Theoretical Physiology

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Lecture 4 , 5 **M.Sc. Awham Kareem**

First Stage

***Blood Cells**

***Blood Groups System**

*Red Blood Cells RBCs (Erythrocytes)

Are the non nucleated formed elements in the blood . The cytoplasm of RBCs contains a special pigmented protein called the hemoglobin.

Hemoglobin is captures O2 molecules as the blood moves through the lungs.

RBCs make up almost 45% of the blood volume.

Average lifespan of RBCs is about 120 days. Destroyed in reticuloendothelial system.

The function of RBCs is carry O2 from the lungs to body tissues and to transfer CO2 from tissues to the lungs.

The Life Cycle Of Red Blood Cells

Hematopoiesis involves three stages the Production, Maturation and Destruction of blood cells.

In the adult all new cells arise from Bone marrow (stem cells). With a rate of 2.5 million RBCs/sec. old RBCs removed from blood by phagocytic cells in liver, spleen and bone marrow. iron of the destroyed RBC's recycled back into hemoglobin production.

Infant and newborn RBCs formed in yolk sac, spleen ,liver and lymph nodes .

In adult RBCs formed by bone marrow.

Stage of Erythropoiesis

1.Proerythroblast: is the earliest recognizable cell of the erythroid series seen in the red bone marrow with size of 15-20 µm . it contains a large nucleus but doesn't have hemoglobin.

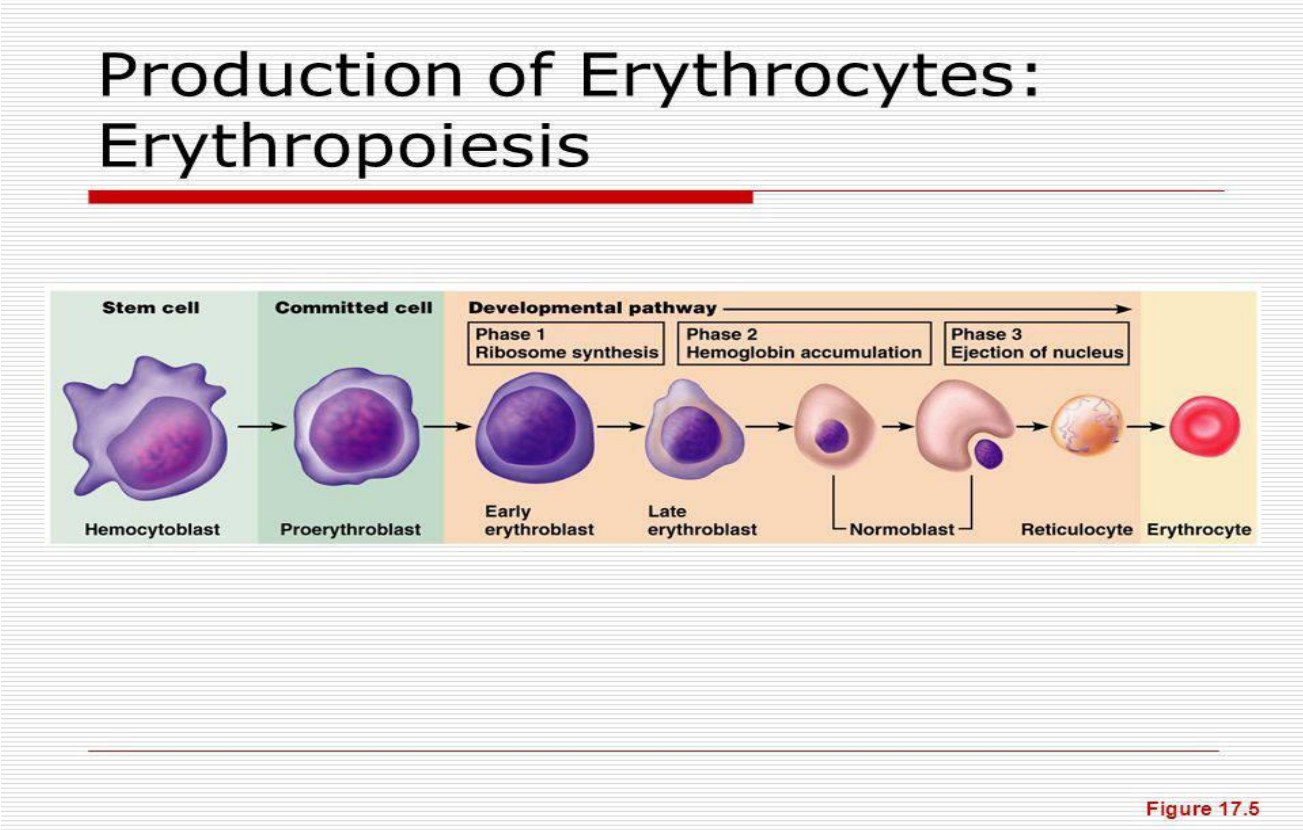
2. Early normoblast: Size is large with a diameter of 12-16 um. cytoplasm is basophilic. The nucleus here disappears .

