytes

2. Lymphoid Stem Cells Lymphopoiesis:

- The production of lymphocytes
- All WBCs, except monocytes, develop fully in bone marrow
- Monocytes develop into macrophages in peripheral tissues



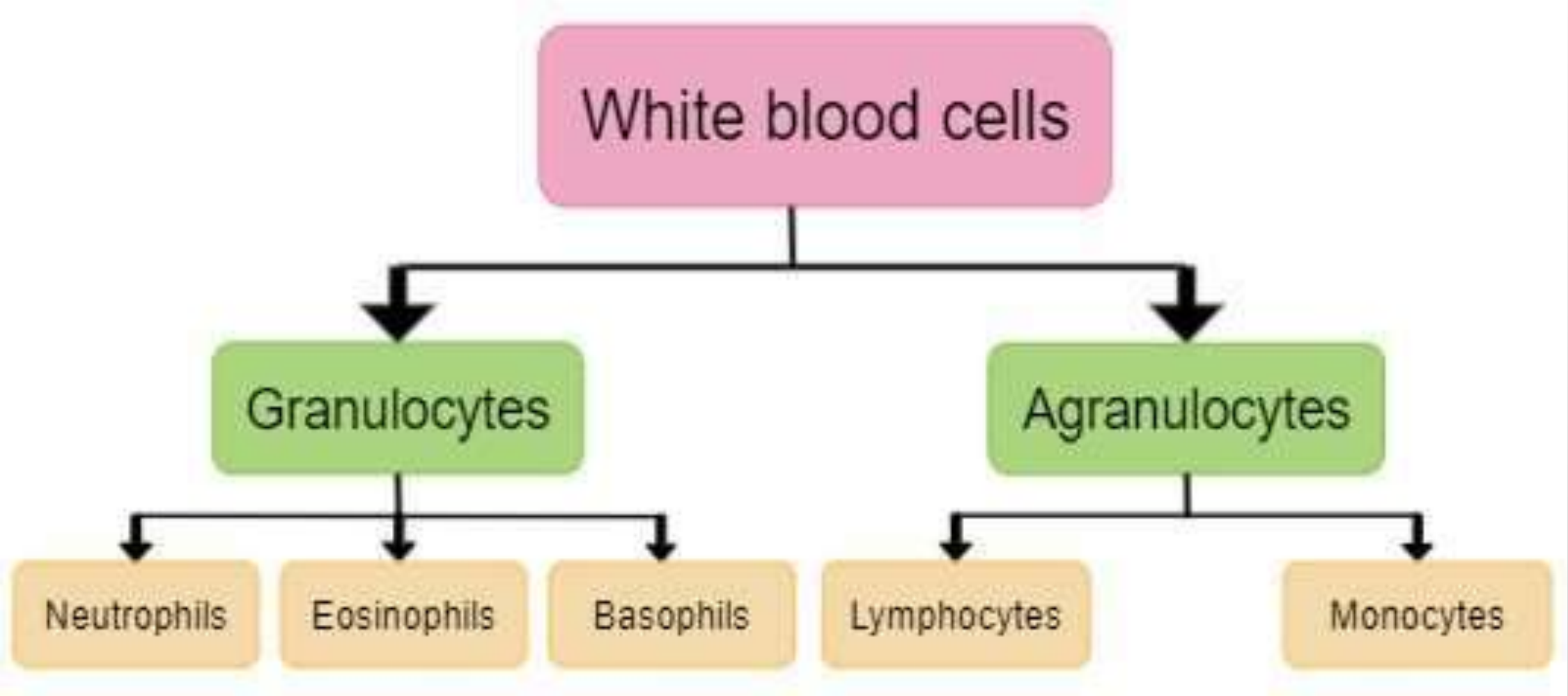
Leukopoiesis

- Myeloid stem cells →

Basophils, Eosinophils, Neutrophils, Monocytes as directed by specific colony stimulating factors (CSFs) produced by Macrophages and T cells

