## Lecture six:

## Leucocytes (White blood cells):

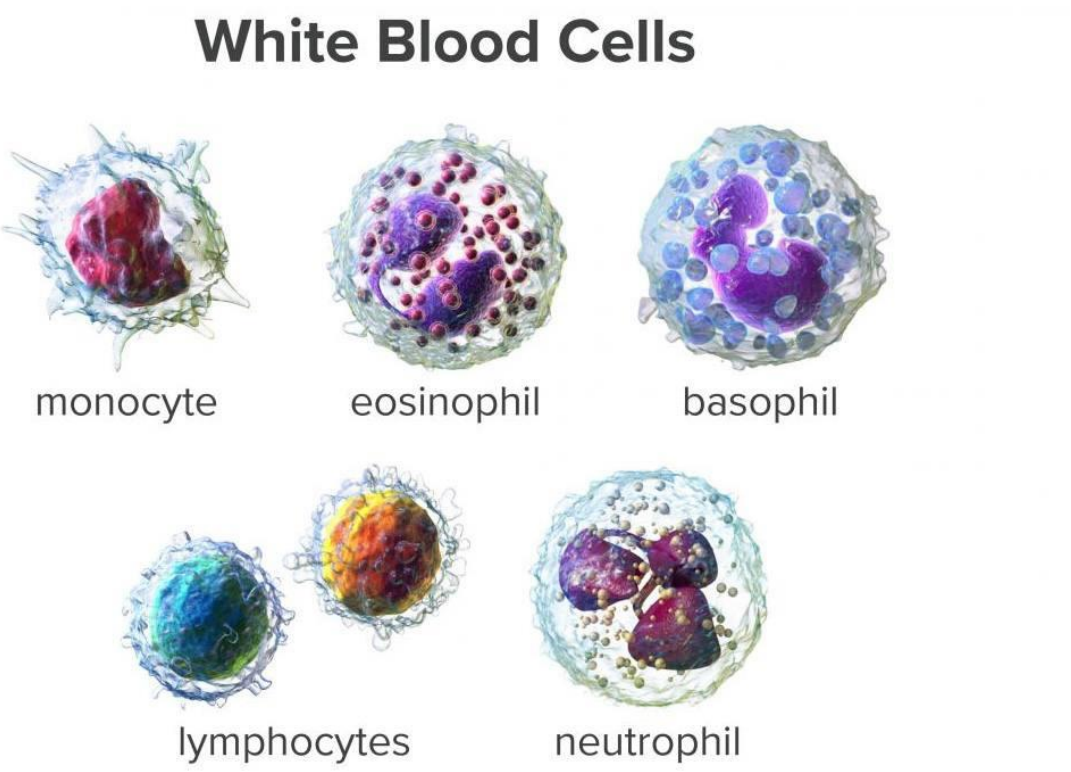
The leukocytes, also called white blood cells:

Are the mobile units of the body's protective system.

They are formed partially in the:

1- Bone marrow (granulocytes and monocytes and a few lymphocytes).
2- Partially in the lymph tissue (lymphocytes and plasma cells).

After formation, they are transported in the blood to different parts of the body where they are needed.




## The number of leukocytes in the blood:

Is often an indicator of disease, and thus the white blood cell count is an important subset of the complete blood count. The normal white cell count is usually between **$4 \times 10^9$/L and $1.1 \times 10^{10}$/L**. Usually expressed as: 4,000 to 11,000 white blood cells per microliter of blood.

**A-** White blood cells make up approximately **1%** of the total blood volume in a

healthy adult, making them substantially less numerous than the red blood cells at 40% to 45%.

**B-** However, this 1% of the blood makes a large difference to health, because immunity depends on it.

**C-** An increase in the number of leukocytes over the upper limits is called leukocytosis.

**D-** It is normal when it is part of healthy immune responses, which happen frequently.

**E-** It is occasionally abnormal, when it is neoplastic or autoimmune in origin.

**F-** A decrease below the lower limit is called leukopenia. This indicates a weakened immune system.

## The main features of white Blood Cells:

1- White blood cells are spherical cells that lack hemoglobin.
2- White blood cells are larger than red blood cells.
3- Each has nucleus.
4- White blood cells can leave the blood and travel by amoeboid movement through the tissues.

## Functions of white blood cells:

1- Protect the body against invading microorganisms and other pathogens.
2- Remove dead cells and debris from the tissues by phagocytosis.

