



Department of Medical Laboratory Techniques Physiology / Theoretical

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Lecturer 2

Introduction to Hematology

Introduction to Blood Composition

The word of hematology comes from two words, the Greek haima (means blood) and logos (means discourse); therefore, hematology is the science of study blood cells components and coagulation.

What is Blood?

It is a specialized connective tissue, that is a body fluid in humans and other animals, which delivers nutrients and gasses (O₂ and CO₂) to the cells, also transports metabolic waste away from those same cells, it propelled mainly by rhythmic contractions of the heart, within the closed circulatory system.

-Approximately 8% of an adult's body weight is made up of blood.

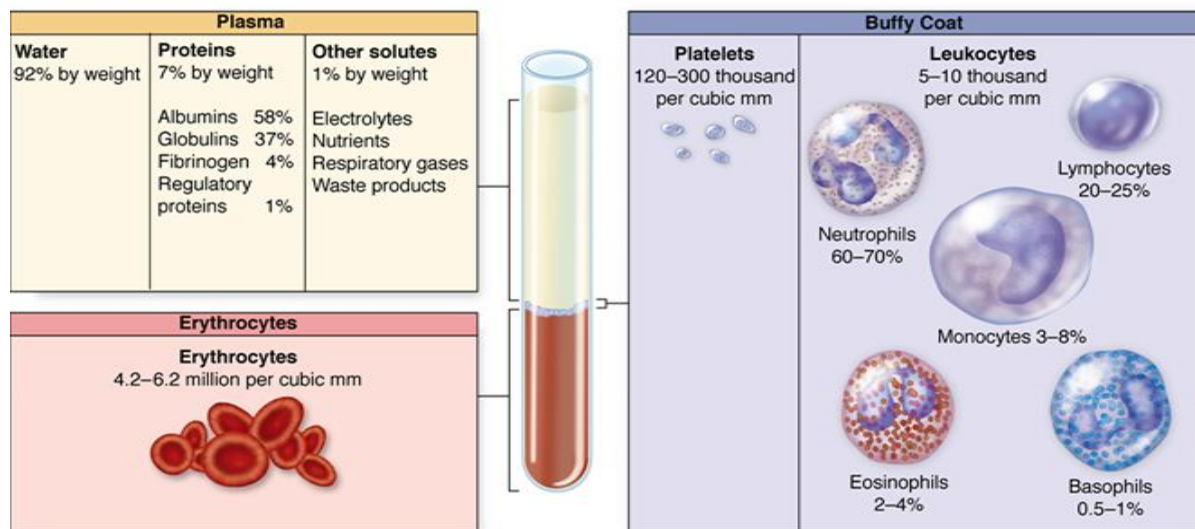
-**Females** have around **4-5** liter's , while **males** have around 5-6 liters.

This difference is mainly due to the differences in body size between men and women.

- It has a pH of 7.35-7.45, making it slightly basic (less than 7 is considered acidic).

- Whole blood is about **4.5-5.5** times as viscous as water, indicating that it is more resistant to flow than water. This viscosity is vital to the function of blood because if blood flows too easily or with too much resistance, it can strain the heart and lead to severe cardiovascular problems.

Blood components: after centrifugation of blood samples with anticoagulant factor: that produce three layers:



- 1- Plasma 55% (**proteins**, water, electrolytes, nutrients and waste)
- 2- Buffy coat <1% contain: platelets and leukocytes (WBC : white blood cell)
- 3- Erythrocytes 44% (RBC : red blood cell) .

But when centrifugation of blood without anticoagulant factors, we are see two layers: serum and blood clot.

Serum is pale yellow fluid of blood which doesn't play any role in clotting, or its plasma of blood without clotting factors, or as blood with all cells and clotting factors removed.

Serum contain all proteins not used in blood clotting; all electrolytes, antibodies, antigens, hormones; and any exogenous substances such as drugs.

Physical features of blood:

1-Color: red because contain **hemoglobin** on RBC surface

2-Temperature: it has same degree of body 37C°

3-Density: which depend on solutes concentration in plasma of blood and cellular concentration (RBC, WBC, platelets) in whole blood.

Normal values of density:

Male: 1.057 --- 1.067 gm /cm³

Female: 1.051 --- 1.061 gm /cm³

4-Viscosity: that result from friction of blood with vessels wall, and depend on proteins concentration (specialized fibrinogen).

Normal values of viscosity: 5-6 times more than water, measure by m²/sec

5-Osmotic pressure: which come from crystals of salts in plasma and it's important to maintain equilibrium between salts and liquid between inside and outside (blood vessels) of cells, osmotic pressure for plasma 5000 --- 5200 mm/hg.