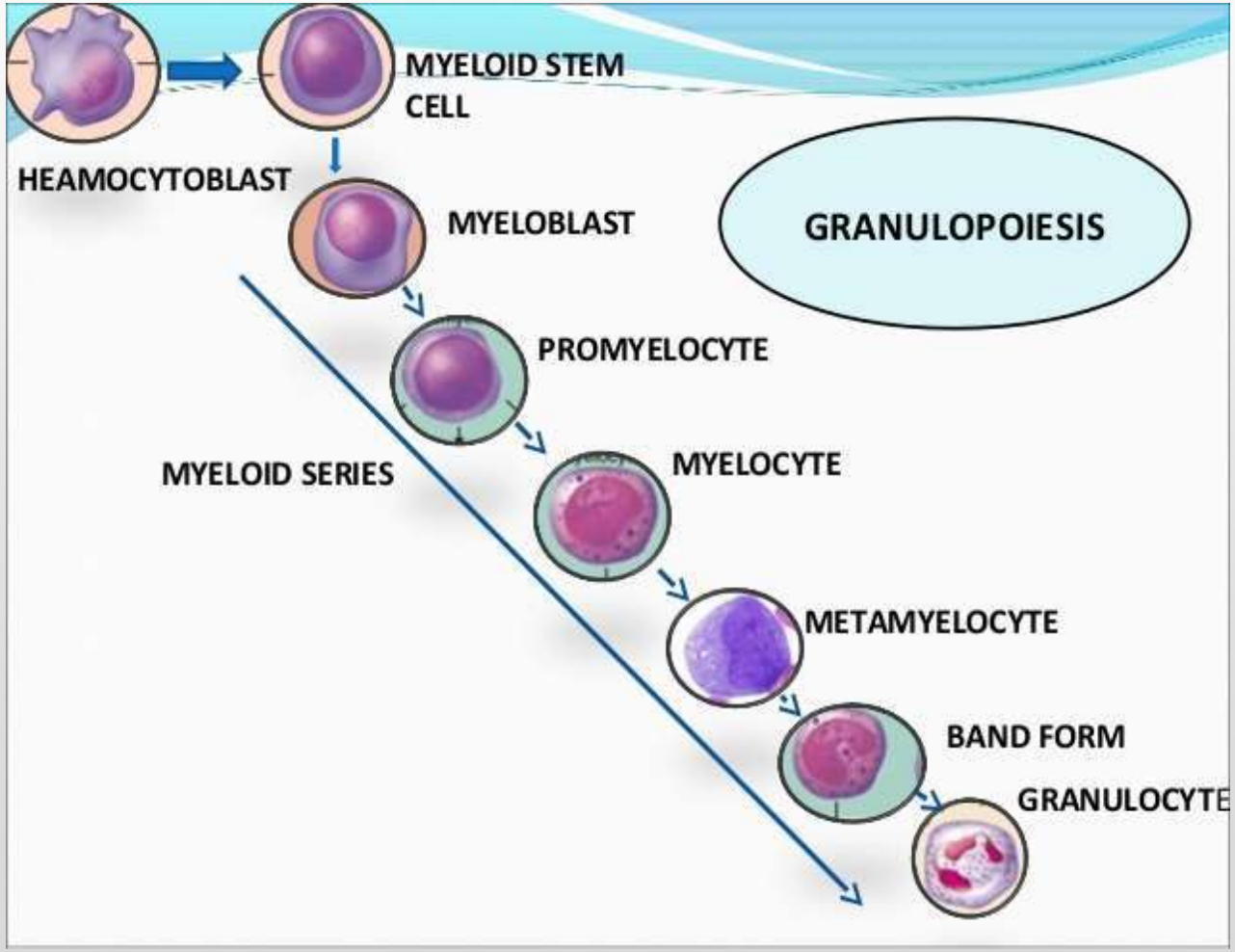
- Different CSFs (hormones) results in different cell types:
  - M-CSF stimulates monocyte production
  - G-CSF stimulates production of granulocytes (neutrophils, eosinophils, and basophils)
  - GM-CSF stimulates granulocyte and monocyte production
  - Multi-CSF accelerates production of granulocytes, monocytes, platelets, and RBCs

