



White Blood Cell

The second important type of blood cell components, although called leukocytes, they are important to body defense against pathogenic agents.

They account for less than 1 percent of total blood volume. White blood cells are the only true cells in blood; they are **containing nuclei and the usual organelles**.

Leukocytes form a protective, movable army that helps defend the body against damage by bacteria, viruses, parasites, and tumor cells.

White blood cells, are able to slip into and out of the blood vessels, the circulatory system is simply their means of transportation to areas of the body where their services are needed for inflammatory or immune responses.

Whenever WBCs mobilize for action, the body speeds up their production, and as many as twice the normal number of WBCs may appear in the blood within a few hours.

(White blood cell formation we were discuss in lecture of hematopoiesis)

Types of WBCs

That classified into two major groups, depending on whether or not they contain visible granules in their cytoplasm after staining (figure 1).

a-Granulocytes, cytoplasm of WBCs contain granules, and they have lobed nuclei. specifically, with Wright's stain. The granulocytes include the **neutrophils, eosinophils and basophils**.

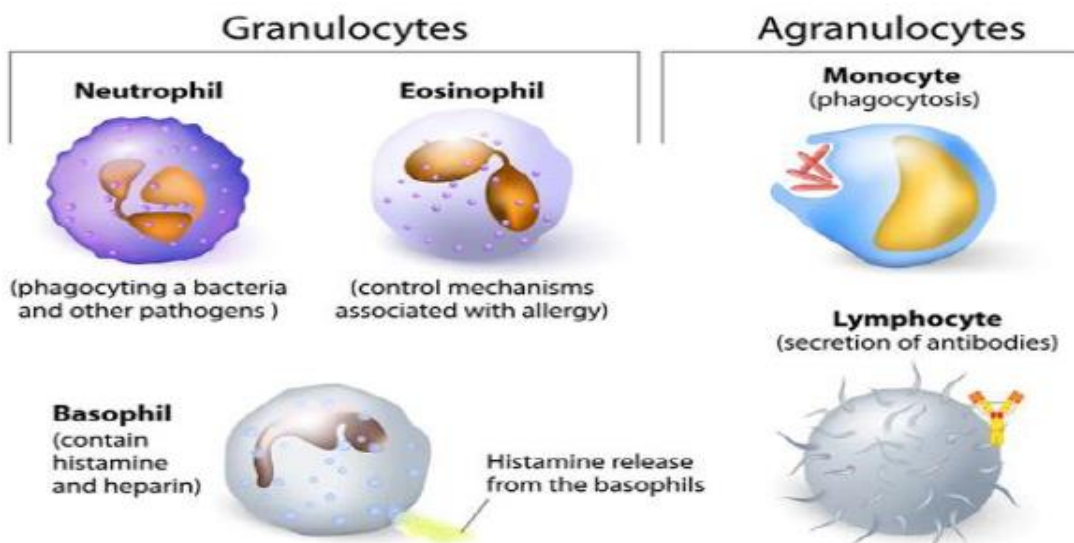


Figure 1
Leukocyte
types



- Neutrophils** have a multilobed nucleus (3-5 lobes) and very fine granules that respond to **both acid and basic stains**. Consequently, the cytoplasm as a whole stains pink.
- Eosinophils** have a **bilobed blue-red nucleus** that resembles an old fashioned telephone receiver and large red cytoplasmic granules. Their number increases rapidly during **allergies and infections by parasitic worms** (flat-worms, tapeworms, etc.).
- Basophils**, the rarest of the WBCs, have **S shaped nucleus contain large histamine-containing granules** that stain dark blue. **Histamine** is an inflammatory chemical that makes blood vessels leaky and attracts other WBCs to the inflammatory site.

Cell Type	Normal Value (percent)
Neutrophil	54–62
Lymphocyte	25–33
Monocyte	3–9
Eosinophil	1–3
Basophil	<1

(Table 1 normal range of WBCc)

b-A-granulocytes lack visible cytoplasmic granules.

