Biomedical Engineering Department
Title of the lecture4,5 :- Erythrocytes
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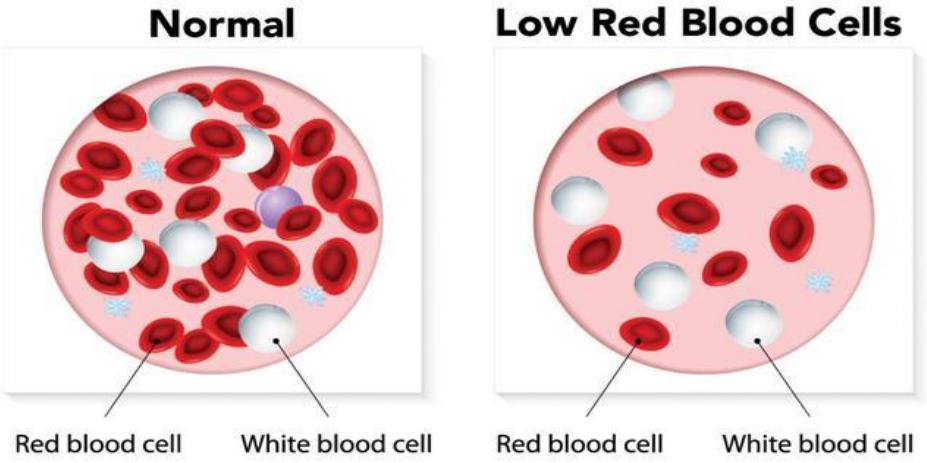
RED BLOOD CELLS (Erythrocytes)

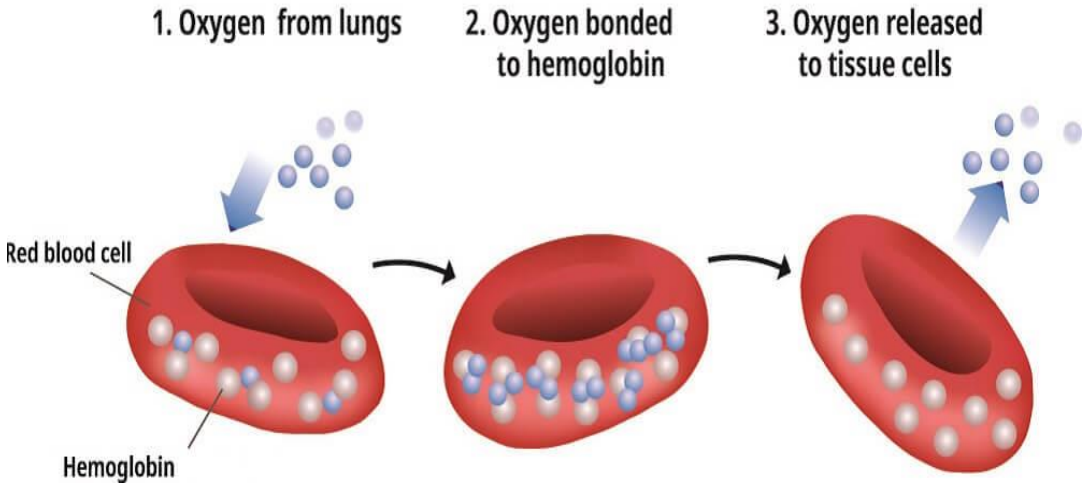
RBC, hemoglobin, erythropoiesis, anemia



Introduction:

- Red blood cells (also known as erythrocytes) are the most abundant blood cells in comparison to white blood cells.
- They are red in color due to the presence of hemoglobin which is known as red characteristic pigment.
- Their life span in circulation is about 120 days.
- Red blood cells (RBC) are made in the bone marrow and contain hemoglobin, a protein that carries oxygen to the tissues in the body.
- A red blood cell (RBC) count measures the number of red blood cells, also known as erythrocytes .This test is most often done as part of a complete blood count (CBC) that also measures other types of blood cells. Red blood cells carry oxygen from lungs to every cell in body. cells need oxygen to grow, reproduce, and stay

healthy. An RBC count that is higher or lower than normal is often the first sign of an illness.



- single drop of blood contains millions of erythrocytes and just thousands of leukocytes. Specifically, males have about 5.4 million erythrocytes per microliter of blood, and females have approximately 4.8 million.

•Abnormal decrease in RBC count is called anemia

Function:

• They are playing a vital role in transport of respiratory gases (oxygen and carbon dioxide) due to the presence of hemoglobin as a major constituent of red blood cell.