Leukopoiesis



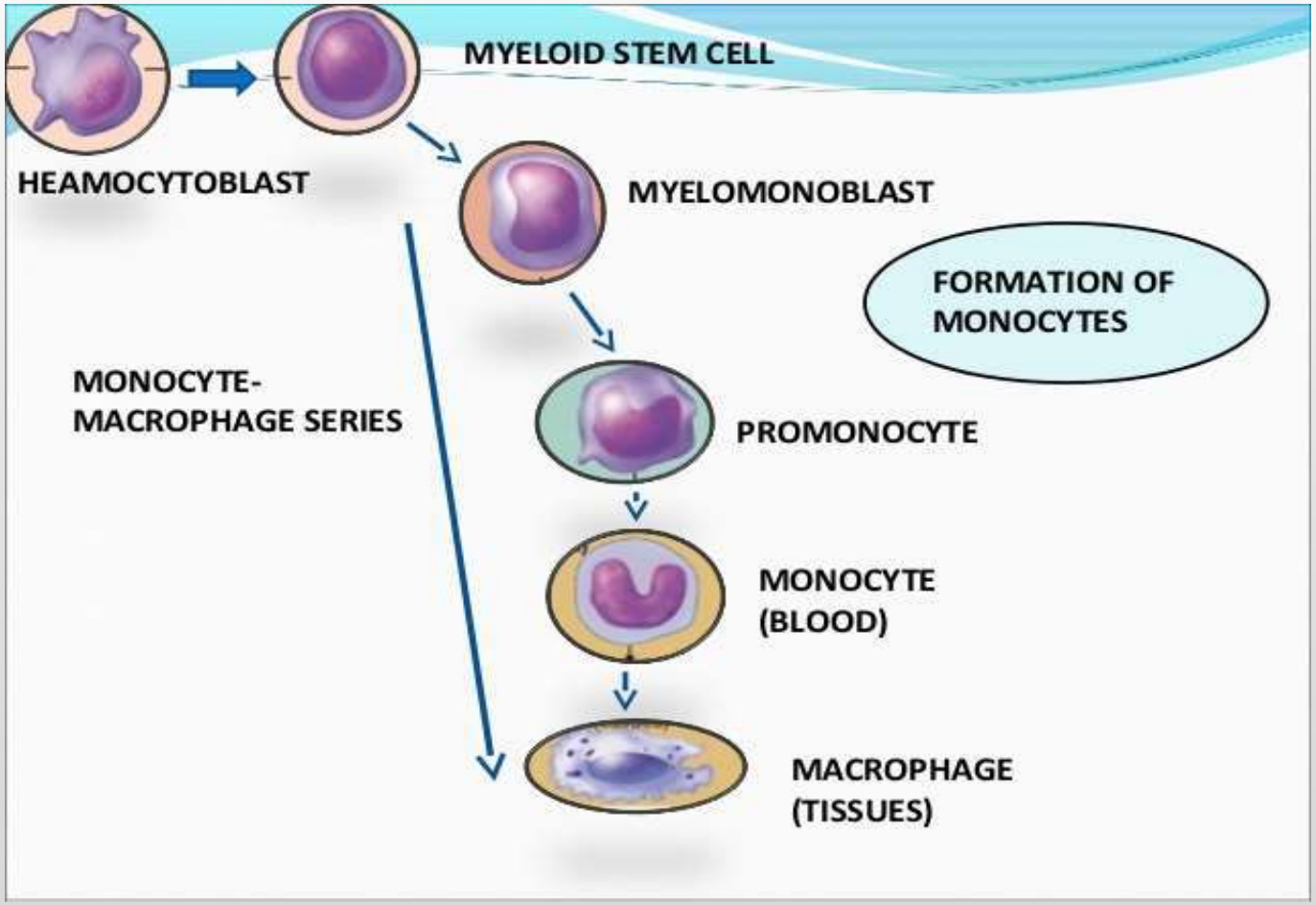
Granulopoiesis

- Development of granulated leukocytes (neutrophils, eosinophils, basophils)



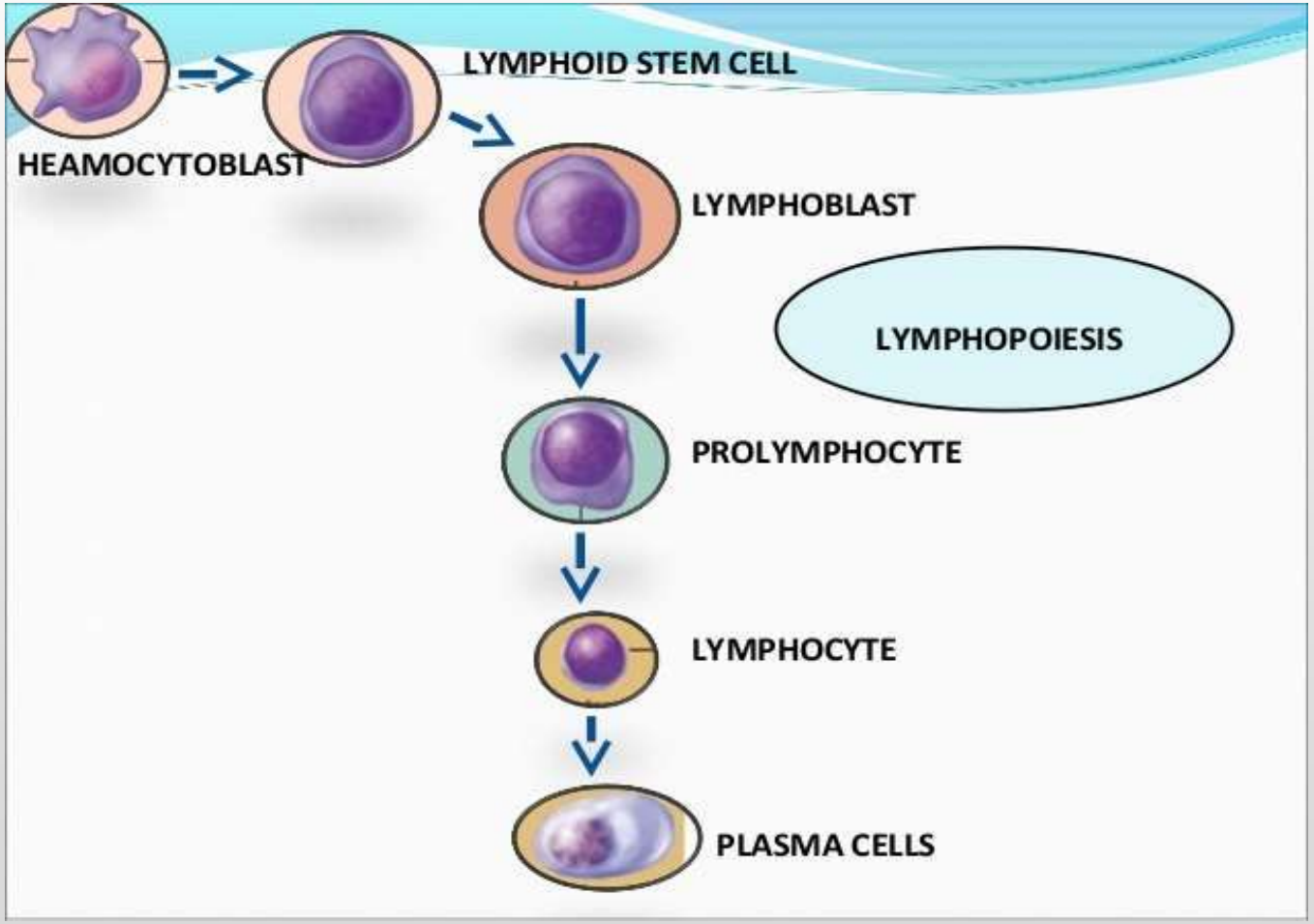
Monopoiesis

- Process of monocyte formation,
- Monocytes are derived from common myeloid progenitors (CMP) through two distinct developmental pathways.
- Play critical roles in inflammation and maintaining homeostasis within the immune system.



Lymphopoiesis

- Production of new lymphocytes, including B lymphocytes, T lymphocytes, and natural killer (NK) cells.
- The primary (or central) lymphoid organs are thymus that is involved in T-cell lymphopoiesis, and the bone marrow that hosts both B-cell and T-cell precursors.