Their nuclei are spherical oval or kidney-shaped. A-granulocytes include **lymphocytes and monocytes**

- Lymphocytes** have a large dark purple nucleus that occupies most of the cell volume. Only slightly larger than RBCs, lymphocytes reside in lymphatic tissues, **where they play an important role in the immune response**, there are two types of lymphocytes:

* **T lymphocytes**: provide cell mediated immunity, Percentage 60-80% from all lymphocyte percentage, site of production: bone marrow, site of developing thymus

* **B lymphocytes**: provide humoral immunity, it has Percentage 20% of all lymphocyte, site of production: bone marrow site of developing: the secondary lymphoid organs (spleen, lymph nodes).

- Monocytes** are the largest of the WBCs, that has abundant cytoplasm and indented (kidney like) nucleus.

Immature monocyte in the peripheral blood and cannot fight infections, after they stay 2-3 days in the peripheral blood they migrate into the tissues to form **Macrophage**.

Monocyte take new name when enter to different tissue:

1-Macrophages in the Lymph Nodes **2-Alveolar Macrophages** in the Lungs

3-Kupffer Cells Macrophages in the Liver Sinusoids **4-Macrophages** of the Spleen and Bone Marrow **5-Microglia** in brain



Function of Macrophage (Monocyte):

- 1-Defense against bacteria, fungi, viruses, and foreign bodies
- 2-Remove the dead cells from tissue and circulation

The granulocytes and the **monocytes** protect the body against invading organisms by ingesting them by the process of **phagocytosis**. The lymphocytes function mainly in connection with the immune system, however, a function of lymphocytes is to attach themselves to specific invading organisms and destroy them, an action similar to those of the granulocytes and monocytes. The main types of phagocytes are **monocytes, macrophages, neutrophils, tissue dendritic cells, and mast cells**

Phagocytosis Steps: -

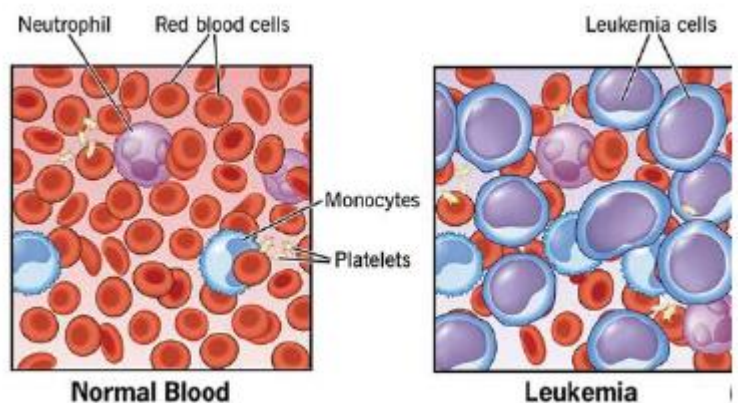
A- chemotaxis: Include chemical signals release by foreign body and tissues damage, induce phagocytic cell to mobilize and rush to site of infection.

B- opsonization: It needs the help of IgG+C3 to make it easily recognized by phagocytic cell and ingested.

C- ingestion: The foreign body is engulfed pseudopod membranes (phagosome formation).

D-killing: The foreign body killed by specific enzymes (**phagolysosome**).

(The normal range of WBCs in CBC is 4000 to 11.000 WBCs/mm³, when increase that may refer to inflammation or Patients with acute or even chronic leukemia may come in with a white blood cell count up into the 100,000-400,000 range).



References:

- 1- Tamang, T., Baral, S., & Paing, M. P. (2022). Classification of White Blood Cells: A Comprehensive Study Using Transfer Learning Based on Convolutional Neural Networks. *Diagnostics*, 12(12), 2903.
- 2- Gordon, S. (2016). Phagocytosis: an immunobiologic process. *Immunity*, 44(3), 463-475.