## Types of white blood cells (leukocytes):

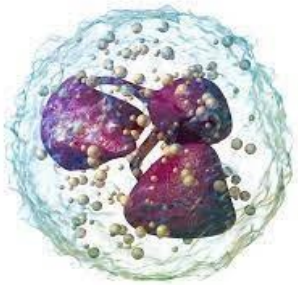
Each white blood cell type is named according to its appearance in stained preparations.

1- **Granulocytes:** those containing large cytoplasmic granules.
2- **Agranulocytes:** those with very small granules that cannot be seen easily with the light microscope.

There are three types of granulocytes:

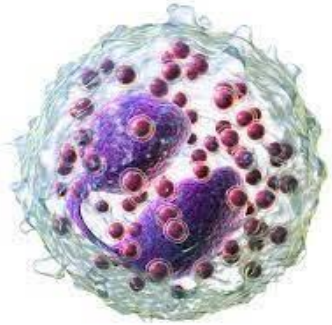
A- Neutrophils.
B- Basophils.
C- Eosinophils.

**Neutrophils features:**



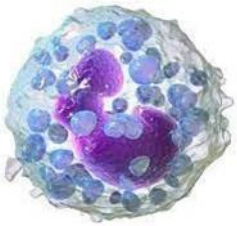
1- The most common type of white blood cells.
2- Have small cytoplasmic granules that stain with both acidic and basic dyes.
3- Their nuclei are commonly lobed, with the number of lobes varying from (2-5).
4- Neutrophils usually remain in the blood for a short time (10–12 hours), move into other tissues, and phagocytize microorganisms and other foreign substances.
5- Dead neutrophils, cell debris, and fluid can accumulate as pus at sites of infections.

**Basophils features:**



1- It's the least common of all white blood cells.
2- Contain large cytoplasmic granules that stain blue or purple with basic dyes.
3- Basophils release histamine and .They also release heparin, which prevents the formation of clots.

**Eosinophil's features:**

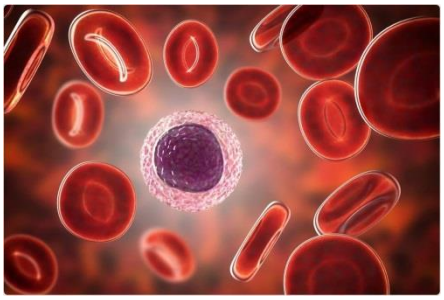


1- Contain cytoplasmic granules that stain bright red with eosin, an acidic stain.
2- They often have a two-lobed nucleus.
3- Eosinophils are involved in inflammatory responses associated with allergies and asthma.
4- Chemicals from eosinophil's are involved in destroying certain worm parasites

There are two types of a granulocytes:

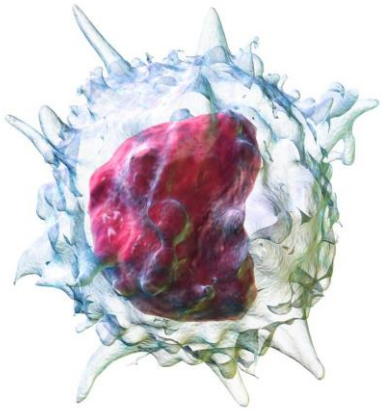
1- **Lymphocytes.**
2- **Monocytes.**

**Lymphocytes features:**



1- The smallest of the white blood cells.
2- The lymphocytic cytoplasm consists of only a thin, sometimes imperceptible ring around the nucleus.
3- There are several types of lymphocytes,( T,B, and natural killer cells ).
4- They play an important role in the body's immune response.
5- Their diverse activities involve the production of antibodies and other chemicals that destroy microorganisms, contribute to allergic reactions….etc.

**Monocytes features:**



1- The largest of the white blood cells.
2- After they leave the blood and enter tissues, monocytes enlarge and become macrophages, which phagocytize bacteria, dead cells, cell fragments, and any other debris within the tissues.
3- Macrophages can break down phagocytized foreign substances and present the processed substances to lymphocytes causing activation of the lymphocytes

## Life spans of the white blood cells

The life of the granulocytes after being released from the bone marrow is normally 4 to 8 hours circulating in the blood and another 4 to 5 days in tissues where they are needed.

In times of serious tissue infection, this total life span is often shortened to only a few hours because the granulocytes proceed even more rapidly to the infected area, perform their functions. And, in the process, are they destroyed.

