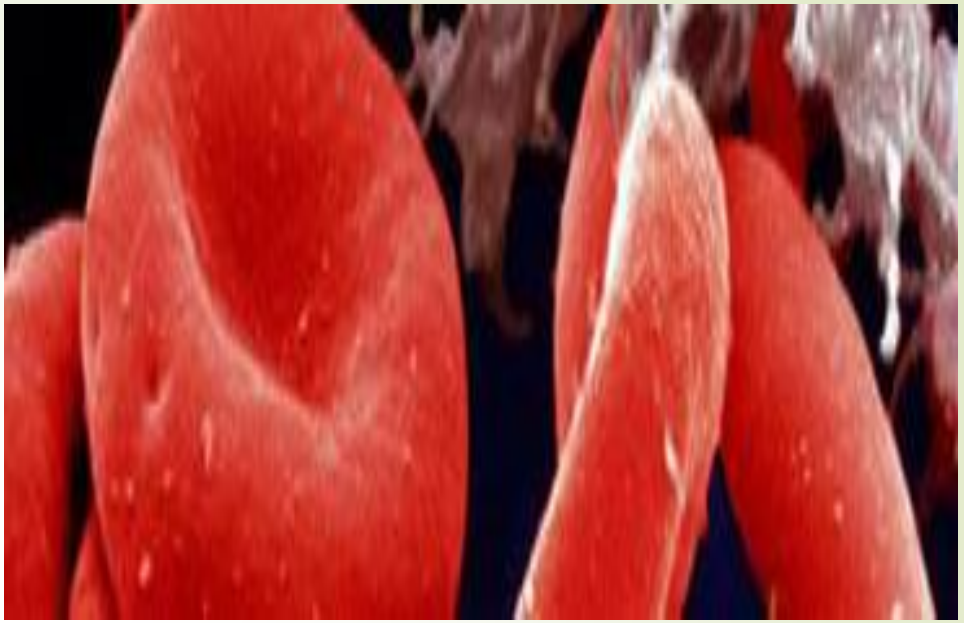


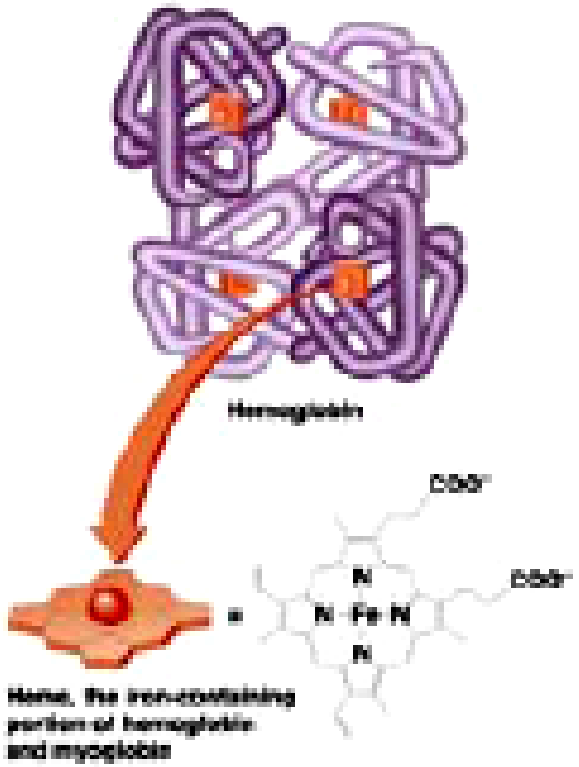
Iron

Objectives

- Describe the biochemical role & distribution of Iron
- Outline Iron absorption, transport, metabolism & excretion
- State the adverse clinical effects of excess or deficiency (iron deficiency & hemochromatosis)

Iron

- Most common nutrient deficiency in the world.
- Functions
  - Oxygen transport via hemoglobin
    - Thus, necessary for ATP production!
  - Essential component of many enzymes
  - Immune function
  - Brain function
    - Iron deficiency/toxicity thought to slow mental development in kids.



IRON BODY CONTENT AND DISTRIBUTION

The body contains about 4-5 g of iron.
65% of this is in ***Heamoglobin (Hb)***.
25% in ***iron stores:***
liver, spleen and ***bone marrow***.
5-10% is contained in ***heam proteins:***
(myoglobin, and the cytochromes).
1% is present free in the ***plasma***.

IRON BALANCE

- is regulated by alteration in intestinal absorption.
- there is only a limited capacity to increase or decrease the rate of loss of iron.
- The amount that is absorbed daily is only 1-3 mg.
- the exact amount depending on:
- age, physiological state and blood loss.
- Most of the needs of iron are met by:
- reutilization of iron from heam protein degradations.

The internal iron cycle

Means the reutilization of iron released by heam protein digestion.

Thus there is an ***internal iron cycle*** which means that:
once iron enters human body,
it cycles in a ***closed system*** with only a little iron entering the body daily to replace the small amount that is lost.

