

Ministry of Higher Education and Scientific Research

Al-Mustaqbal University College

Radiology Technique Department



Subject: Physiology

Class: 1st

Lecture Number: 6

Lecture Title: **The Hemoglobin**

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(((The hemoglobin)))

-**Haemoglobin** is the iron – containing pigment of the red blood cells that functions to carry oxygen from the lungs to the tissues.

-**Hb**, a conjugated protein, synthesized in bone marrow by nucleated precursors of the erythrocytes.

- since approximately **65% of Hb** synthesis occurs during the **nucleated stages of RBC maturation** & **35% occurs** during the **reticulocytes stage**.

-**Hb is the main** constituent of RBCs, which comprises 95% of the RBC's dry weight.

-**Normal blood has about 16 gm/dl (deciliter) of Hb** in **adult men** & **about 14 gm/dl** in adult women.

-Hemoglobin structure:-

-Hb is a globular molecule made up of four subunits each subunit contains a heme conjugated to a poly peptide.

Synthesis of Hemoglobin:-

-Normal hemoglobin production is dependent on three processes :-

- 1- Adequate iron delivery & supply.
- 2- Adequate synthesis of protoporphyrins (the precursor of heme).
- 3- Adequate globin synthesis.

- The globin synthesis :-

-Globin chain synthesis occurs on RBC –specific cytoplasmic ribosomes, which are initiated from the inheritance of various structural genes. Each gene results in the formation of a specific polypeptide chain.

-The RBC contains four alpha (α) genes, two beta (β) genes, two delta (δ) genes & four gamma (γ) genes.

-The alpha genes are located on chromosome 16 & the beta, delta & gamma genes are located on chromosome 11.

-All adult normal Hb are formed as tetramers consisting of two alpha chains Plus two (non- alpha) globin chains.

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-Catabolism of hemoglobin :-

-The average life span of normal erythrocyte in the circulation is 120 days.

-When old red blood cells are destroyed in the reticulo – endothelial system, the Hb is first split into globin & heme.

-The first pigment formed is biliverdin, but this is rapidly reduced to bilirubin, which is gradually released into plasma, immediately combines with plasma albumin.

-Then this combination is transport to liver, & the bilirubin is released from albumin.

-The iron from the heme is reused for Hb synthesis.

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❖ Iron

-The tissues of a 70 kg adult male contain between 3 and 4gm of iron, which is distributed in various compartment.

-70 % of the iron in the body is in Hb, 3% in myoglobin and the remainder in ferritin.

-Normal Plasma iron level is about 130 μg /dI in men and 110 μg /dI in women.

- Iron metabolism :-

-Iron metabolism involves **absorption, transportation, utilization, storage & excretion.**

1- Absorption :-

-Iron is released from food complexes by digestive enzymes & is partially reduced to the ferrous form (Fe^{+2}).

-The intestinal mucosa controls iron absorption from food sources by an energy.

. -Iron is absorbed in all parts of the small intestine, but absorbed almost entirely **in the upper part of the small intestine, mainly in the duodenum.**

-The best sources of dietary iron are **liver, red meat, egg yolk, dried fruits.**

2- Transport :-

-Iron absorbed from the intestinal tract or released by hemoglobin catabolism.

-Iron is transported from the mucosal cells to the blood in the ferrous state, where it is converted to the ferric state by serum ferroxidases.

-It is then incorporated into specific iron – transport protein, **transferrin.**

-One molecule of transferrin can bind two molecules of ferric iron.

-Excess iron in blood is deposited in all cells of the body but especially in the liver cells.

3- Utilization :-

-Iron within the cell is found in the mitochondria.

-The mitochondrial iron is incorporated rapidly into protoporphyrin to form heme.

4- Iron storage :-

-Iron is stored in the tissues in two forms: as **a soluble form**, called **ferritin** & as **insoluble iron** or **hemosiderin.**

-Ferritin is found in all tissues & in high concentration in liver, spleen & bone marrow.

-About 70% of the storage iron is present as ferritin & the remainder as hemosiderin.

-Hemosiderin is insoluble protein complex with higher iron content than ferritin (37% by weight).

- Requirement :-

- **-The average daily** loss of iron in urine, faeces & sweat is 1-2 mg & although the normal diet contains about 15 mg of iron only (1-2 mg) are absorbed.

-Since the average quantity of iron derived from the diet each day must at least equal that lost from the body.

- **-In menstruating women,:**

the average blood loss is 60 to 80 ml / month, representing approximately 30 to 40 mg of iron lost per month; an additional 1 to 1.5 mg of iron daily is therefore needed to maintain iron balance.

- **-Pregnancy :** creates an iron requirement of about 700 mg (fetus, placenta, blood loss & lactation), so during pregnancy, iron absorption increases up to 20 percent.

-Vitamins needed for formation of RBCs :-

- **-Vitamin B₁₂ (cobalamin) or (cyanocobalamin) :-**

✓ -Vitamin B₁₂ or cobalamin has a similar structure to heme in having four pyrrole rings, but these are linked to a cobalt atom.

✓ - the only source of Vitamin B₁₂ to man is dietary & mainly in foods of animal origin, such as meats, eggs, dairy products & liver.

- ✓ -Vit. B₁₂ is an essential nutrient for cells of the body, & growth of tissues in general is greatly depressed when this vitamin is lacking.
- ✓ -This results from the fact that vit .B₁₂ is required for **synthesis of DNA**. Since tissues that produce RBCs are among the most rapidly growing & proliferating of all the body's tissues, lack of this vitamin especially inhibits the rate of RBCs production.
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- ✓ -Total body vit. B₁₂ is **about 3000µg & is stored** mainly in **the liver**.
- ✓ -Between 1 to 4µg are required daily to replace that lost by the body.
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➤ **Folic Acid :-**

-Folic acid is also concerned with the maturation of RBCs. Since folic acid, like vit. B₁₂ is required for **formation of DNA**.

-If there is a deficiency of folic acid the marrow fills with **megaloblasts** & the number of mature red cells in the peripheral blood is reduced & cause **megaloblastic anemia**.

-Dietary deficiency results from a poor diet usually owing to alcoholism, poverty, old age or chronic overcooking of vegetables.

-In the alcoholic, foliate deficiency is the number one cause of anemia.

-Folic acid is present in green vegetables (**especially spinach**), **liver & kidney**.

-Total body content is **6-10 mg present in the liver**.

-In normal pregnancy **300-500 µg are required daily**.