3. Intermediate normoblas: Size is about 10-14 um, cytoplasm becomes polychromatic with nucleoli and hemoglobin .

4.Late normoblast: is the last nucleated cell of the erythroid series. Size is 8-10 um. Cytoplasm is acidophilic with a small nucleus and hemoglobin.

5.Reticulocyte it is also called young red cell. It is a flat, disc-shaped, Size is 7-7.5 um, cytoplasm contains small amounts of RNA. Nucleus is absent.

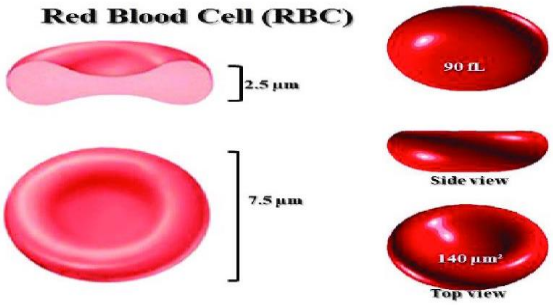
6. Matured erythrocyte: Reticular network disappears and the cell becomes the matured RBC and attains the biconcave shape. The matured RBC is with hemoglobin but without nucleus It requires 7 days for the development and maturation of RBC from proerythroblast.

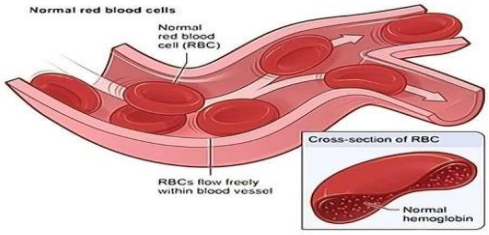


Structure of Red Blood Cells

Normal Shape Normally, the RBCs are disk shaped. Central portion is thinner and periphery is thicker. The shape helps RBCs in equal and rapid diffusion of oxygen and other substances , also while passing through minute capillaries.

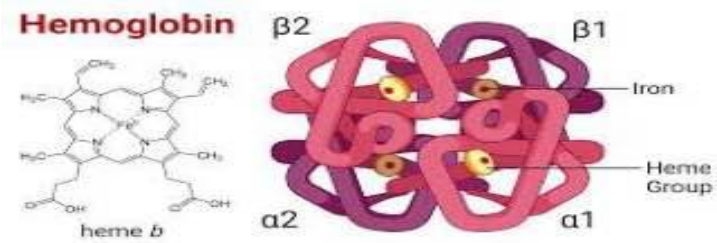
Erythrocytes do not have a nucleus or any other intracellular organelles.





Hemoglobin (Hb) is large, complex molecule containing a globular protein (globin) and a pigmented iron-containing complex called heme.

Each hemoglobin molecule contains four globin chains and four heme units, each with one atom of iron.



Types of Hemoglobin in the Blood human

1. Type A 1.. in adult (commune type)
2. Type A2.. 1in adult
3. Type F….. in newborn

The factor Effecting on Hb Value

Age

At birth:25 g/dL, after 3rd month:20 g/dL..after 1 year: 17 g/dL.20 :

From puberty onwards : 14 to 16 g/dL.