The monocytes also have a short transit time, 10 to 20 hours in the blood, before wandering through the capillary membranes into the tissues. Once in the tissues, they swell too much larger their sizes to become tissue macrophages and, in this form, they can live for months unless destroyed while performing phagocytic functions.

These tissue macrophages are the basis of the tissue macrophage system.

1- Which provides continuing defense against infection. Lymphocytes enter the circulatory system continually along with drainage of lymph from the lymph nodes and other lymphoid tissue.
2- After a few hours, they pass out of the blood back into the tissues, then they reenter the lymph and return to the blood again and again; thus, there is continual circulation of lymphocytes through the body.

The lymphocytes have life spans of weeks or months, depending on the body's need for these cells.

**Table 13.2 | Formed Elements of the Blood**

| Component | Description | Number Present | Function |
|---|---|---|---|
| Erythrocyte (red blood cell) | Biconcave disc without nucleus; contains hemoglobin; survives 100 to 120 days | 4,000,000 to 6,000,000 / $mm^3$ | Transports oxygen and carbon dioxide |
| Leukocytes (white blood cells) | | 5,000 to 10,000 / $mm^3$ | Aid in defense against infections by microorganisms |
| Granulocytes | About twice the size of red blood cells; cytoplasmic granules present; survive 12 hours to 3 days | | |
| 1. Neutrophil | Nucleus with 2 to 5 lobes; cytoplasmic granules stain slightly pink | 54% to 62% of white cells present | Phagocytic |
| 2. Eosinophil | Nucleus bilobed; cytoplasmic granules stain red in eosin stain | 1% to 3% of white cells present | Helps to detoxify foreign substances; secretes enzymes that dissolve clots; fights parasitic infections |
| 3. Basophil | Nucleus lobed; cytoplasmic granules stain blue in hematoxylin stain | Less than 1% of white cells present | Releases anticoagulant heparin |
| Agranulocytes | Cytoplasmic granules not visible; survive 100 to 300 days (some much longer) | | |
| 1. Monocyte | 2 to 3 times larger than red blood cell; nuclear shape varies from round to lobed | 3% to 9% of white cells present | Phagocytic |
| 2. Lymphocyte | Only slightly larger than red blood cell; nucleus nearly fits cell | 25% to 33% of white cells present | Provides specific immune response (including antibodies) |
| Platelet (thrombocyte) | Cytoplasmic fragment; survives 5 to 9 days | 130,000 to 400,000 / $mm^3$ | Enables clotting; releases serotonin, which causes vasoconstriction |

## Platelets

Platelets, also called thrombocytes. Are minute component of blood cells, play an important role in preventing blood loss.

## General features:

1- Platelets have no cell nucleus.

2- They are fragments of cytoplasm.

3- Are the second most abundant of the formed elements, with each microliter of blood

4- Containing between (150,000 and 400,000 platelets).

## Structure:

1- Platelets are biconvex discoid (lens-shaped) structures.2–3 µm in greatest diameter.

2- On a stained blood smear, platelets appear as dark purple spots, about 20% the diameter of red blood cells.

3- The ratio of platelets to red blood cells in a healthy adult ranges from

1:10 to 1:20.

## Hemostasis events

Hemostasis: the process of stopping bleeding at the site of interrupted endothelium.

Whenever a vessel is severed or ruptured, hemostasis is achieved by several mechanisms:

(1) Vascular constriction.

(2) Formation of a platelet plug.

(3) Formation of a blood clot as a result of blood coagulation.

(4) Growth of fibrous tissue into the blood clot to close the hole in the vessel permanently.

## Platelet function:

1- The platelets' primary function is to stop bleeding if a blood vessel gets damaged. During an injury, platelets cluster together at the site of the wound to act as a plug.
2- They also help seal the blood vessels in a process called clotting (coagulation) to prevent excess blood from leaving your body.

The official process to stop bleeding from a damaged blood vessel is called hemostasis

## Thrombopoiesis:

Is the formation of platelets in the Bone marrow. Thrombopoietin is the main regulator of thrombopoiesis.

Thrombopoietin affects most aspects of the production of platelets.

This includes self-renewal and expansion of hematopoietic stem cells, stimulating the increase of megakaryocyte progenitor cells, and supporting these cells so they mature to become platelet-producing cells.

The process of Thrombopoiesis is caused by the breakdown of proplatelets (mature megakaryocyte membrane pseudopodial projections).

During the process almost all of the membranes, organelles, granules, and soluble macromolecules in the cytoplasm are being consumed.