Blood

Is considered as a special type of connective tissue because it develop from embryonic mesenchymal cells.

Major components and functions of blood

The blood is composed of blood elements or cells suspended in a fluid matrix called **plasma**. The volume of blood in healthy adult human is about 5 liters.

*The cellular element composed of:

1. **Erythrocytes (red blood cells).**
2. **Leucocytes (white blood cells).**
3. **Platelets or thrombocytes.**

*Plasma is a viscous, translucent, and yellowish fluid composed of:

* 1- Water (90%).
* 2- Proteins (7%).
* 3- Organic salts (1%).
* 4- Organic compound (2%) such as amino acids, lipids, and vitamins.

*The ratio of erythrocytes to the total blood volume is about 43% and known as hematocrit.

*Blood functions involved:

*1- transport of oxygen, carbon dioxide and hormones.

*2- Maintenance of acid-base balance.

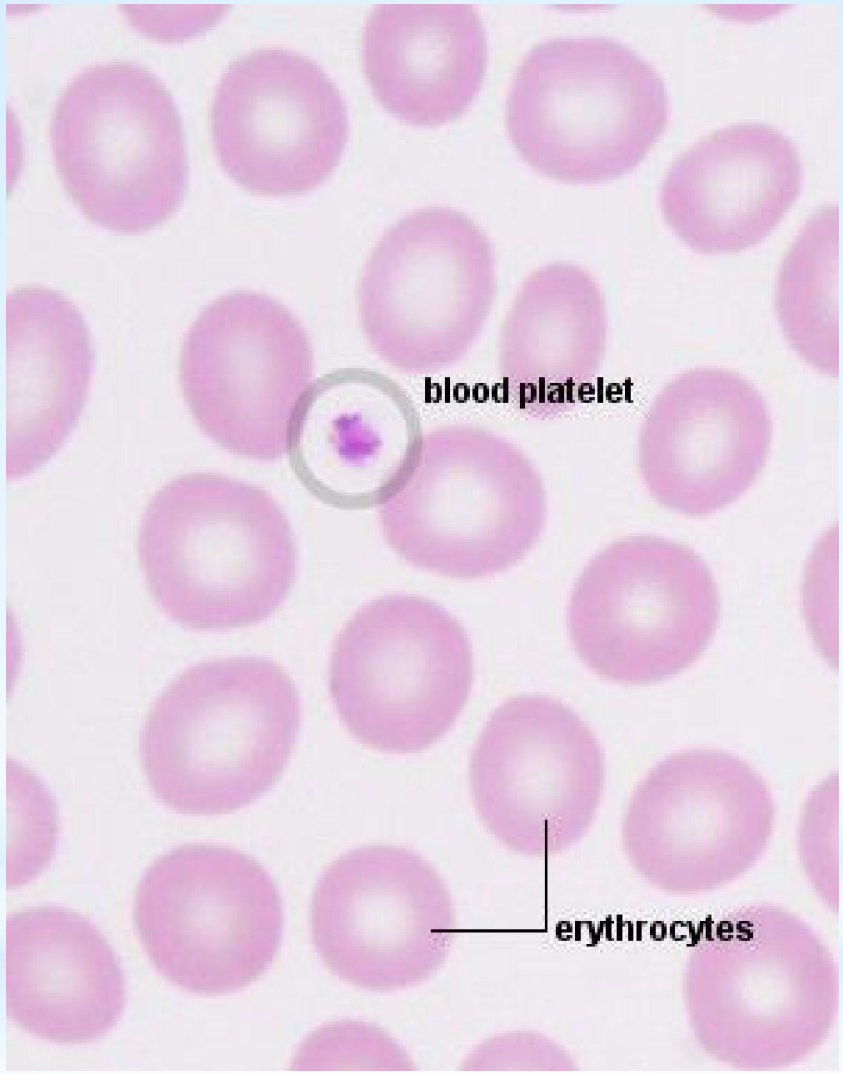
*3- Removal of waste products of cell metabolism.

*4- temperature control of the body.

*5- Defense against infection.

* Erythrocytes (RBCs)

* In the normal male the average number of (RBC) is about 5-6 million/cubic millimeter, in the female it is about 4.5-5 million/cubic millimeter.
* The life span of RBCs is 4 months.
* Mature RBCs are flexible and oval biconcave disks.
* They lack a cell nucleus and most organelles, in order to accommodate maximum space for hemoglobin.
* Erythrocytes function involved:
* 1- Transport oxygen from the lungs to the tissues.
* 2- Transport carbon dioxide from the tissue to the lung.


blood platelet
erythrocytes

*Leukocytes (WBC)

*Leukocytes are colorless because they do not have hemoglobin, however, each cell has a nucleus .

