HUMAN ANATOMY AND PHYSIOLOGY-I

HAEMOPOIESIS

Haemopoiesis or hematopoiesis is the process of origin, development and maturation of all the blood cells.

- Erythropoiesis is the process of the origin, development and maturation of erythrocytes.
- Leucopoiesis is the process of the origin, development and maturation of leucocytes.
- Thrombopoiesis is the process of the origin, development and maturation of platelets.

Site of hemopoiesis:

In the first two months of gestation, the yolk sac is the main site of haem**o**poiesis

From third month of gestation,liver and spleen become the main site of blood formation

At birth haemopoiesis occurs in the bone marrow

In young children,active haemopoietic bone marrow is found in both axial skeleton and bones of extremities

In adults bone marrow is confined to axial skeleton and proximal ends of bones

SITE OF ERYTHROPOIESIS:

The red blood cells are derived from pluripotent stem cells

STAGES:

1.Pronormoblast:

It is the earliest recognizable cell of erythroid series seen in the red bone marrow

2.Early normoblast:

The pronormobalst progrsses into the early normoblast

Intermediate normoblast:

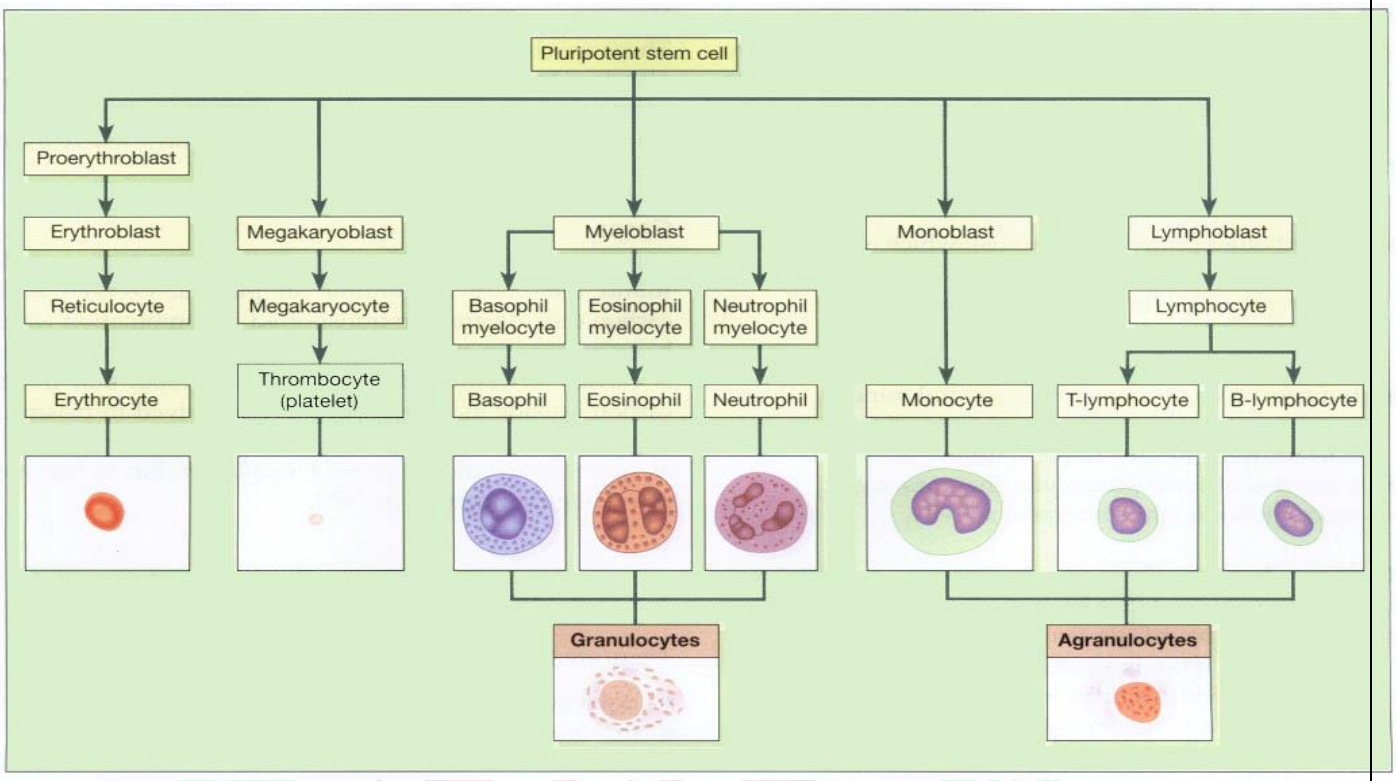
It is the next maturation stage in erythroid series.haemoglobin appears in this stage