. • At the time of birth, hemoglobin content is very high because of increased number of RBCs.

Sex

In adult males: 15 g/dl In adult females: 14.5 g/dL.

White Blood Cells WBCs (leukocytes)

Its part from the immune system that are involved in protecting the body against both infectious disease and foreign invaders.

WBCs are colorless and nucleated formed elements of blood, which distinguishes them from the a nucleated red blood cells and

All the WBCs are able to move like an amoeba, and can migrate out of blood vessels into the surrounding tissues.

*Lifespan of WBCs is not constant. It depends upon the demand in the body and their function. Lifespan of these cells may be as short as half a day or it may be as long as 3 to 6 months, after which time they are destroyed in the lymphatic system.

*The differences between WBCs and RBCs are Larger in size, Irregular in shape, nucleated, Many types, Granules are present in some type of WBCs and Lifespan is shorter.

Types of WBCs (leukocytes)

1.**Agranulocytes** (which do not have granules)

*__Monocytes__.. **1**.are largest leukocyte and form about 2 to10% of WBCs **2.**cytoplasm is without granules **3**.nucleus oval or horseshoe **4**.(chronic infection)

* __Lymphocytes__ ..**1**. making up about 20 to 50 % of WBCs **2**.cytoplasm without granules **3**. nucleus occupied whole of the cytoplasm **4**.there are two types of lymphocytes T Cells and B Cells **5.**(viral infection)

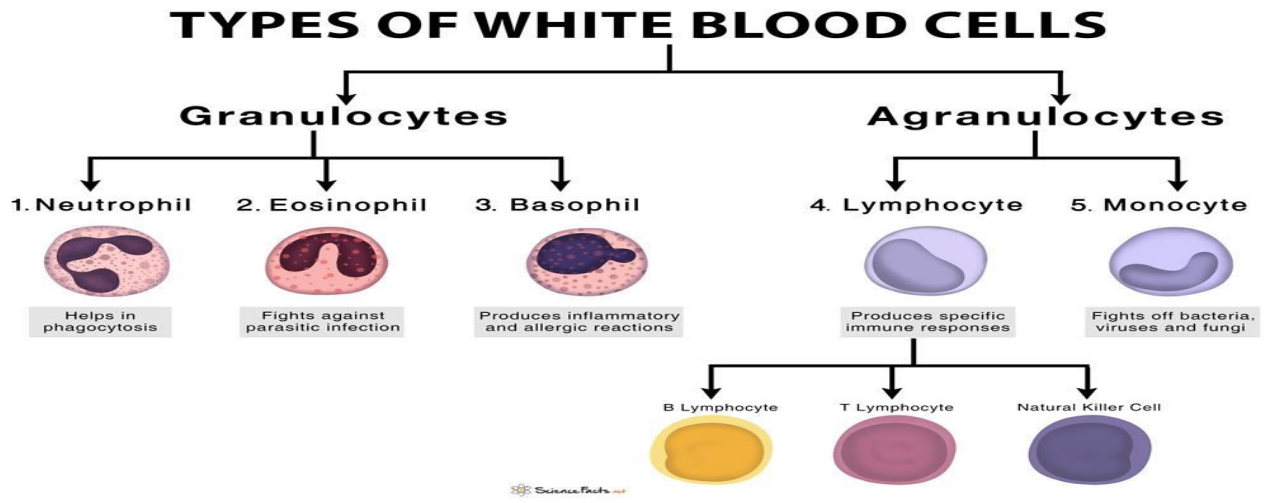
2.**granulocytes** (which have granules)

*__Neutrophils__..**1**.making up 60 to 70% of WBCs **2**. cytoplasm contain of granules which take acidic and basic stains(Leishman stain) **3**.nucleus is multilobed 2 to5 lobes depend of the age of cell **4**.(bacterial infection)

*__Eosinophils__ ..**1**.Its have large granules taking acidic stain(appear pink or red under microscope with staining) **2**.make up 1 to 2 of total White blood cells **3**.nucleus is double lobed(u shape)**4**.(Parasitic infection)