6-Power of hydrogen (PH): blood is alkaline in normal range, artery blood has 7.4, but in vein 7.35, and in cell blood has 7 – 7.2 because CO₂.

7-Volume: 5-6 L in adults (Infants have a larger blood volume in proportion to body weight than adults).

Blood contain plasma, cells and platelets:

1-Plasma: is yellow liquid part of blood which contain cells of blood and configure 55% from blood, have density 1.027 gm/cm³.

Components of plasma:

a-Water: 90%

b-Organic materials: 9% that include:

Proteins (albumin 55%, globulin 38% and fibrinogen 7%) .

Non-protein materials include secretory materials (such as creatinine and uric acid) and nutrition (such as glucose and lipid).

c-Non-organic materials:

includes ions such as (Fe⁺⁺, K, Na, Ca, Mg, Cl⁻ and HCO₃).

2-Cells:

a- Erythrocyte (Red blood cells RBC):

Red blood cells are biconcave discs, they have no nucleus and cytoplasmic organelles. They contain a red coloured protein called hemoglobin. Their 5 main function is in gas transport, mainly of O₂ but they also carry some CO₂.

- Human erythrocytes are 7.5 µm in diameter, 2.6 µm thick at the rim and 0.8 µm thick in the center.
- The biconcave shape increases their surface area for gas exchange, and the thinness of the central portion allows fast entry and exit of gases.
- The cells are flexible so they can squeeze through narrow capillaries.

Normal value of RBC: (number of cell per million in one milliliter of blood sample)

Male: 4.7 – 6.1 million/mil.

Female: 4.2 – 5.4 million/mil.

b- Leucocyte (White blood cells WBC): the normal range of WBC 4000-11000 cell/mm³ include two types:

granular (basophil, neutrophil and acidophil)
and a granular (monocyte and lymphocyte).

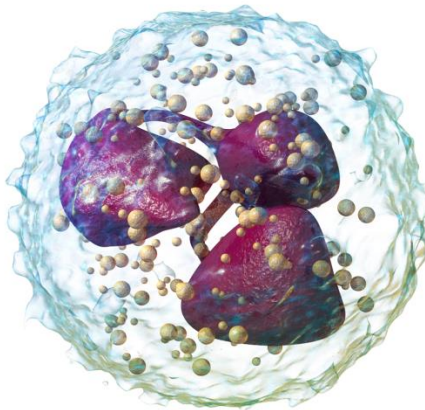
Granulocytes

Neutrophils, basophils, and eosinophils are all granulocytes. These cells also all have azurophilic granules (lysosomes) and specific granules that contain substances unique to each cell's function. Histologically, granulocytes can be distinguished from one another by the morphology of their nucleus, their size, and how their granules stain.

Neutrophils :-

Constitute 60-70% of circulating leukocytes.

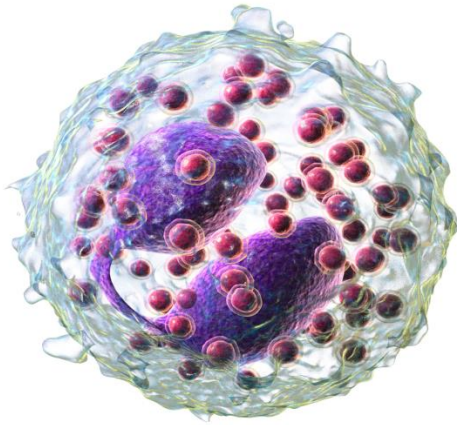
- They are 12-15 μm in diameter with nucleus consisting of 2-5 lobes.
- Neutrophils have short half-life 6-7 hours in blood and 1-4 days in the tissues.
- Neutrophils have phagocytic activity against bacteria and other small particles.
 - During phagocytosis, superoxide (O_2^-) and hydrogen peroxide (H_2O_2) are formed that kill microorganisms.
 - Myeloperoxidase with O_2^- form a powerful killing system.



Eosinophils

Eosinophils constitute 2-4% of leukocytes in normal blood.

- Life span in circulation is about 10 hours and 10 days in tissues.
- These cells have bi lobed nucleus.
- The cytoplasm of eosinophil contains large granules that are stained by eosin. The granules contain many types of enzymes e.g. *peroxidase*, *RNAase*, *phospholipase*, and others, additionally the granules contain a protein called the **major basic protein**. **This protein has ability to kill parasitic worm.**
- An increase in the number of eosinophils in the blood is associated with **allergic reaction** and **parasitic infection**.

