Leukocytes

Leukocytes (white blood cells, or **WBCs)** are the mobile units of the body's immune defense system.

Leukocytes and their derivatives, along with a variety of plasma proteins, make up the **immune system**, an internal defense system that recognizes and either destroys materials that are foreign to the "normal self."

Specifically, the immune system (1) defends against invading disease-producing microorganisms (such as bacteria and viruses); (2) functions as a "cleanup crew" that removes worn-out cells (such as aged red blood cells) and tissue debris (for example, tissue damaged by trauma or disease), paving the way for wound healing and tissue repair; and (3) identifies and destroys cancer cells that arise in the body.

Leukocytes primarily function as defense agents outside the blood.

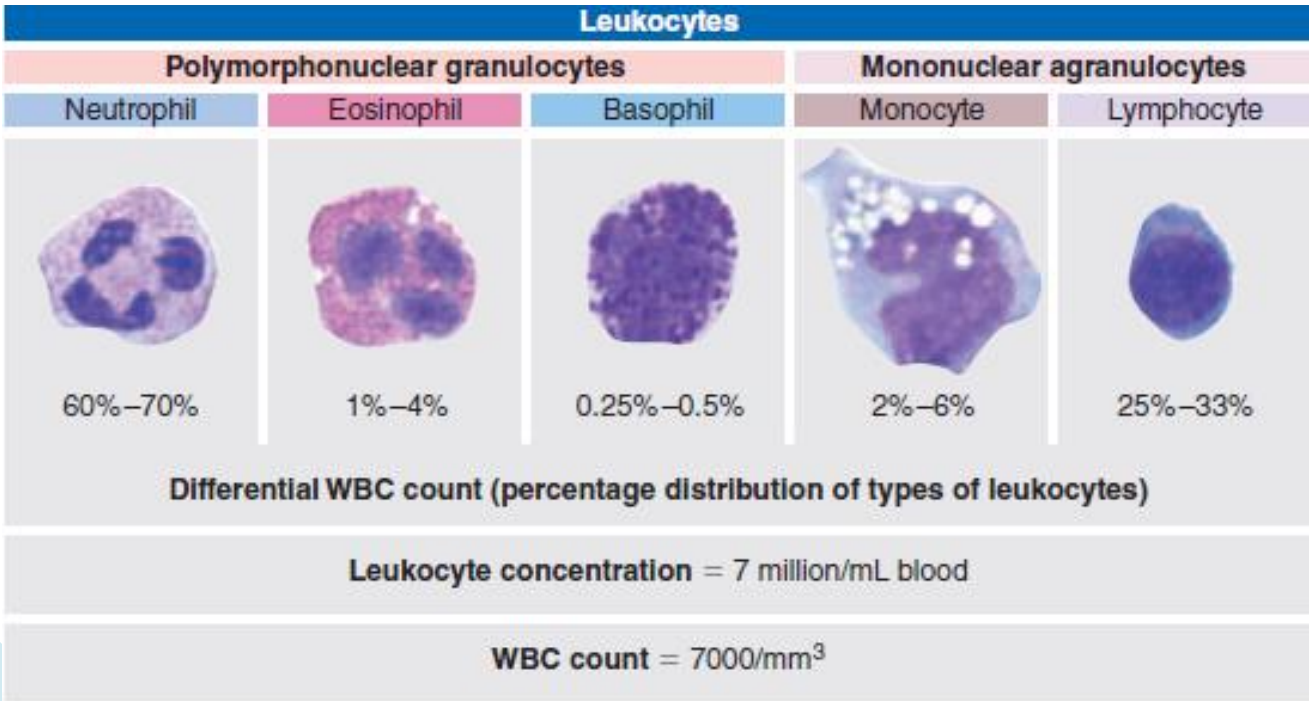
To carry out their functions, WBCs go to sites of invasion or tissue damage. The main reason WBCs are in the blood is for rapid transport from their site of production or storage to wherever they are needed. Unlike erythrocytes, leukocytes are able to exit the blood by assuming amoebalike behavior to wriggle through narrow capillary pores and crawl to assaulted areas

There are five types of leukocytes.

Leukocytes lack hemoglobin, so they are colorless (that is, "white") unless specifically stained for microscopic visibility. Unlike red blood cells, which are of uniform structure, identical function, and constant number, white blood cells vary in structure, function, and number.

There are five types of circulating WBCs: **neutrophils**, **eosinophils**, **basophils**, **monocytes**, and **lymphocytes**. each with a characteristic structure and function.

They are all somewhat larger than RBCs.



Granulocytes and Agranulocytes

The five types of leukocytes fall into two main categories, depending on the appearance of their nuclei and the presence or absence of granules in their cytoplasm when viewed microscopically.

Neutrophils, eosinophils, and basophils are categorized as **polymorphonuclear** (meaning "many-shaped nucleus") **granulocytes** (meaning "granule-containing cells"). Their nuclei are segmented into several lobes of varying shapes, and their cytoplasm contains an abundance of membrane-enclosed granules.

The three types of granulocytes are distinguished on the basis of the varying affinity of their granules for dyes: *Eosinophils* have an affinity for the red dye eosin, *basophils* preferentially take up a basic blue dye, and *neutrophils* are neutral, showing no dye preference.