* __Basophils__ **1**.It have coarse granules taking basic stain (appear purple blue by methylene blue) **2**.nucleus has two lobes

3.making up 1% of all WBCs **4**. (Allergic infection)



Normal Cell Blood White Count

Age Group	Total WBC count
Adults	4000–11,000/mm^3 of blood
At birth, in full-term infant	10,000–25,000/mm^3 of blood
Infants up to 1 year of age	6000–16,000/mm^3 of blood
Children, 4–7 years of age	5000–15,000/mm^3 of blood
Children, 8–12 years of age	4500–13,500/mm^3 of blood

The Increase in total WBC count called Leukocytosis occurs in both physiological and pathological conditions.

The decrease in total WBC count called Leukopenia. The term leukopenia is generally used for pathological conditions only.

Platelets (Thrombocytes)

Platelets are called thrombocytes because they are involved in the blood clotting process, which is necessary for wound healing, and stop or prevent bleeding. Average lifespan of platelets is 10 days. It varies between 8 and 11 days.

Platelets are destroyed by tissue macrophage system in spleen, so splenomegaly (enlargement of spleen) decreases platelet count and splenectomy (removal of spleen) increases platelet count.

Leishman staining shows a platelet consists of a faint bluish cytoplasm containing reddish-purple granules.

Structure of platelets

1.Cell membrane or surface membrane

Each platelet is enclosed in a 6 nm thick trilaminar membrane identical to plasma membrane of tissue cells. It consists of lipids [phospholipids (plays an activating role at several points in the blood clotting process), cholesterol and glycolipids],carbohydrates, proteins and glycoproteins (prevent the adherence of platelets to normal endothelium, but accelerate the adherence of platelets to collagen and damaged endothelium in ruptured blood vessels).

2.Microtubules

Microtubules are made up of polymerized proteins called tubulins. These form a compact package that is present immediately under the platelet membrane and encircles the whole cytoplasm. These are responsible for the maintenance of the discoid shape of circulating platelets.

3.Cytoplasm

have all organelles .It has two types of granules are dense granules contain substances (like: phospholipids, triglycerides, cholesterol) ATP, ADP and serotonin, and Alpha granules contain secreted proteins such as clotting factors and platelet-derived growth factor (PDGF).

Platelets of properties

Platelets have three important properties.

1.Adhesiveness: the property of sticking to a rough surface.

2.Aggregation: by substances released from dense granules of platelets

3.Agglutination: the clumping together of platelets.

Functions of Platelets

1.Platelets are responsible for activating prothrombin which important for blood clotting.

2.Play important role in prevention of blood loss (hemostasis)

3.Platelets are useful for the repair of the endothelium and the ruptured blood vessels.

4.Play role in defense mechanism by the property of agglutination

Normal count of platelets

Normal platelet count is 250,000/cu mm of blood. It ranges between 200,000 and 400,000/cu mm of blood.

Decrease in the number of platelets below 150,000 µL is called **thrombocytopenia.**

Increase in the number of platelets below 450,000 µL is called **thrombocytosis**.

Hemostasis.. refers to spontaneous stop or prevention of bleeding from injured/ damaged vessels by the physiological process. The process of hemostasis is initiated

immediately after an injury/damage to the blood vessel. It involves three main steps:

1.Vasoconstriction

Immediately after injury, the blood vessel constricts and decreases blood loss from the damaged portion. When the blood vessels are cut, the endothelium is damaged and the collagen is exposed.

Platelets adhere to this collagen and get activated. The activated platelets secrete serotonin and other vasoconstrictor substances which cause constriction of the blood vessels.

Adherence of platelets to the collagen is accelerated by von Willebrand factor. This factor acts as a bridge between a specific glycoprotein present on the surface of platelet and collagen fibrils.

2.Platelets plug formation

Platelets get adhered to the collagen of the ruptured blood vessel and secrete adenosine diphosphate (ADP) and thromboxane A2. These two substances attract more and more platelets and activate them.

All these platelets aggregate together and form a loose temporary platelet plug or temporary hemostatic plug,

which closes the ruptured vessel and prevents further blood loss. Platelet aggregation is accelerated by the platelet-activating factor (PAF).