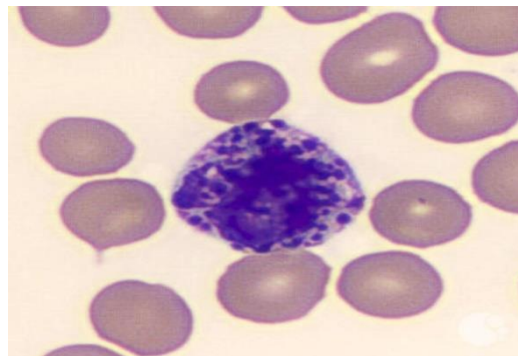
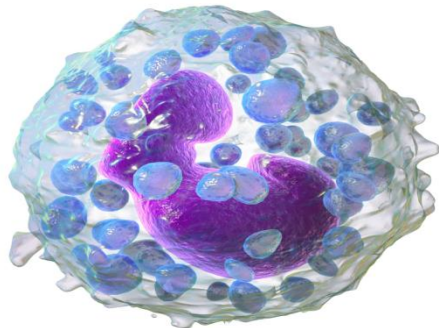


Basophils

Basophils make up less than 1% of blood leukocytes.

- There are about 12-15 μm .
- The nucleus is divided into irregular lobes or S shaped.
- The cytoplasm contains very large granules that are stained with basic dye.
- The granules contain mainly **histamine** and **heparin**.

These cells play an important role in the **allergy**



2- A granulocytes

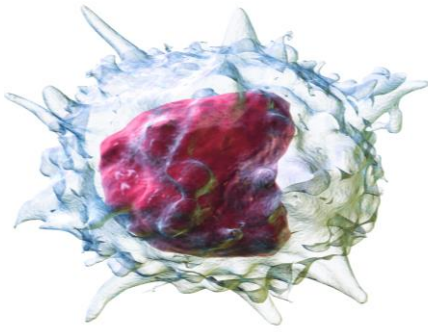
A granulocytes consist of lymphocytes and monocytes:-

A-Monocytes

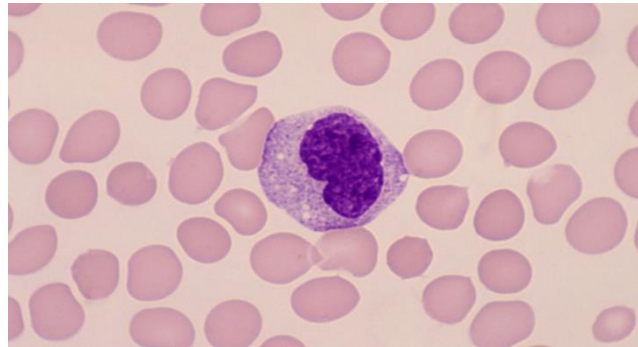
These are the largest of the white blood cells.

- The nucleus is horseshoe- or kidney-shaped.
- The cytoplasm of monocyte is basophilic and contains very fine azurophilic granules (lysosomes).
- Blood monocytes migrate into the tissues and develop into macrophages.
- Macrophages engulf large particles and pathogens (large cell eater).

- The life span in the circulation is few days but 60-120 days in the tissues.
- They account 4-11%
- The main function monocyte is phagocytosis but also has ability to secret certain substances like interleukins e.g. interleukin 1 (IL-1).
- Macrophages have important functions in inflammation and immunity



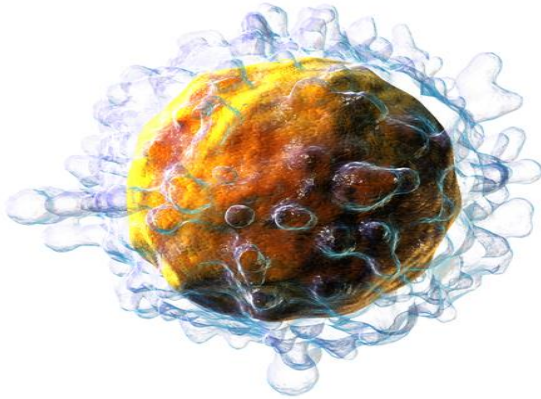
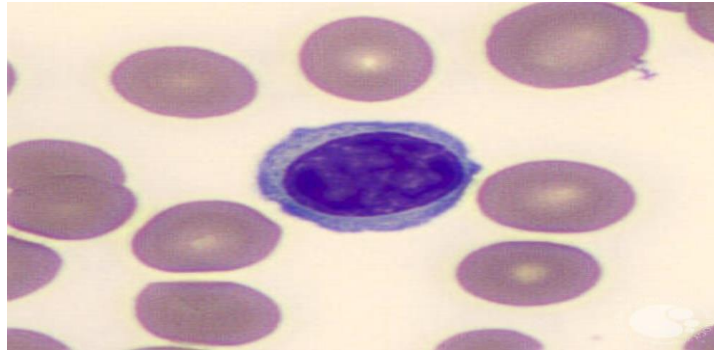
Monocyte