*In the blood stream leukocytes are spherical in shape and capable of amoeboid movement.

*According to the type of cytoplasmic granules and the shape of nuclei leukocytes are classified into:

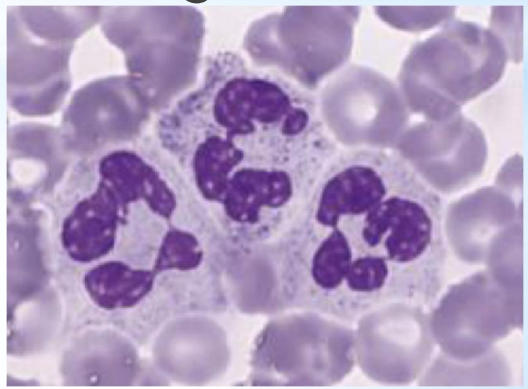
*

*A- Granular leukocytes

* They contain specific granules and lobulated nuclei. This type of leukocytes involved:

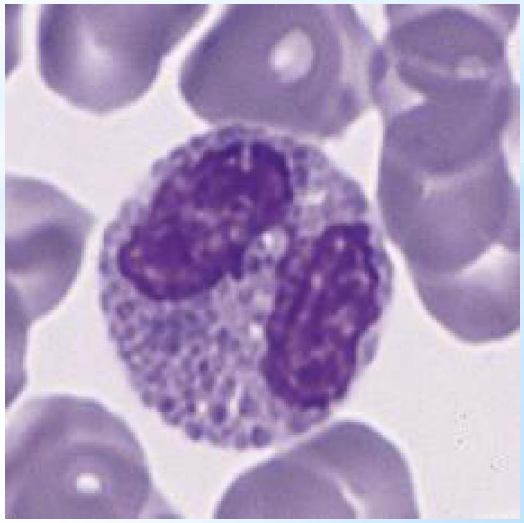
*1- Neutrophils

* **Compose 60 to 70% of the blood leukocytes.**
* **Nuclei have 3-5 lobes, which are connected together by thin strands of chromatin.**
* **Barr body is a drumstick chromosome or condensed chromatin visible in Neutrophils contain all the organelles that make up a typical cell.**
* **The neutrophil cytoplasm contains fine violet or pink granules that are difficult to see with a light microscope. As a result, the cytoplasm appears clear or neutral.**
* **First line of cellular defense against microorganisms, especially bacteria. Phagocytose small particles and microorganisms.**



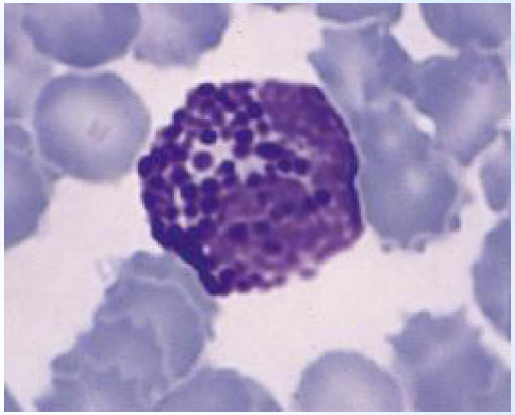
*2- Eosinophils

* Compose 2 to 4% of the blood leukocytes.
* Eosinophils are identified in a blood smear by their cytoplasm, which is filled with distinct, large, eosinophilic (bright pink) granules.
* The nucleus in eosinophils typically is bi lobed, but a small third lobe may be present.
* The cytoplasm granules are stained red or pink with eosin or other similar dyes.
* Recognize and phagocytose antigen-antibody complexes and particles that are associated with these complexes that are formed during an immune response.



*3- Basophils

- The basophils constitute less than 1% of the blood leukocytes and are therefore the most difficult to find and identify in a blood smear.
- The nucleus is bi lobed which hidden by the large cytoplasmic granules.
- The granules in basophils are not as numerous as in eosinophils; however, they are more variable in size, less densely packed, and stain dark blue or brown.
- These cell carry histamine, heparin, and various mediators of inflammation and other protein chemicals.
- Its appear as a site of ectoparasite infection, or allergies.



*B- Non granular leukocytes

*They do not have a specific granule with non-lobulated nuclei. This type can be sub divided into:

*1- Lymphocytes

*Lymphocytes represent 20 to 40% of the differential white cell count.

