

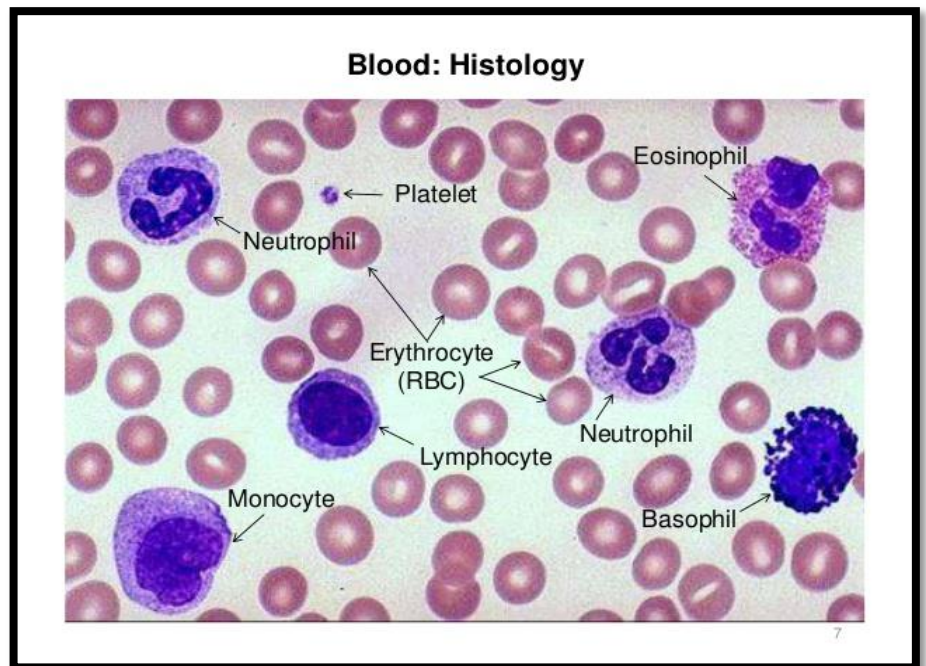
Hemopoiesis

White Blood Cells

(Leukocytes):

The WBCs are involved in the body's **defense against microorganism** and other foreign materials, although these cells do most of their work outside the circulating system, they use blood for transportation.

In healthy adult there are roughly 4000-11 000/mm³. The number of WBC in the blood varies according to age, sex and physiological conditions .



Leukocytes are divided in to 2 major groups according to the type of cytoplasmic granules and the shape of their nuclei :

- 1- **Granulocytes (polymorphonuclear):** Neutrophils, Eosinophils and Basophils .
- 2- **A granulocytes (mononuclear):** Lymphocytes and Monocytes.

Granulocytes possess 2 types of granules :

- 1- **Specific granules** that bind neutral, **basic or acidic** stains and have specific functions .
- 2- **Azurophilic granules** which are **specialized lysosomes stain** darkly purple and present at some level in all leukocytes .

When the cells phagocytize microorganisms, several azurophilic granule proteins act collectively to kill and then digest them .

Leukocytes have a short life span of a few days dying by **apoptosis** in the C.T; the resulting cellular debris is removed by macrophage .

Diapedesis: is a process by which leukocytes leave the blood vessels by passing between the endothelial cells lining of capillaries and venules to enter C. T, diapedesis is increased in individual infected by microorganism

❖ Granulocytes

Include 3 types: Neutrophils, Eosinophils, and Basophils .

1- Neutrophils : are the commonest type of white blood cell found in a blood smear. They make up 60-70% of the total amount of white blood cells.

Neutrophils have 3 types of granules:

1. azure granules (lysosomes),
2. secretory granules in salmon pink cytoplasm, anti-microbial enzymes.
3. have glycoproteins and gelatinase.

Function:

Neutrophils are born in the bone marrow. They circulate in the blood for 6-10 hours, and then enter the tissues. They are motile, and phagocytic and will destroy damaged tissue and bacteria.

They are important in inflammatory reactions.

2- Eosinophils are rarely found in blood smears - making up 1-6% of the total white blood cells.

Function :

These cells are born in the bone marrow, and migrate from the peripheral blood system after a few hours, into loose connective tissue in the respiratory and gastrointestinal tracts. They phagocytose antigen-antibody complexes. They also produce **histaminase**. A high eosinophil blood count may indicate an **allergic reaction**. Eosinophils are also important in killing **parasitic worms**.

3- Basophils are the rarest type of white blood cell, making up only 1% of the white blood cells found in a blood smear.

Function:

These cells are involved in **immune responses to parasites**. They have **IgE** receptors and the granules are released when the cells bind **IgE**. These cells also accumulate at sites of infection, and the release of prostaglandins, serotonin and histamine help to increase blood flow to the area of damage, as part of the inflammatory response.

❖ A granulocytes (lymphocyte and monocyte)

Non-granular leukocytes (mononuclear leukocytes) include lymphocytes and monocytes. This group of cells has

- 1- Homogeneous cytoplasm

- 2- Does not have specific granules but they do contain azurophilic granules (lysosomes)
- 3- The nucleus is round or indented .