Normal range of WBC

- At birth,in full term infant: 10,000-25,000/µl of blood
- Infants upto 1 yr of age:6000-16,000/µl of blood
- Adults:4000-11,000/µl of blood

Variations in WBC count

TLC > 11,000/µL(**Leucocytosis**)

Physiological

1. Age
2. Exercise
3. Mental stress
4. Pregnancy
5. After food intake
6. Exp.to low temp.

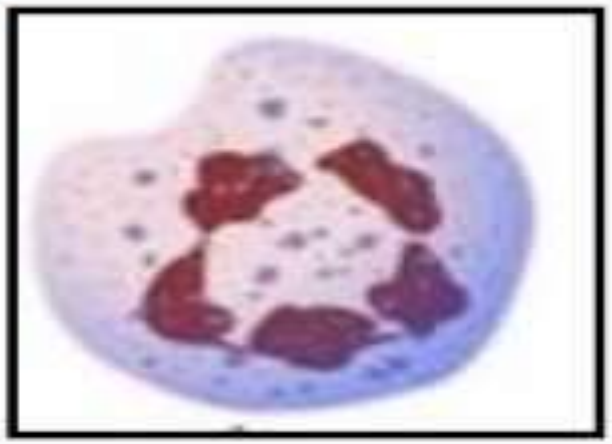
Pathological

1. Acute bacterial infections (pyogenic org.)
2. Burns
3. Post-operative period
4. Tuberculosis
5. Glandular fever

Classification

- Granulocytes
  - Neutrophils
  - Eosinophils
  - Basophils
- Agranulocytes
  - Lymphocytes
  - Monocytes

Neutrophils

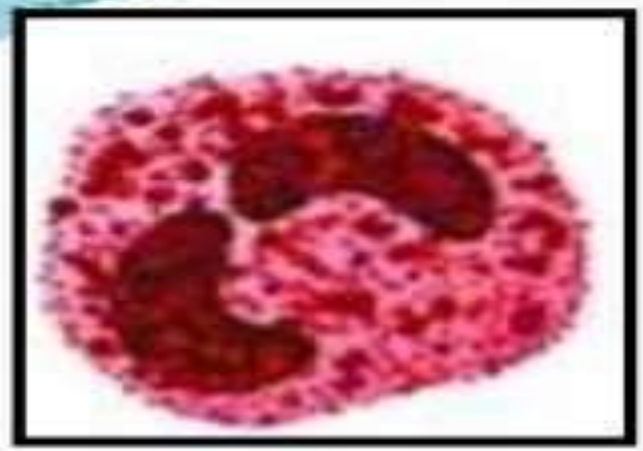


1. **Cell size-** 10-14µm
2. **Nucleus-** central or eccentric; 2-6 lobes;deep purplish blue
3. **Cytoplasm-** faint pink
4. **Granules-** fine(pin-point); violet-pink in color

Normal values

- Differential:40 -75%
- Absolute:2000 -7500/µl of blood

Eosinophils

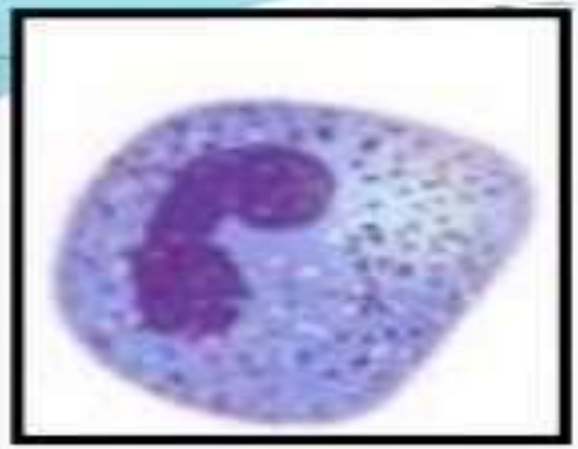


1. **Cell size-** 10-14µm
2. **Nucleus-** central or eccentric; 2-3 lobes; purplish blue; "spectacle shaped"
3. **Cytoplasm-** acidophilic;bright pink in color
4. **Granules-** large; coarse; crimson red

Normal values

- Differential: 1-6%
- Absolute:40-440/µl of blood

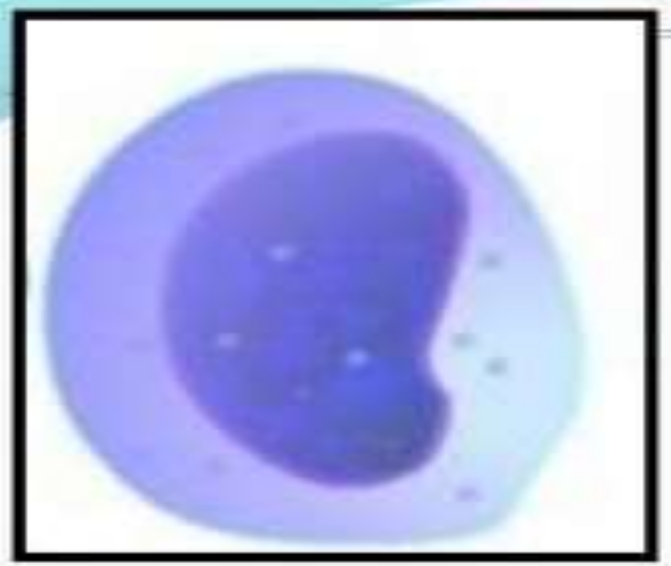
Basophils



1. **Cell size-** 10-14µm
2. **Nucleus-** central; 2-3 lobes; purplish blue; overlaid with granules
3. **Cytoplasm-** basophilic; full of granules
4. **Granules-** very coarse,deep purple or blue

Normal values

- Differential: 0-1%
- Absolute: 0-100/µl of blood



Monocyte

1. **Cell size-** 12-20µm
2. **Nucleus-** eccentric or central; round or oval; pale bluish violet
3. **Cytoplasm-** abundant; pale blue; clear

Normal values

- Differential: 2-10%
- Absolute:500 -800/µl of blood

Lymphocyte

1. **Cell size-** LL:12-16µm; SL:7-10µm
2. **Nucleus-** eccentric; large round nucleus; deep purplish blue
3. **Cytoplasm-** scanty; light blue color

Normal values

- Differential:20-40%
- Absolute: 1500-4000/µl of blood

Life Span Of WBC

- Not constant.