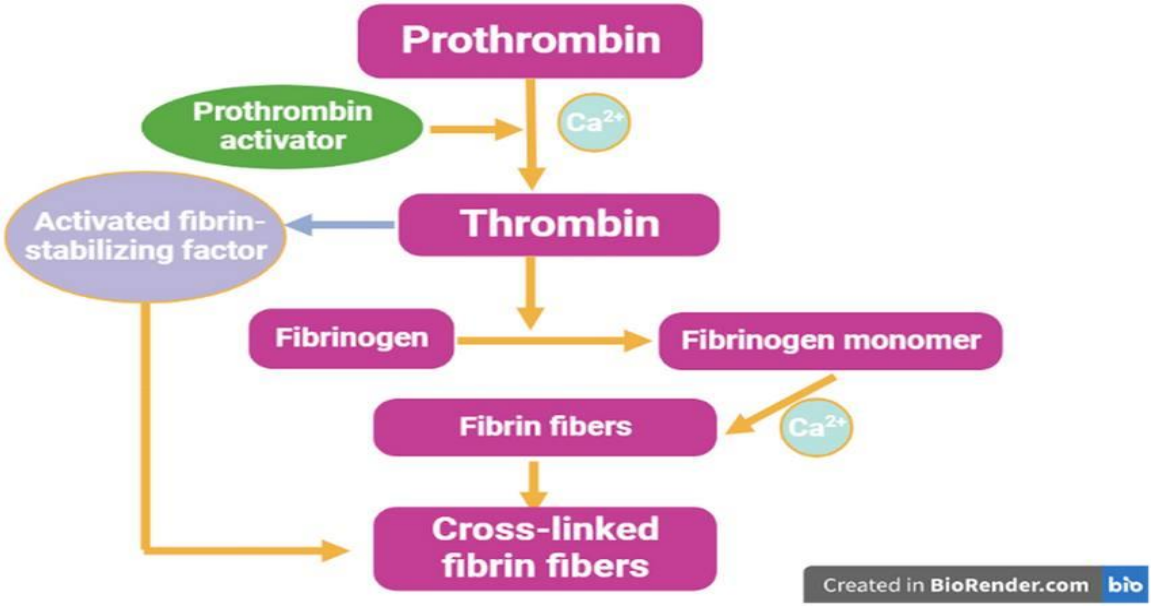
3.Coagulation of blood

Coagulation or clotting is defined as the process in which blood loses its fluidity and becomes a jelly-like mass.

✓ The temporary platelet plug is converted into the definitive hemostatic plug by the process of clot formation (blood coagulation), which involves a complex series of events. Platelets play an important role in the formation of the intrinsic prothrombin activator which is responsible for initiating the process of clot formation.

✓Once the platelet plug has been formed by the platelets, the clotting factors (including calcium ion (Ca2), several enzymes that are synthesized by liver cells and released into the bloodstream)

are activated in a sequence of events known as ‘coagulation cascade’ which leads to the formation of fibrin from inactive fibrinogen plasma protein. Thus, a Fibrin mesh is produced all around the platelet plug to hold it in place.



System Groups Blood

The world Karl Landsteiner discovered two blood group systems called the ABO system and the Rh system. These two blood group systems are the most important ones that are determined before blood transfusions.

Determination of ABO blood groups depends on the immunological reaction between antigen and antibody. Landsteiner found two antigens on the surface of RBCs and named them as A antigen and B antigen. These antigens are also called agglutinogen because of their capacity to cause agglutination of RBCs.

Landsteiner noticed the corresponding antibodies or agglutinins in the plasma and named them anti-A or A-antibody and anti-B or B-

antibody) However, a particular agglutinogen (antigen) and the corresponding agglutinin (antibody) cannot be present together.