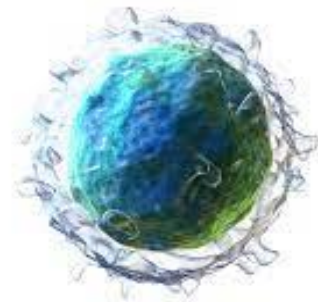
B- Lymphocytes

Lymphocytes are spherical cells

- There are small lymphocytes with diameter of 6-8 μm and large lymphocytes with diameter up to 18 μm .
- The nucleus of lymphocyte are large and rounded.
- The cytoplasm of the small lymphocytes is scanty and in blood smear it appears as a thin rim rounded the nucleus. And it is slightly basophilic.
- Lymphocytes vary in life span; some live only a few days and other survive for many years.
- Lymphocytes are classified according to their function to; B lymphocyte, T lymphocyte, and Natural Killer cell.
- All types of lymphocytes are related to immune reactions in defending against invading microorganisms, foreign macromolecules, and cancer cells.



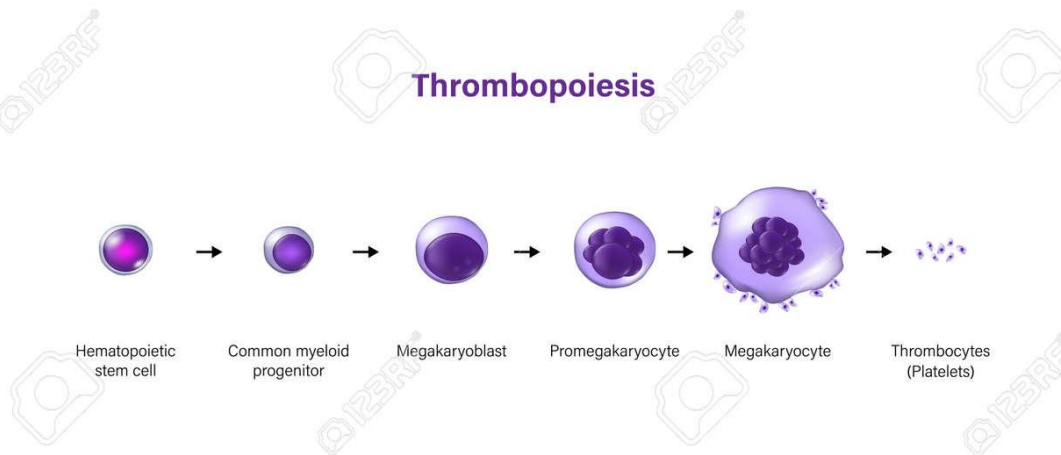
Lymphocyte
T cell



Lymphocyte
B cell

Thrombocytes (Platelets)

- Blood platelets are non-nucleated disc like cell fragments 2-4 μm in diameter. Platelets are not true cells. They originate from fragments of megakaryocyte cytoplasm that reside in the red bone marrow.
 - Each platelet has a peripheral light blue stain transparent zone the hyalomere and a central zone containing granules called the granulomere.
 - Platelets granules contain calcium ions, ADP, ATP, serotonin, pyrophosphate, hydrolytic enzymes, P- selectin, fibrinogen, platelet-derived growth factor, coagulation factor V and XIII and other substances.
 - Platelets are very sticky so appear under light microscope as clumps of cells.
 - Platelets promote blood clotting and help repair gaps in the walls of blood vessels, preventing loss of blood.
 - Normal platelets counts range from 200,000- 400000 per microliter of blood.
- Thrombopoietin** released by kidneys has ability to stimulate platelets synthesis.
- Platelets have a life span of about **10 days**.



Functions of blood:

- 1- Respiratory: transport O₂ from lungs tissues to all cells of body by artery, also transport CO₂ from body cells to lungs.
- 2- Nutritive: also blood transport nutrition from digestive system to cells and deliver metabolic wastes to decretory organs.
- 3- Regulation of body temperature: distributed heating energy in all body by movement in all blood vessels.
- 4- Regulation of metabolism: by transport hormones from manufactured place to all body cells that regulated catabolism and anabolism.
- 5- Defenses: this function specialized for WBC, which have ability to engulfs microbes, also blood contain important antibodies against antigen.
- 6- Water balances: transport and excretion high amount of water from kidney and urinary tract.
- 7- Buffering: regulate concentration of hydrogen ions, by contain specific components for process.