Monocytes and lymphocytes are known as **mononuclear** (meaning "single nucleus") **agranulocytes** (meaning "cells lacking granules"). Both have a single, large, nonsegmented nucleus and few granules. *Monocytes* are the larger of the two and have an oval or kidney-shaped nucleus. *Lymphocytes,* the smallest of the leukocytes, characteristically have a large spherical nucleus that occupies most of the cell.

Functions and Life Spans of Leukocytes

1-**Neutrophils** are phagocytic specialists; they engulf and destroy bacteria intracellularly

2- **Eosinophils** are specialists of another type. An increase in circulating eosinophils is associated with allergic conditions (such as asthma and hay fever) and with internal parasite infestations (for example, worms).

3- **Basophils** are the least numerous of the leukocytes. They are quite similar structurally and functionally to *mast cells,* Both basophils and mast cells synthesize and store *histamine* and *heparin,*

Histamine release is important in allergic reactions, whereas heparin speeds up removal of fat particles from the blood after a fatty meal and plays a role in certain immune responses.

Once released into the blood from the bone marrow, a granulocyte usually stays in transit in the blood for less than a day before leaving to enter the tissues, where it survives another 3 to 4 days unless it dies sooner in the line of duty.

By comparison, the functions and life spans of the **agranulocytes** are as follows:

1- **Monocytes**, like neutrophils, become professional phagocytes. monocytes continue to mature and greatly enlarge, becoming large tissue phagocytes known as **macrophages** .

2- **Lymphocytes** are of two types:

a. **B lymphocytes (B cells)** produce antibodies that indirectly lead to the destruction of foreign material (antibody-mediated immunity).

b. **T lymphocytes (T cells)** directly destroy virus-invaded cells and mutant cells by releasing chemicals that punch lethal holes in the victim cells (cell-mediated immunity).

Platelets and Hemostasis

An average of 250 million platelets are normally present in each milliliter of blood (range of 150,000 to 350,000/mm3).

Platelets are cell fragments shed from megakaryocytes.

Platelets, or **thrombocytes**, are not whole cells but small cell fragments shed from the outer edges of extraordinarily large bone marrow cells known as **megakaryocytes**. A single megakaryocyte typically produces about 1000 platelets.

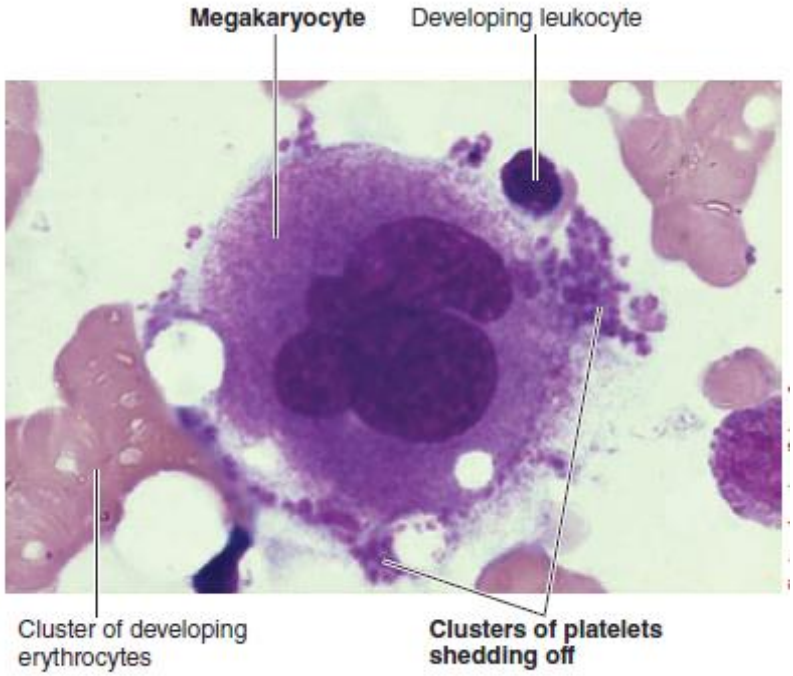


Figure 11-10 A megakaryocyte forming platelets.

Platelets remain functional for an average of 10 days, at which time they are removed from circulation by tissue macrophages, especially those in the spleen and liver, and are replaced by newly released platelets from bone marrow.

Hemostasis prevents blood loss from damaged small vessels.

Platelets are important in several stages of hemostasis. They help stop bleeding by forming a plug in injured or damaged vessel walls. They also release chemicals and enzymes that are important in another stage of hemostasis, the coagulation cascade.

Blood vessels

1. Arteries

- deliver oxygenated blood to the tissues.
- are thick-walled, with extensive **elastic tissue** and **smooth muscle.**
- are under **high pressure.**

2. Arterioles

- are the smallest branches of the arteries.
- are the **site of highest resistance in the cardiovascular system.**
- have a smooth muscle wall that is extensively innervated by autonomic nerve fibers.
- Arteriolar resistance is regulated by the autonomic nervous system (ANS).

3. Capillaries

- consist of a single layer of endothelial cells surrounded by basal lamina.
- are thin-walled.
- are the site of exchange of nutrients, water, and gases.

4. Venules

- are formed from merged capillaries.

5. Veins

- progressively merge to form larger veins. The largest vein, the vena cava, returns blood to the heart.
- are thin-walled.
- are under **low pressure.**
- contain the **highest proportion of the blood** in the cardiovascular system.