•Buffering Action in Blood: hemoglobin functions as a good buffer. It is playing an important role in acid base balance.

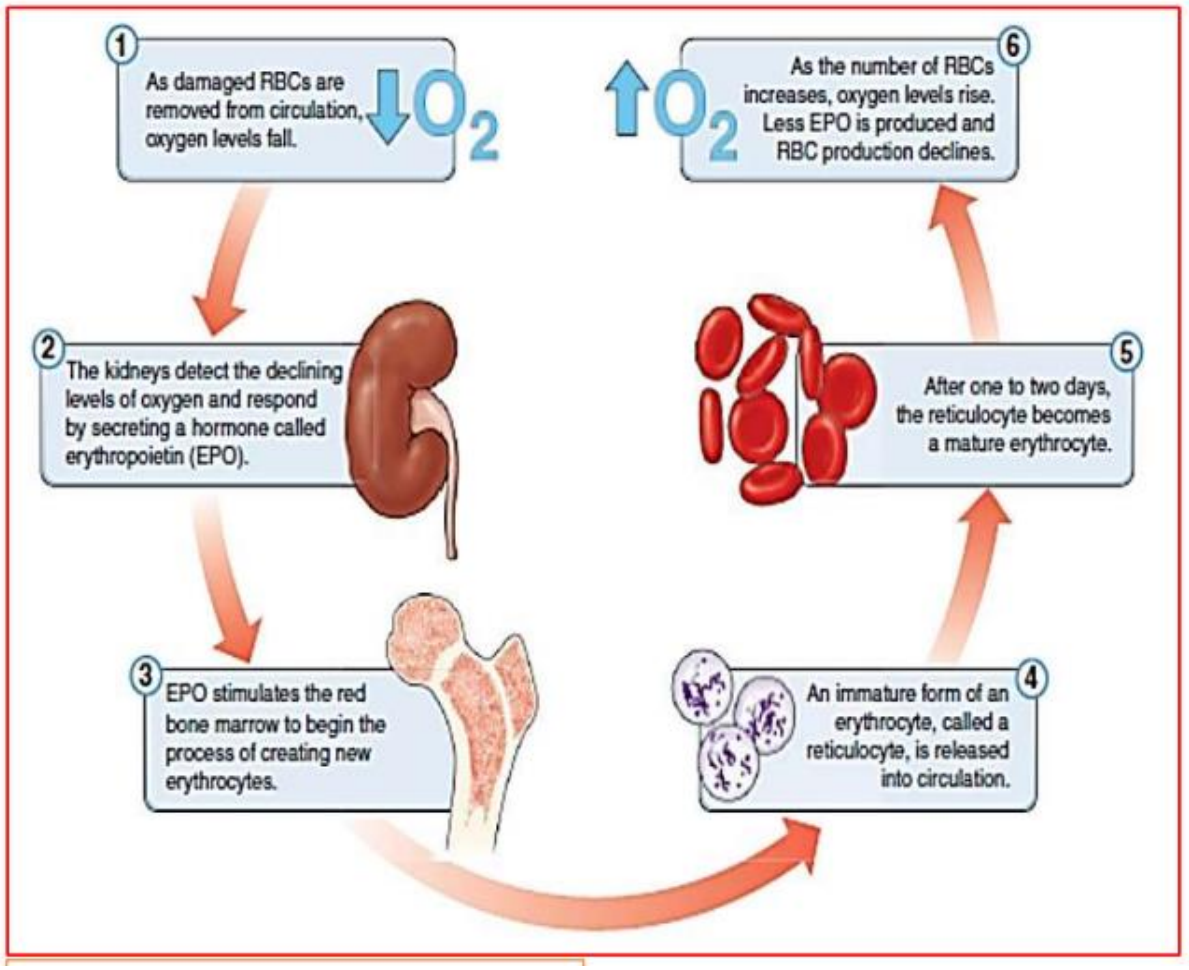
• In Blood Group Determination: RBCs carry the blood group antigens like A antigen, B antigen and Rh factor. This helps in determination of blood group and enables to prevent reactions due to incompatible blood transfusion.

Synthesis of RBC

Production of red blood cells (erythropoiesis)

Erythropoiesis is the process which produces erythrocytes, which is the development from erythropoietic stem cell to mature red blood cell. Within the bone marrow the red cell is derived from erythroblast, a nucleated cell in which there is no hemoglobin. Proliferation occurs as a result of several successive cell divisions.