- Neutrophils -> 2-5 days
- Eosinophils -> 7-12 days
- Basophils -> 12-15 days
- Monocytes -> 2-5 days
- Lymphocytes -> ½-1 day

Properties of WBC,s

- **Diapedesis:**

Passage through the intact walls of the capillaries, typically accompanying inflammation.

- **Amoeboid movement:**

Achieved by pseudopodia and involves the flow of cytoplasm as extensions of the organism

- **Chemotaxis:**

Directed migration of cells in response to concentration gradients of extracellular signals.

- **Phagocytosis:**

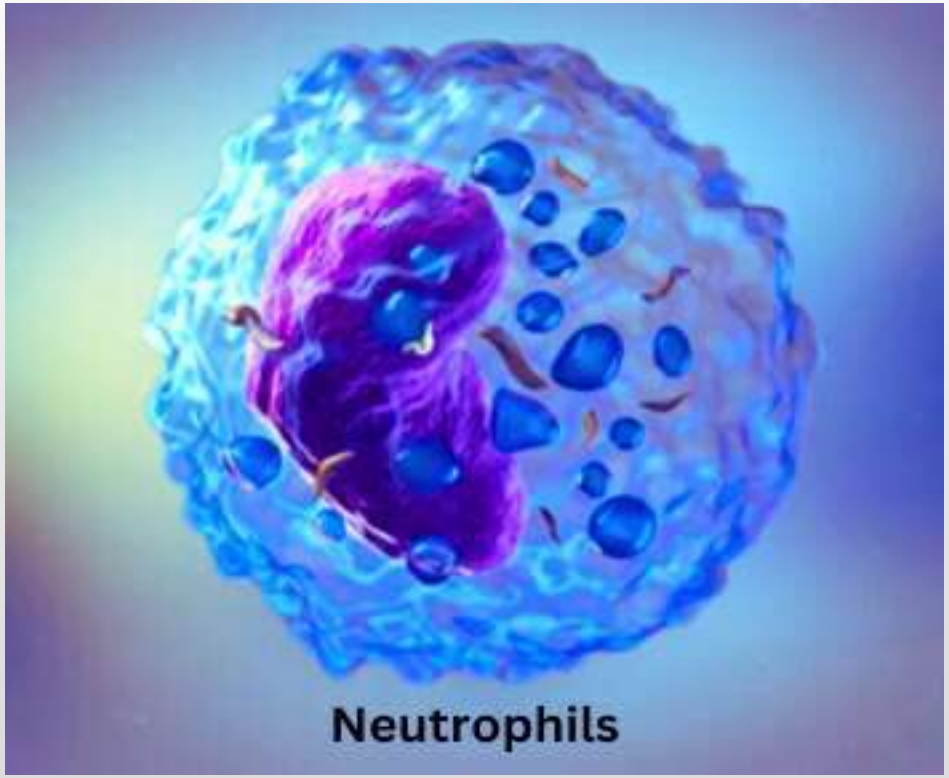
Living cells called phagocytes ingest or engulf other cells or particles.

Neutrophils or Polymorphonuclear [PMN] Leukocytes

- Non-specific, defense
- Phagocytic
- 50-70% of all WBCs
- 2 - 6 lobed nucleus, 12 µm diameter
- Granules (lysosomes) contain digestive enzymes & defensins that kill bacteria, fungi & enveloped viruses
- Very mobile: first at injury
- Life span < 10h

Function :

- Respiratory burst: H202 & 02 -, acts a bactericide
- Degranulation: defensins (peptide) lyse bacteria
- Prostaglandins: induce inflammation to stop spread of injury
- Leukotrienes: attract phagocytes