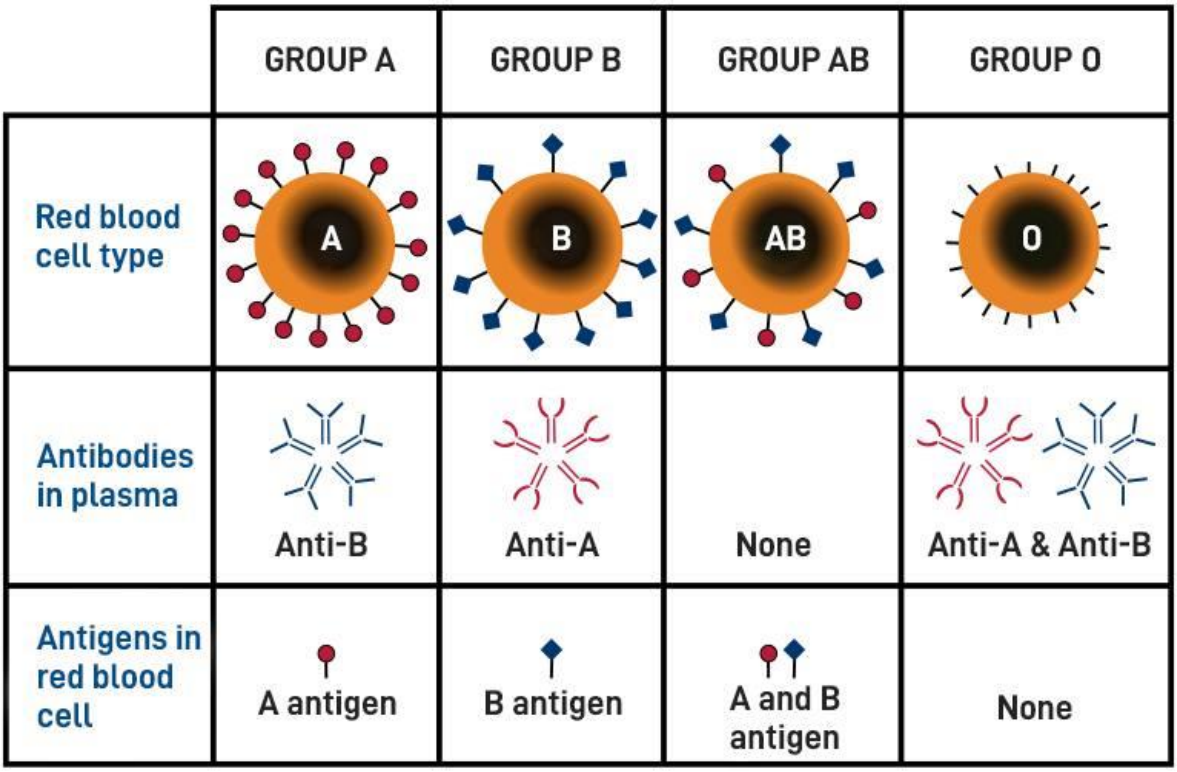
If present, it causes clumping of the blood. Based on this, Karl Landsteiner classified the blood groups into four groups:

1.Blood group A-has A antigens on the red blood cells with anti-B antibodies plasma. there are two types of it A positive or A Negative Depends on Antigen D

2.Blood group B-has A antigens on the red blood cells with anti-A antibodies plasma. there are two types of it B positive or B Negative Depends on Antigen D

3.Blood group AB -has A antigens on the red blood cells without (don't have) antibodies plasma. (general Recipient) there are two types of it AB positive or AB Negative Depends on Antigen D

4.Blood group O-has A antigens on the red blood cells with anti-AB antibodies plasma.(General Donor) there are two types of it O positive or O Negative Depends on Antigen D



RH System

RH4 The surface of Red blood cells sometimes have another antigen, is an inherited protein known as the Rh (D) antigen. If this is present, blood group is Rh (D) positive. If it's absent, blood group is Rh (D) negative.

✓Rh-positive or Rh negative Rh-positive is much more common than Rh-negative. Having an Rh-negative blood type is not an illness, and it usually does not affect

the health but it can affect pregnancy. The pregnancy needs special care if Rh-negative and the baby is Rh-positive that's called Rh incompatibility (The mother's body makes antibodies against the fetal blood cells. These antibodies may cross back through the placenta into the developing baby. They destroy the baby's circulating red blood cells)

✓ A baby can inherit the Rh factor from either