During maturation, hemoglobin appears in the cell, and the nucleus become smaller. After a few days the cell loses its nucleus and is then introduced into the bloodstream.



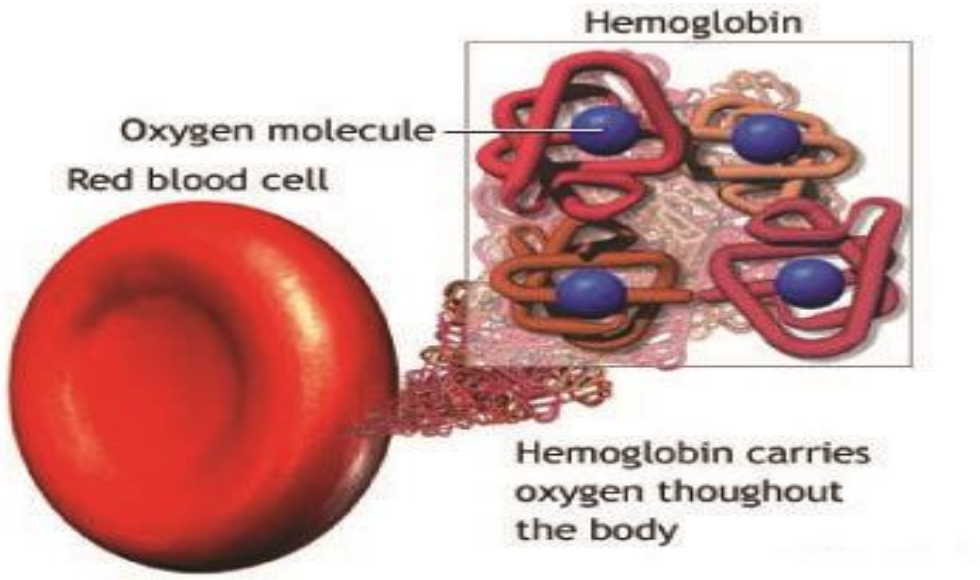
Red Blood Cell Erythropoiesis

- The process of RBC development from stem cells takes about 7 days and is called erythropoiesis.

- The hormone erythropoietin and substances such as iron, folic acid, and vitamin B12 are essential for the production of erythrocytes.

- Erythropoietin hormone is a glycoprotein hormone produced in the kidneys and stimulates the production of globin (the protein component of Hb). Hypoxia is the stimulant for the secretion of erythropoietin.

Hemoglobin



Hemoglobin is a characteristic red pigment of red blood cells

❖ FUNCTION OF HEMOGLOBIN

It is carrying the respiratory gases, oxygen and carbon dioxide.

➢ Oxygen from the lungs to tissues (oxyhemoglobin).

➢ Carbon dioxide from tissues to lungs (carbhemoglobin).

• One molecule of hemoglobin transports four molecules of oxygen.

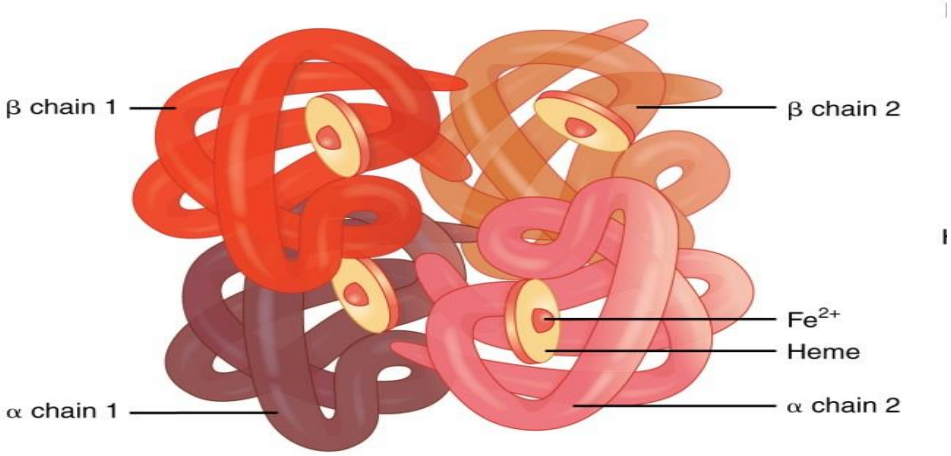
• There are approximately 250 million hemoglobin molecules in one red blood cell.

• One red blood cell transport 1 billion molecules of oxygen.