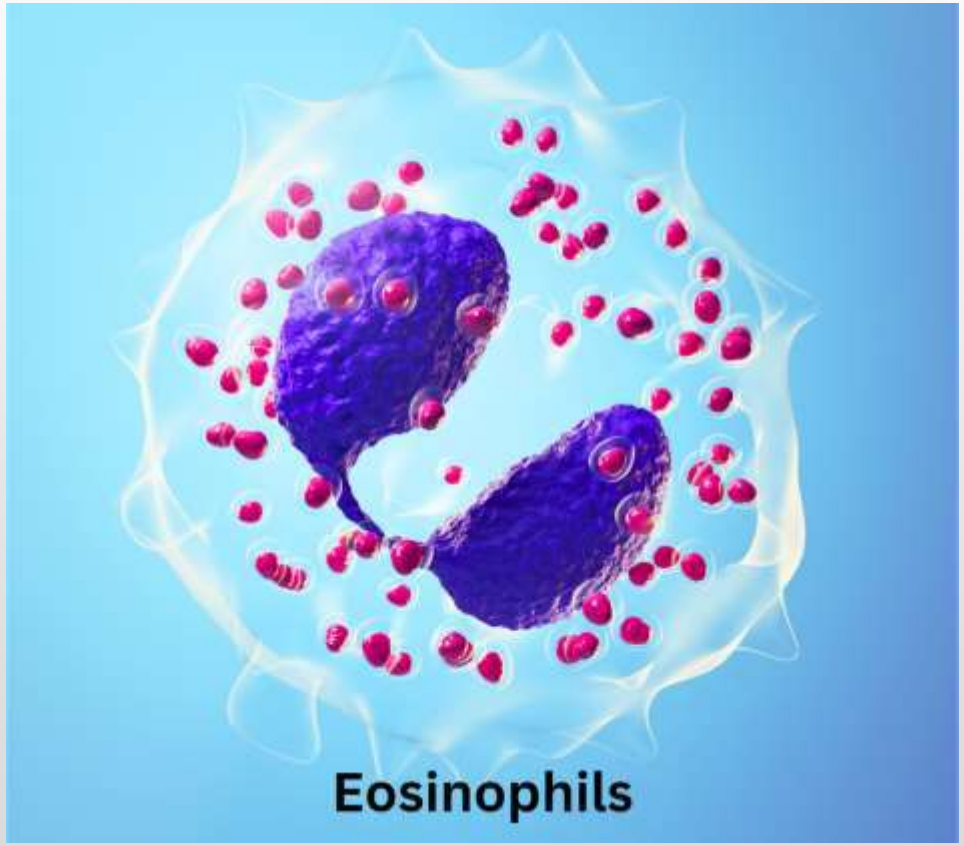


Eosinophils or Acidophils

- Non-specific defense
- Phagocytic
- 2–4% of circulating WBCs
- Bilobed nucleus
- 12 μm diameter; 9-day life

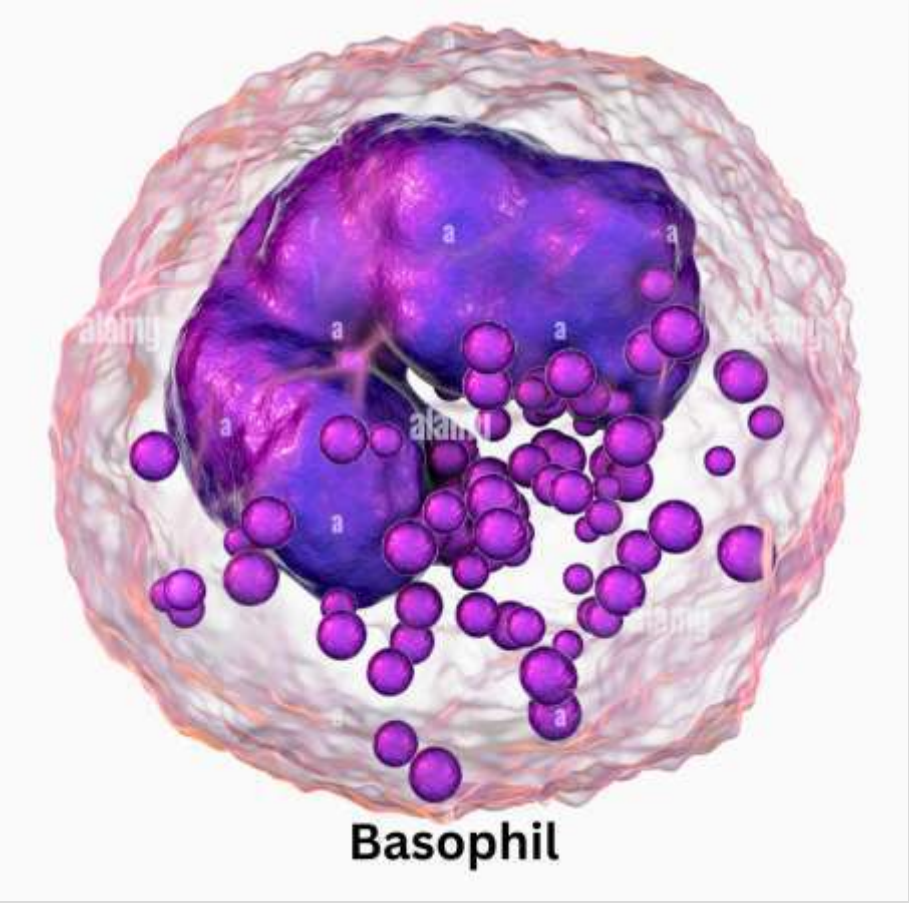
Functions:

- Attack antibody-coated objects (bacteria, protozoa, cell debris)
- Defense against large parasites
- Excrete toxic compounds



Basophils

- Non-specific defense
- Not phagocytic
- < 1% of WBCs
- “U” shaped nucleus
- 8 - 10µm diameter
- Granules contain
- histamine – dilate blood vessels
- heparin – prevent clotting
- Life span = 9



Functions:

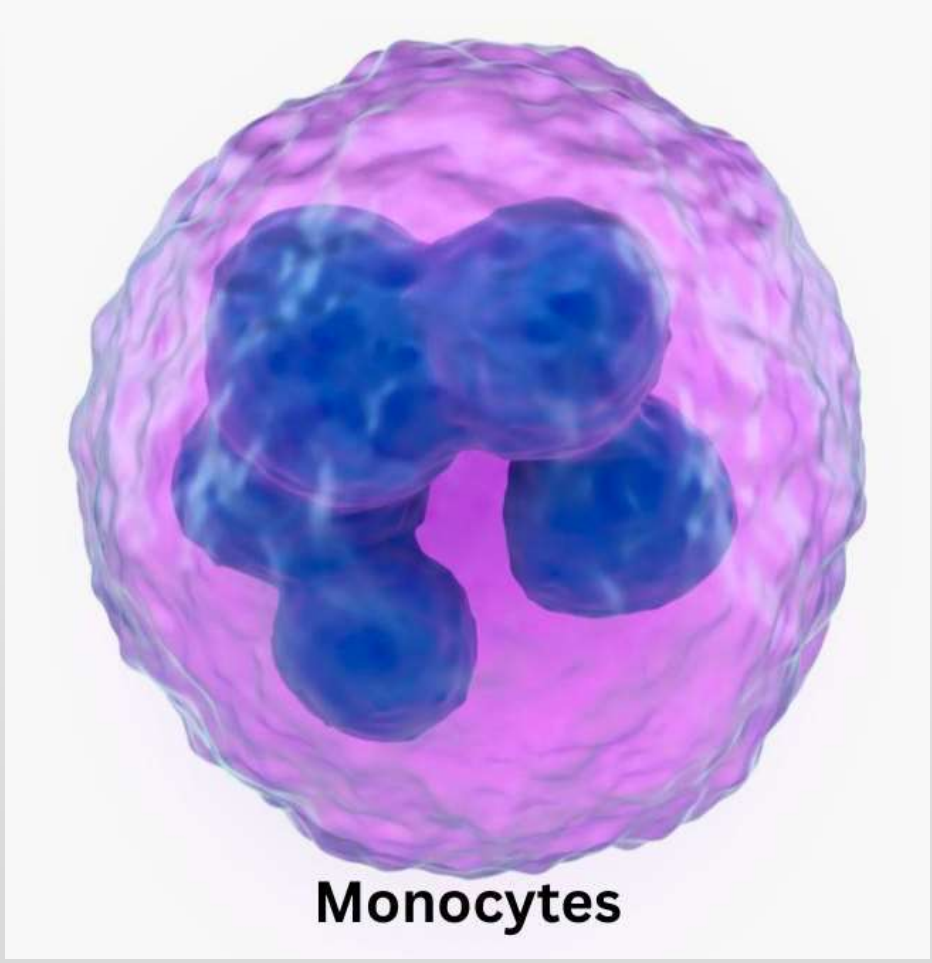
☐ Inflammation ☐ Allergic response (via histamine)

Monocytes

- Non-specific defense (Phagocytic)
- 2-8% of WBCs
- Kidney shaped nucleus (15 µm + diameter)
- Circulate 24 h, then exit to tissues = macrophage
- Life span = several months

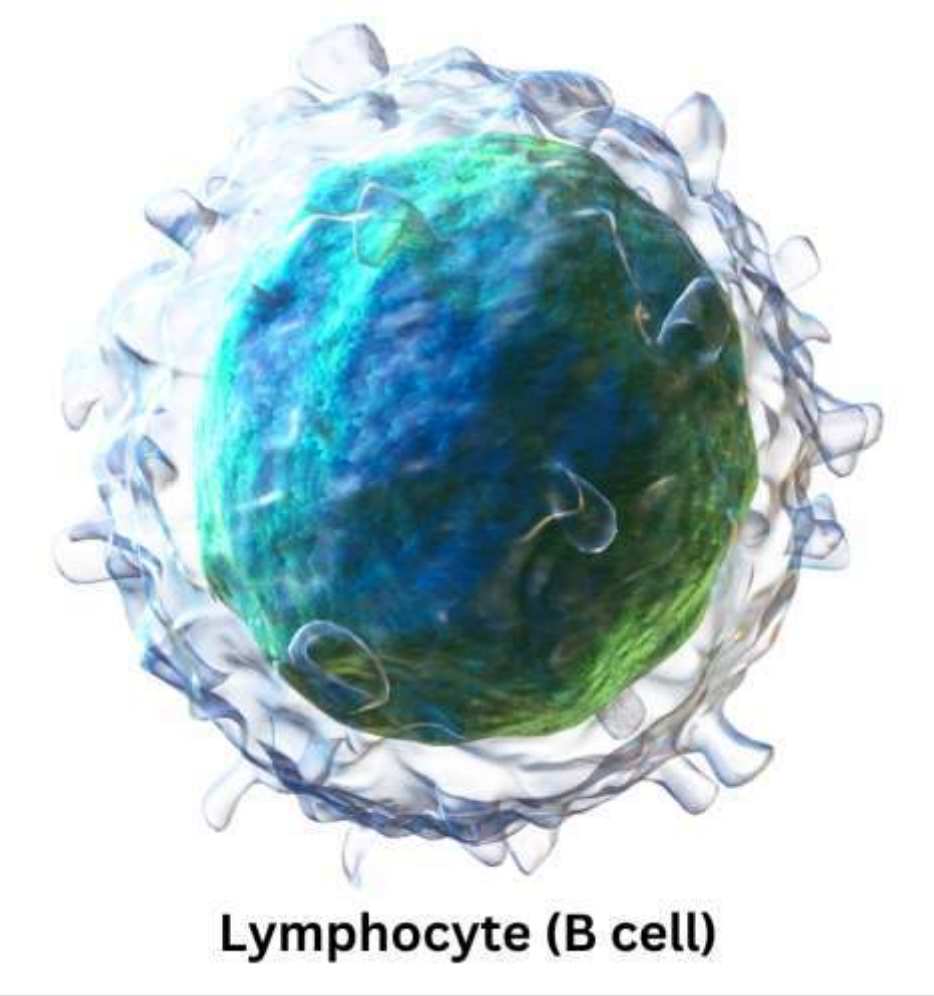
Functions:

- Phagocytosis: viruses and bacteria
- Attract phagocytes
- Attract fibroblasts for scar formation
- Activate lymphocytes: to mount immune response



Lymphocytes

- Immune-Specific Response
- 20-30% of WBCs, Large round nucleus
- 5-17µm diameter,
- Migratory between blood and tissues (bidirectional)
- Most in lymphatic system
- Life span = days to lifetime

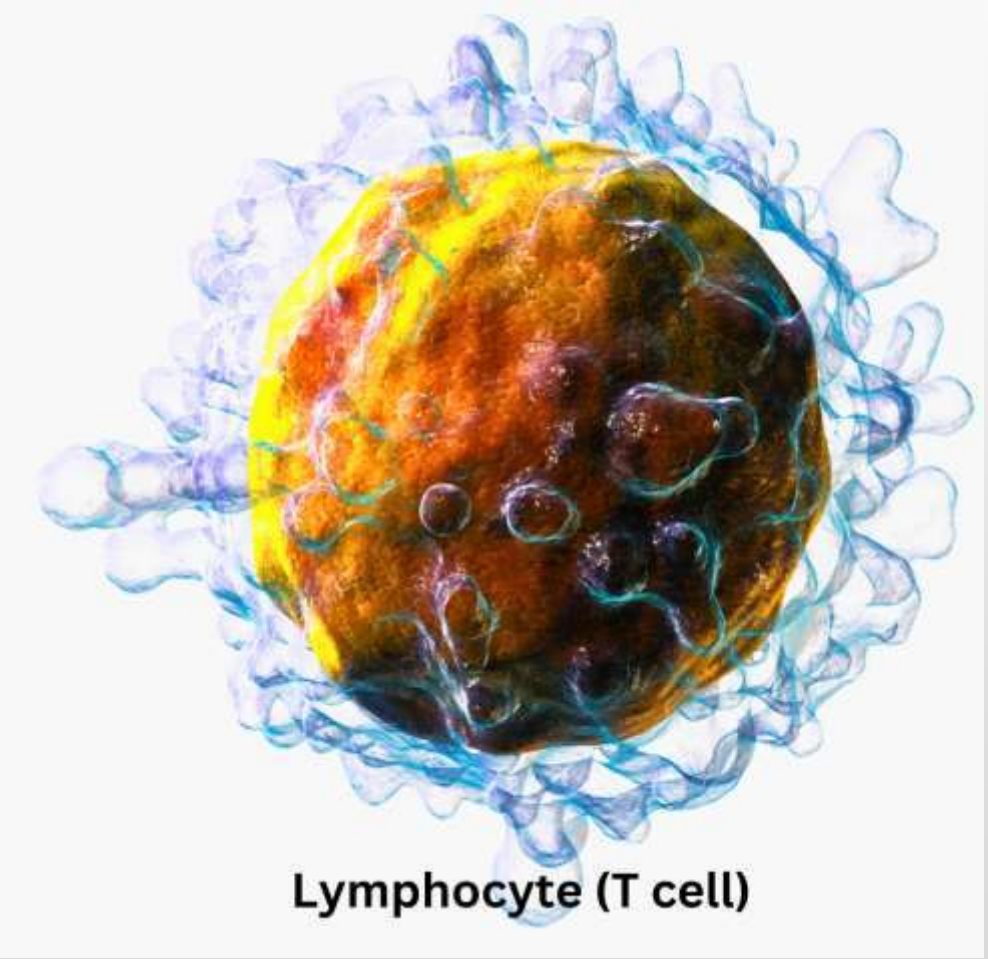


Lymphocyte (B cell)

Function

Depends on type: ☐

- T cells: cell-mediated immunity (attack foreign cells directly or control the activity of other lymphocytes)
- B cells: humoral immunity (differentiate into plasma cells & synthesize and secrete antibodies)
- Natural Killer (NK) cells: immune surveillance (detect and destroy abnormal tissue; e.g., cancer)



Lymphocyte (T cell)

Difference between the different types of leucocytes:

Characters	Lymphocytes	Monocytes	Eosinophils	Basophils	Neutrophils
Percentage in total leucocytes	$20-25\%$	$2-8\%$	$2-3\%$	$0.5-1\%$	$60-65\%$
Granules in cytoplasm	Absent	Absent	Coarse	Coarse	Fine
Nucleus	Round	Bean-shaped	Bilobed	S-shaped	Multilobed
Life span	Few days or maybe years	$10-12\ hours$	$14\ hours$	$8-12\ hours$	$10-12\ hours$
Functions	Responsible for the body's immune responses	Phagocytic	Role in immunity and antiallergy	Involved in inflammatory reactions	Phagocytic

Common white blood cell disorders

- Leukocytosis:

This is an increased number of white blood cells. Possible causes include bacterial or viral infections, certain medications, allergies, smoking, inflammatory diseases, autoimmune disorders, a genetic condition, and cancer.

- Autoimmune neutropenia:

This is seen when the body produces antibodies that attack and destroy neutrophils. It is associated with various conditions, including Crohn's disease and rheumatoid arthritis.

Cont.

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This is seen when the body produces antibodies that attack and destroy neutrophils. It is associated with various conditions, including Crohn's disease and rheumatoid arthritis.

- **Severe congenital neutropenia:**

This occurs secondary to a genetic mutation. People with severe congenital neutropenia have recurrent bacterial infections.

- **Chronic granulomatous disease:**

This is a disorder where multiple types of WBCs (neutrophils, monocytes, macrophages) are unable to function properly. It is an inherited condition and results in multiple infections, particularly pneumonia and abscesses.

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