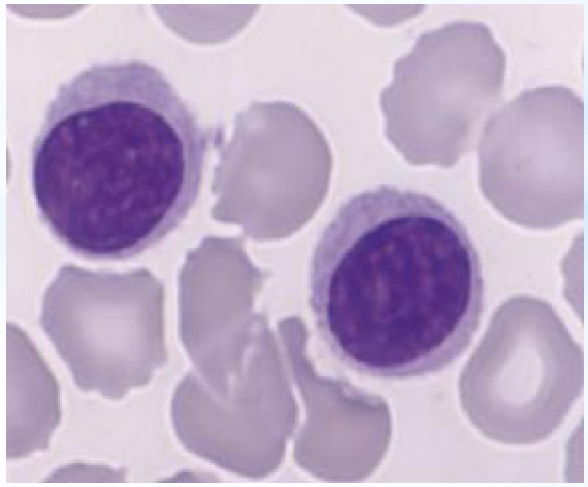
*There are two structural types:

*a- Small lymphocytes:

* ~5µm in diameter, and represent 3% of lymphocytes in peripheral blood. Most small lymphocytes in the blood stream belong to either the group of B-lymphocytes (~5%) or the group of T-lymphocytes (~90%).

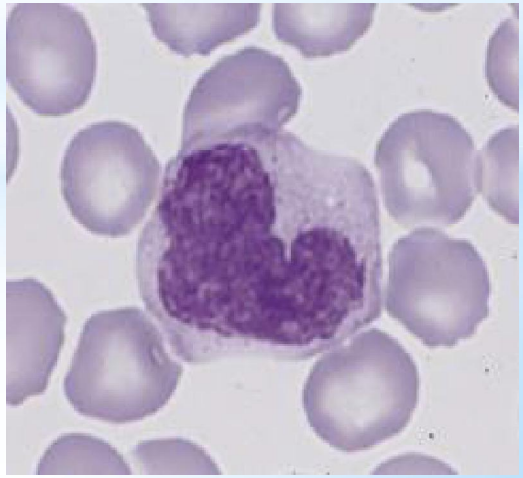
*b- Large lymphocytes:

* 9 to 15µm in diameter, possibly natural killer cells; possibly dividing lymphocytes
* The cell is rounded with densely stained nucleus, small amount of pale basophilic cytoplasm with free ribosomes; short microivilli (seen in EM) more numerous on B lymphocytes than T lymphocytes.
* Only blood lymphocyte capable of division outside of bone marrow.



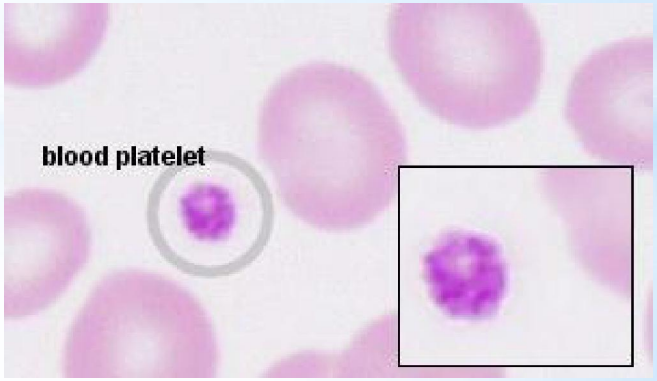
*2- Monocytes

* Monocytes are large cells, 12-18 µm in diameter; represent 2 to 10 % of the differential white cell count.
* Monocytes are highly motile and phagocytic cells; i.e. they are the precursor of tissue phagocytes that migrate into tissues; engulf and destroy tissue debris & foreign material.
* Their nucleus less dense than lymphocytes; deeply indented, C-shaped or kidney shaped.
* Their cytoplasm is pale grayish blue with small pink to purple stained lysosomal granules, and contain cytoplasmic vacuoles (frosted glass).
* Monocytes contain granules (visible in the EM) which are similar to the primary granules of neutrophils, i.e. Lysosomes containing acid phosphatase, aryl granules.
* They contain also secondary granules of unknown function.



*Blood platelets or thrombocytes

* Platelets or thrombocytes are small fragments of cytoplasm measuring about 2-5 µm in diameter.
* Blood platelets do not contain nucleus, they are cytoplasmic fragments of very large thrombocyte (megakaryocytes) that are found in the bone marrow.
* Their number is 150,000 - 400,000/mm3.
* They are rounded or oval, biconvex discs.
* The cytoplasm is divided into two zones: an outer **hyalomere**, and an inner **granulomere**, which contains bluish staining granules.
* The hyalomere contains cytoskeletal fibers, which include actin and myosin.
* Their cytoplasm is purple-staining, granular; organelles concentrated toward center; granules constitute about 20% volume.