3.Late normoblast:

It is the last nucleated cell of erythroid series

4.Reticulocyte:

It is the last stage in formation of erythrocytes and it is called as young red cells



HAEMOGLOBIN:

Protein combined with an iron containing pigment. The protein part is globin and the iron containing pigment is **heme.** Heme also forms a part of the structure of **myoglobin** (oxygenbinding pigment in muscles) and **neuroglobin** (oxygenbinding pigment in brain).

„ IRON

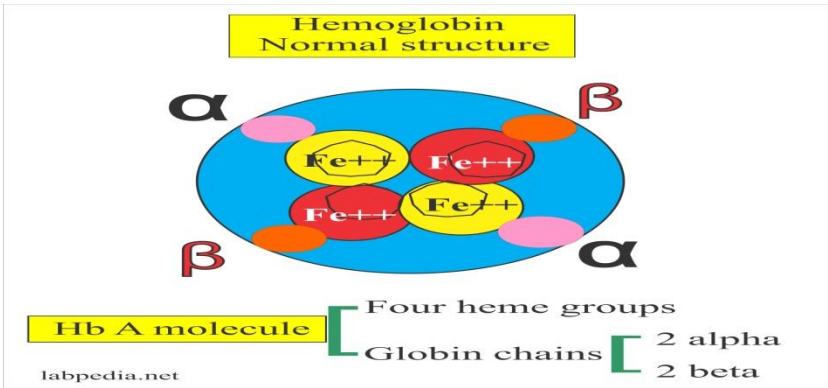
Normally, it is present in ferrous (Fe2+) form. It is in unstable or loose form. In some abnormal conditions, the iron is converted into ferric (Fe3+) state, which is a stable form.

„ PORPHYRIN

The pigment part of heme is called porphyrin. It is formed by four pyrrole rings (tetrapyrrole) called, I, II, III and IV. The **pyrrole rings** are attached to one another by methane (CH4) bridges. The iron is attached to 'N' of each pyrrole ring and 'N' of globin molecule.

„ GLOBIN

Globin contains four polypeptide chains. Among the four polypeptide chains, two are chains and two are α-chains



NORMAL HEMOGLOBIN CONTENT

Average hemoglobin (Hb) content in blood is 14 to 16 g/dL. However, the value varies depending upon the age and sex of the individual.

Age

At birth : 25 g/dL

After 3rd month : 20 g/dL

After 1 year : 17 g/dL

From puberty onwards : 14 to 16 g/dL

FUNCTIONS OF HEMOGLOBIN

„ TRANSPORT OF RESPIRATORY GASES

Main function of hemoglobin is the transport of respiratory gases:

1. Oxygen from the lungs to tissues.
2. Carbon dioxide from tissues to lungs.

1. *Transport of Oxygen*

When oxygen binds with hemoglobin, a physical process called **oxygenation** occurs, resulting in the formation of oxyhemoglobin. The iron remains in ferrous state in this compound. Oxyhemoglobin is an unstable compound and the combination is reversible, i.e. when more oxygen is available, it combines with hemoglobin and whenever oxygen is required, hemoglobin can release oxygen readily . When oxygen is released from oxyhemoglobin, it is called reduced hemoglobin or ferrohemoglobin.

2. *Transport of Carbon Dioxide:* When carbon dioxide binds with hemoglobin, carbhemoglobin is formed. It is also an unstable compound

and the combination is reversible, i.e. the carbon dioxide can be released from this compound. The affinity of hemoglobin for carbon dioxide is 20 times more than that for oxygen

