UNIVERSITY OF MEDICAL SCIENCES, ONDO

DEPARTMENT OF PHYSIOLOGY

BLOOD AND BODY FLUID PHYSIOLOGY

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OBJECTIVES

- Leukopoiesis
- Thrombopoiesis

Leukopoiesis and Lymphopoiesis

➢ White blood cells 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

Lymphopoiesis

- Hemocytoblasts differentiates into Lymphoid Stem Cells → Prolymphocytes → Lymphocytes

- Some lymphocytes are derived from lymphoid stem cells that remain in bone marrow → B cells and NK cells

- Many lymphoid stem cells migrate to peripheral lymphoid tissues (e.g., thymus, spleen & lymph nodes) and then differentiate into mature lymphocytes

- Lymphoid stem cells in the thymus give rise to T cells

White Blood Cells

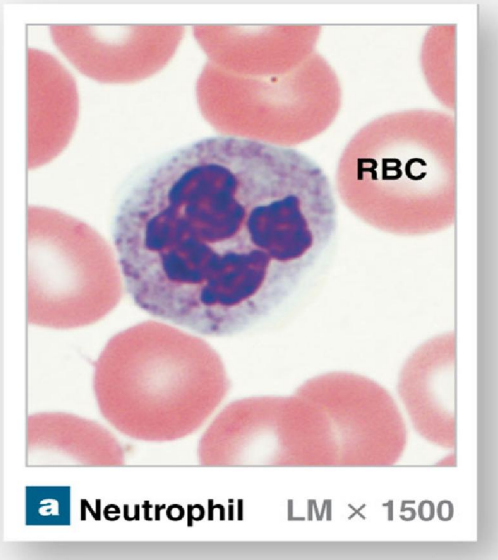
- Leukocytes (5 types)
- Have nuclei & organelles but no hemoglobin (hence "white" or buff)
- 5000 – 10,000 leukocytes/μl blood; < 1% total blood volume
- Use blood to travel; most are found in connective tissue & lymph

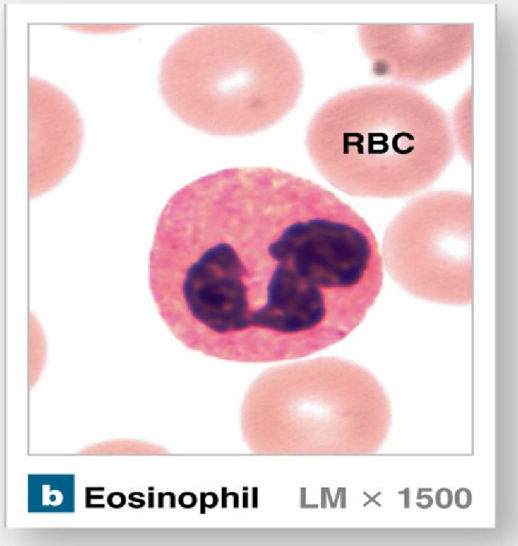
Functions:

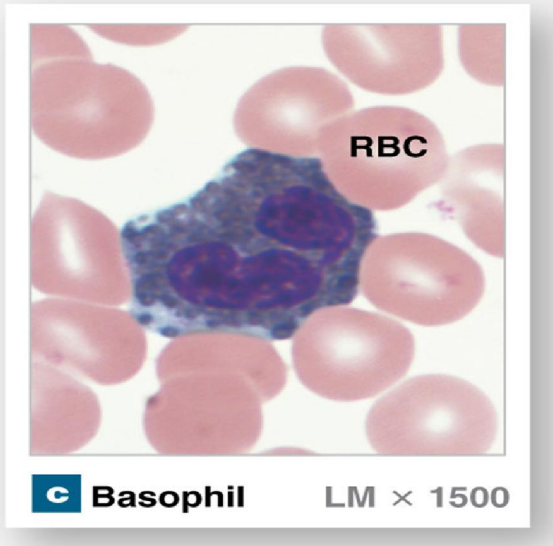
- Defend against pathogens
- Remove toxins and wastes
- Attack abnormal/damaged cells

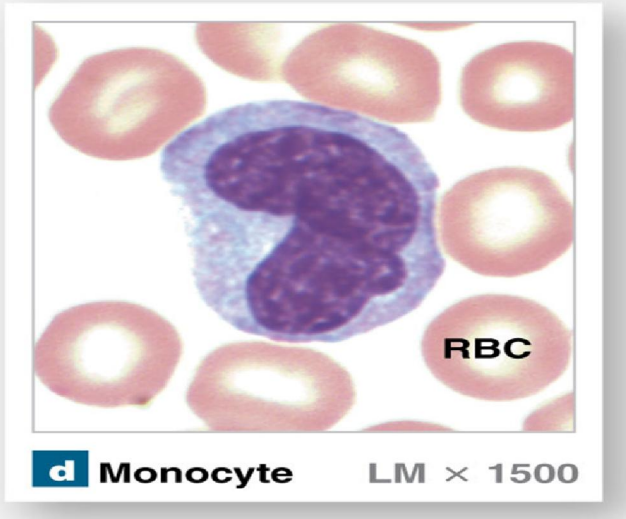
Characteristics

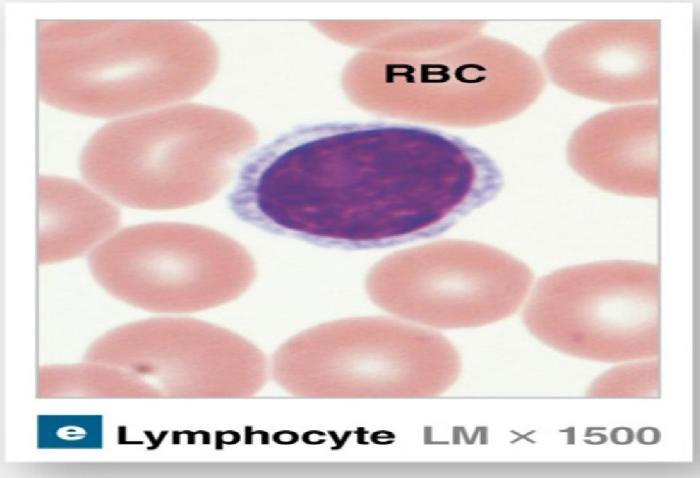
- Ameoboid movement – flow of cytoplasm into cellular processes
- Diapedesis (move out of blood)
- Exhibit positive chemotaxis - pathogens, damaged tissue, other WBCs
- Phagocytosis (engulf pathogens and debris)











Types of Leukocytes

a-d: Non specific defense

e: Specific defense

A. Neutrophils or Polymorphonuclear [PMN] Leukocytes

- Non-specific, defense
- Phagocytic
- 50-70% of all WBCs
- 2-5 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

Functions

- Respiratory burst: H_2O_2 & O_2 -, acts a bactericide
- Degranulation: defensins (peptide) lyse bacteria
- Prostaglandins: induce inflammation to stop spread of injury
- Leukotrienes: attract phagocytes

B. **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
- Control inflammation with enzymes that counteract inflammatory effects of neutrophils and mast cells

C. **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 d

Functions:

- Inflammation
- Allergic response (via histamine)

D. **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

E. **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
- Function (depends on type [3]):

- **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)