*Bone marrow

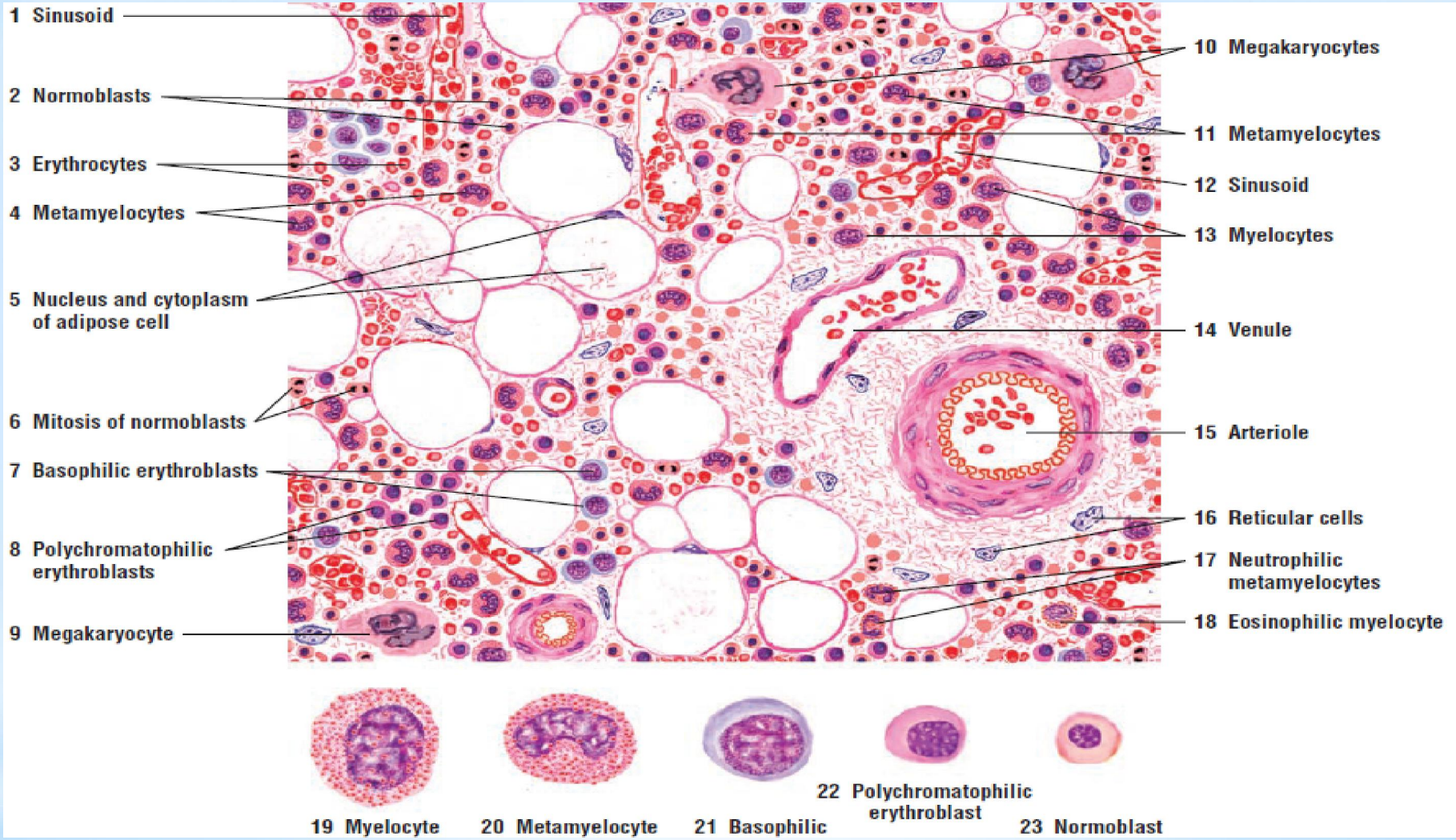
*Bone marrow compose 5% of the total body weight.

*It is responsible for the formation of blood cells (hemopoiesis) and store fat.

*There are two types of bone marrow based on their appearance at gross examination:

1. Red bone marrow.
2. yellow bone marrow.

* From birth to early puberty, the majority of the bone marrow is red marrow.
* As a person grows and matures, increasing amounts of red marrow is replaced by yellow marrow.
* Bone marrow is separated into a vascular section and non-vascular sections.
* The vascular section contains blood vessels that supply the bone with nutrients and transport blood stem cells and mature blood cells away from the bone and into circulation.
* The non-vascular sections of the bone marrow are where hematopoiesis or blood cell formation occurs. This area contains immature blood cells, fat cells, white blood cells (macrophages and plasma cells), and thin, branching fibers of reticular connective tissue.
* While all blood cells are derived from bone marrow, some white blood cells mature in other organs such as the spleen, lymph nodes, and thymus gland.



Development of different blood cells in red bone marrow (decalcified).