SYNTHESIS OF HEMOGLOBIN

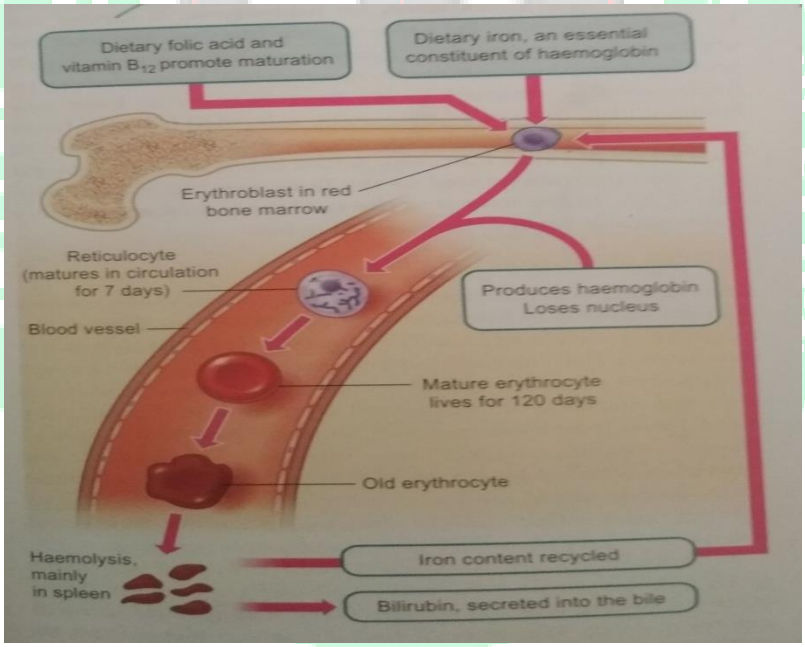
Synthesis of hemoglobin actually starts in proerythroblastic stage . However, hemoglobin appears

in the intermediate normoblastic stage only. Production of hemoglobin is continued until the stage of reticulocyte. Heme portion of hemoglobin is synthesized in mitochondria. And the protein part, globin is synthesized in ribosomes.

TYPES OF NORMAL HEMOGLOBIN

Hemoglobin is of two types:

1. Adult hemoglobin – HbA,HbA_2
2. Fetal hemoglobin – HbF



ANAEMIA:

Anemia is the blood disorder, characterized by the

reduction in:

1. Red blood cell (RBC) count
2. Hemoglobin content
3. Packed cell volume (PVC).

DEFINITION:

It is a not a single disease but a group of disorders in which heamoglobin concentration of blood is below the normal range for the age and sex of the subjects.

Anaemia:

Hb level is less than

Adult male:<13 gm/dl

Adult female:<11.5 gm/dl

New born:<15 gm/dl

3 month of age:<9.5 gm/dl

RBC level is less than 4million/mm^3

CLASSIFICATION

1.Deficiency anaemia:

Perinicious anaemia due to deficiency of vitamin B12 and folic acid (iron deficiency anaemia or megaloblastic anaemia)

Protein and vit c also cause anaemia

2.blood loss anaemia:

It occurs mainly during accidents a)acute post haemorrhagic b) chronic post haemorrhagic anaemia

3.haemolytic anaemia:

It is uncommon and occurs due to increase in destruction of RBC

4.Aplastic anaemia:

It occurs due to failure of bone marrow to produce anaemia

5.*Sickle cell anemia*

Sickle cell anemia is an inherited blood disorder, characterized by sickleshaped red blood cells. It is also called **hemoglobin SS disease** or **sickle cell disease.** It is common in people of African origin. Sickle cell anemia is due to the abnormal hemoglobin called hemoglobin S (sickle cell hemoglobin). In this, αchains are normal and βchains are abnormal. The molecules of hemoglobin S polymerize into long chains and precipitate inside the cells. Because of this, the RBCs attain sickle (crescent) shape and become more fragile leading to hemolysis . Sickle cell anemia occurs when a person inherits two abnormal genes (one from each parent). In children, hemolyzed sickle cells aggregate and block the blood vessels, leading to

infarction (stoppage of blood supply). The infarction is common in small bones. The infarcted small bones in hand and foot results in varying length in the digits. This condition is known as **hand and foot syndrome.** Jaundice also occurs in these children.

6.Thalassemia

Thalassemia is an inherited disorder, characterized by abnormal hemoglobin. It is also known as **Cooley's anemia** or **Mediterranean anemia.** It is more common in Thailand and to some extent in Mediterranean countries.

Thalassemia is of two types

i. α thalassemia

ii. β thalassemia.

α-Thalassemia

α-thalassemia occurs in fetal life or infancy. In this αchain are less, absent or abnormal. In adults, βchains are in excess and in children, γchains are in excess. This leads to defective erythropoiesis and hemolysis. The infants may be stillborn or may die immediately after birth.

β-Thalassemia

In βthalassemia, βchains are less in number, absent or abnormal with an excess of αchains. The αchains precipitate causing defective erythropoiesis and hemolysis.