• At the capillary end the hemoglobin releases the oxygen molecule into the interstitial fluid, which is then transported into the cells.

• It also acts as a buffer. It is playing an important role in acid base balance.

It consists of four folded chains of a protein called **globin**, designated alpha 1 and 2, and beta 1 and 2. Each of these globin molecules is bound to a red pigment molecule called **heme**, which contains an ion of iron (Fe^{2+})



(a)

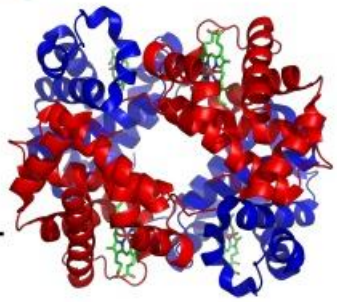
In the lungs, hemoglobin picks up oxygen, which binds to the iron ions, forming **oxyhemoglobin**. The bright red, oxygenated hemoglobin travels to the body tissues, where it releases some of the oxygen molecules, becoming darker red **deoxyhemoglobin**, back to the lungs, where it releases it for exchange of oxygen.

Changes in the levels of RBCs can have significant effects on the body's ability to effectively deliver oxygen to the tissues. Ineffective hematopoiesis results in insufficient numbers of RBCs and results in one of several forms of anemia. An overproduction of RBCs produces a condition called polycythemia.

Lab investigations

↓ hemoglobin

- Men: 13.8 to 18.2 g/dL
- Women: 12.1 to 15.1 g/dL
- Children: 11 to 16 g/dL
- Pregnant women: 11 to 12 g/dL



DISORDERS OF ERYTHROCYTES

The size, shape, and number of erythrocytes, and the number of hemoglobin molecules can have a major impact on a person's health. When the number of RBCs or hemoglobin is deficient, the general condition is called **anemia**. Anemia can be broken down into three major groups: those caused by **blood loss**, those caused by **decreased RBC production**, and those caused by **excessive destruction of RBCs**.

A common test is the mean corpuscular volume (MCV), which measures size RBC . Normal-sized cells are referred to as normocytic, smaller-than-normal cells are referred to as microcytic, and larger-than-normal cells are referred to as macrocytic.

ANEMIA :is a reduction in the number of RBCs, the quantity of hemoglobin, or the volume of RBCs

 Symptoms of anemia

- Loss of energy
- Fatigue
- Weakness
- Difficulty in concentration
- Headache or dizziness
- Rapid heart rate (Tachycardia)
- Joint pain
- Pale skin

Types Of Anemia

*Iron deficiency anemia

*Megaloplastic anemia

*Hemolytic anemia

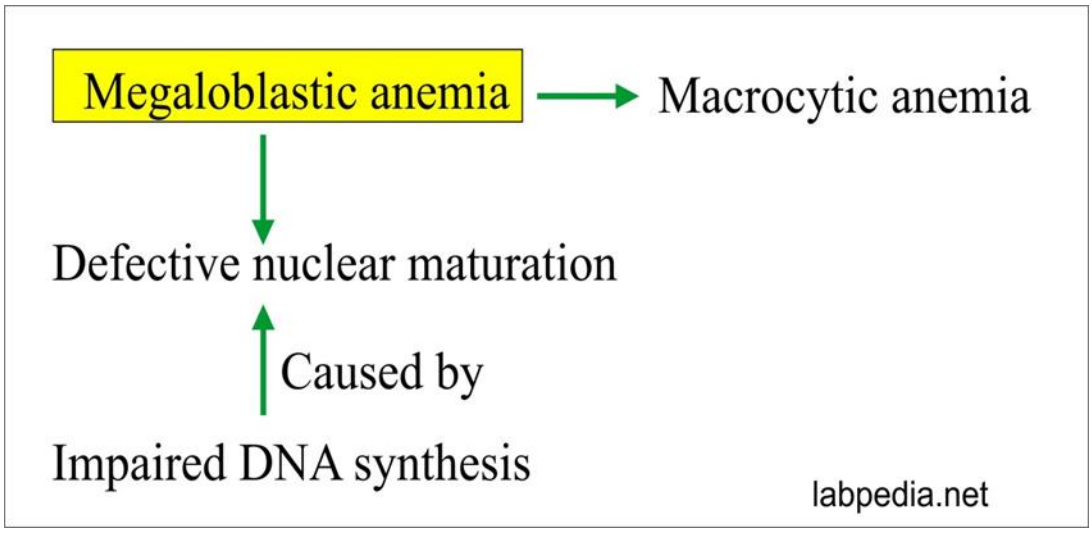
*aplastic anemia

IRON DEFICIENCY ANEMIA (Microcytic anemia)

Anemia is a decrease in hemoglobin, the molecule that carries oxygen in red blood cells and supplies this oxygen to our brains and tissues. Iron is necessary for the creation of hemoglobin, and iron deficiency anemia is the most common human anemia. As iron levels decrease (most commonly from blood loss, such as menses, or from an iron-poor diet), red blood cells become smaller and less able to carry oxygen to the tissues of the body.