1. Lymphocyte These are the second most common white blood cell (20-50%), and are easy to find in blood smears.

Although the cells look similar there are two main types, B-cells and T-cells. There will be more on this in the section on the **immune system**.

Function:

The B-cells develop into plasma cells which make **antibodies**, The T-cells attack viruses, cancer cells, and transplants.

2. Monocytes are the third most common type of white blood cell; about 2-10% of leucocytes are monocytes.

Function:

Monocytes in the circulation are precursors of **tissue macrophages** that are actively phagocytic. Monocytes circulate in the blood for 1-3 days, and then migrate into body tissues, where they transform into **macrophages**. They will phagocytose dead cells and bacteria. Some monocytes can also transform into osteoclasts. Monocytes are important in **the inflammatory response**.

Platelets (Thrombocytes)

Are non-nucleated disk like **cell fragments** (2-4 micron in diameter), platelets originate by fragmentation at the end of cytoplasmic processes extending from giant cells called **megakaryocytes** in the bone marrow .

Normal platelets count range from (200,000 - 400,000 per microliter) .

Blood platelets have a life span of about 8-10 days, and they're mostly engulfed by macrophages of spleen .



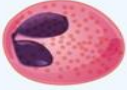
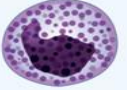



In stained blood smear each platelets has a **lightly blue** stained peripheral zone called **hyalomere**, and a central zone containing purple granules called **granulomere** .

The plasma membrane of each platelet is covered by a **mucopolysaccharide** coat (**glycocalyx cell coat**) which involved in **platelets adhesion** .

Microtubules and **microfilaments** placed just beneath the membranes which have an important role in maintain the biconvex shape of platelets. **The granulomere contains granules, mitochondria and glycogen**

Granules of platelets consist of :

- 1- **Dense Delta Granules:** contain serotonin taken up from plasma .
- 2- **Lambda Granules:** small granules contain only lysosomal enzymes .
- 3- **Alpha Granules:** are the larger granules, which are the most common type of granules. These granules contain platelets growth factor and coagulant factors as fibrinogen.

Formed element	Major subtypes	Numbers present per microliter (μL) and mean (range)	Appearance in a standard blood smear	Summary of functions	Comments
Erythrocytes (red blood cells) 		5.2 million (4.4–6.0 million)	Flattened biconcave disk; no nucleus; pale red color	Transport oxygen and some carbon dioxide between tissues and lungs	Lifespan of approximately 120 days
Leukocytes (white blood cells)	Granulocytes including neutrophils, eosinophils, and basophils	4360 (1800–9950)	Abundant granules in cytoplasm; nucleus normally lobed	Nonspecific (innate) resistance to disease	Classified according to membrane-bound granules in cytoplasm
	Neutrophils 	4150 (1800–7300)	Nuclear lobes increase with age; pale lilac granules	Phagocytic; particularly effective against bacteria. Release cytotoxic chemicals from granules	Most common leukocyte; lifespan of minutes to days
	Eosinophils 	165 (0–700)	Nucleus generally two-lobed; bright red-orange granules	Phagocytic cells; particularly effective with antigen- antibody complexes. Release antihistamines. Increase in allergies and parasitic infections	Lifespan of minutes to days
	Basophils 	44 (0–150)	Nucleus generally two-lobed but difficult to see due to presence of heavy, dense, dark purple granules	Promotes inflammation	Least common leukocyte; lifespan unknown
	Agranulocytes including lymphocytes and monocytes	2640 (1700–4950)	Lack abundant granules in cytoplasm; have a simple-shaped nucleus that may be indented	Body defenses	Group consists of two major cell types from different lineages
	Lymphocytes 	2185 (1500–4000)	Spherical cells with a single often large nucleus occupying much of the cell's volume; stains purple; seen in large (natural killer cells) and small (B and T cells) variants	Primarily specific (adaptive) immunity: T cells directly attack other cells (cellular immunity); B cells release antibodies (humoral immunity); natural killer cells are similar to T cells but nonspecific	Initial cells originate in bone marrow, but secondary production occurs in lymphatic tissue; several distinct subtypes; memory cells form after exposure to a pathogen and rapidly increase responses to subsequent exposure; lifespan of many years
	Monocytes 	455 (200–950)	Largest leukocyte with an indented or horseshoe-shaped nucleus	Very effective phagocytic cells engulfing pathogens or worn out cells; also serve as antigen-presenting cells (APCs) for other components of the immune system	Produced in red bone marrow; referred to as macrophages after leaving circulation
	Platelets 		350,000 (150,000–500,000)	Cellular fragments surrounded by a plasma membrane and containing granules; purple stain	Hemostasis plus release growth factors for repair and healing of tissue

Reference:

1- diFIORE'S Atlas of histology with Functional Correlations, eleventh edition,2008.

2- diFIORE'S Atlas of histology with Functional Correlations, twelfth edition,2013.

3- Jonquiere's basic histology text and atlas 13th edition (2013) by Anthony L. Mescher ; Di Fiore's Atlas of Histology 12th ed. (2013) Victor P. Eroschenko