Megaloblastic anemia (Macrocytic anemia) is characterized by red blood cells that are larger than normal. Because the cells are too large, they may not be able to way out the bone marrow to enter the bloodstream and deliver oxygen.

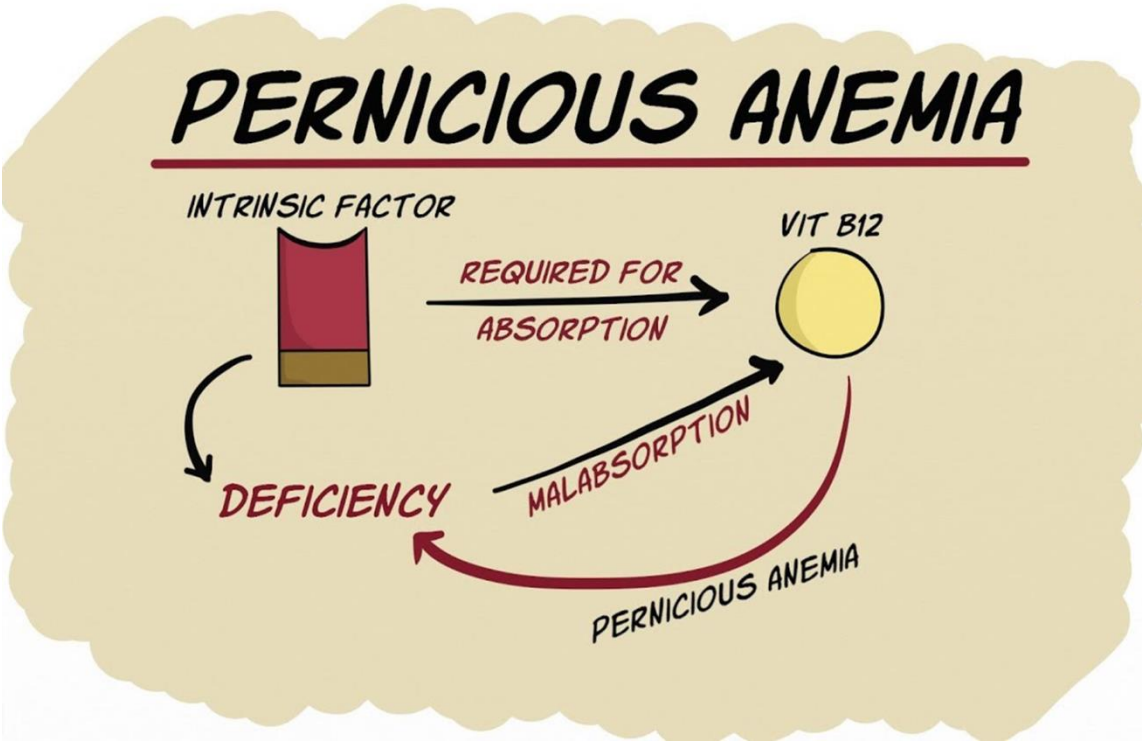
Megaloblastic anemia results from inhibition of DNA synthesis during red blood cell production. When DNA synthesis is impaired, the cell cycle cannot progress through the cell cycle properly, leading to cell growth without division, which presents as macrocytosis



Causes of Megaloblastic Anemia

The two most common causes of megaloblastic anemia are deficiencies of **vitamin B-12 or folate**. These two nutrients are necessary for producing healthy red blood cells. When don't get enough of them, it affects the makeup of red blood cells. This leads to cells that don't divide and reproduce the way they should.

Megaloblastic anemia caused by vitamin B-12 deficiency is referred to as pernicious anemia.


PERNICIOUS ANEMIA
INTRINSIC FACTOR
VIT B12
REQUIRED FOR
ABSORPTION
DEFICIENCY
MALABSORPTION
PERNICIOUS ANEMIA

Folate Deficiency and Anemia