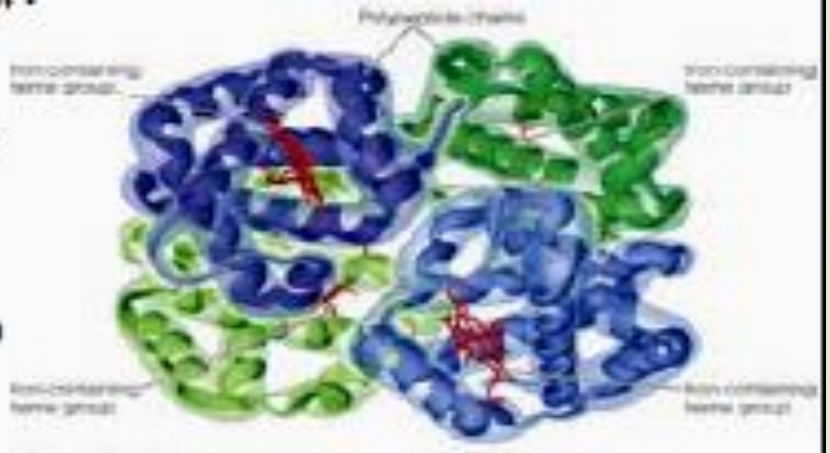
Iron pools and iron binding proteins in the body

1- Heamoglobin **is by far the *largest pool* of body iron.**

N.R= 13.8—17.2 g/dL for male and 12.1—15.1 g/dL for female

Oxygen Transport: Hemoglobin

- Most abundant protein in red blood cells
- 4 protein subunits 4 iron-containing heme groups
- Delivers oxygen to cells
- Picks up carbon dioxide



***2- Iron storage pool*: *ferritin and Haemosiderin*.**

***A- FERRITIN*: is *a* water soluble protein.**

ferritin contains up to 20% of the total body iron.

is present in plasma, liver, and bone marrow.

Each of which contain about 1/3 of total iron stores.

Iron is released from ferritin by the action of the enzyme *ferritin reductase*.

then become available for heam synthesis any where.

N.R= 12—300 ng/mL for male and 12—150 ng/mL for female

***B- Haemosiderin*: formed from *denaturation* of *ferritin*.**

BUT ONLY AFTER *ABNORMAL CONDITIONS* such as:

***repeated blood transfusion*.**

high iron IV or oral doses.

is a water insoluble protein found mainly in:

the *spleen, bone marrow and kupffer cells* of the liver

But affects all the cells of the body

Haemosiderin iron is also available for heam synthesis

but is mobilized much more slowly than that of ferritin.

3- Myoglobin:

O2 storage protein of skeletal and cardiac muscle

Contains about 3 to 4% of total body iron.

N.R= 25==72 ng/mL

Myoglobin

1. Found in muscle cells.
2. Heme group + protein subunit.

Releases oxygen to cells when needed for:

- ATP production.
- Muscle contraction.

4- Cytochromes are:

1. Heme-containing complexes. play an important role in: cellular respiration.
2. Are: a mixture of 3 haemochromogens called: cytochromes A,B, C.
3. Function in electron transport chain.
4. Allow conversion of ADP to ATP.

In Cytochromes Iron acts as cofactor in

- ***Electron Transport Chain.***
- ***Citric Acid Cycle.***
- ***Gluconeogensis.***

***Cytochrome p-450*:**

A protein similar to Hb, present in the **microsomes:**

1. Catalyzing the metabolism of: steroid hormones and fatty acids.
2. Acts as a cofactor for antioxidant enzymes to Protect DNA, cell membranes, proteins.

5- Transferrine:

1. is a protein specific for iron transport in the circulation after its absorption from GIT.
2. Transferrine has specific binding sites for iron, that is 30% saturated in normal situations.
3. its main action is to transport iron from intestine to different iron stores.
4. Estimation of transferrine in blood can give available information about the body iron status.

6- Gastroferrine:

is a protein secreted by the stomach to enhance iron absorption.

factors affecting daily iron absorption

1. **The amount of iron present in the food.**
2. **The chemical status of the ingested iron.**
3. **The presence of : ferritin, apoferritin and gastroferrine in the mucosal cells and antrum.**

factors affecting daily iron absorption

4. **The availability of acidic medium in the stomach.**
5. **Normal intestine and suitable alkaline medium.**
6. **The presence of other chemical in the food stuff.**
7. **Other factors also affecting Iron uptake are: increased erythropoiesis, hypoxia, anemia, and depletion of Iron stores.**

1) Factors increasing absorption:

A- Reducing agents

Eg: vitamin C, SH-containing proteins

B- gastric HCl

C- intestinal bicarbonate

D- healthy GIT

1) Factors decreasing absorption:

A-oxalate

B- Phytate

C-Tannic acid

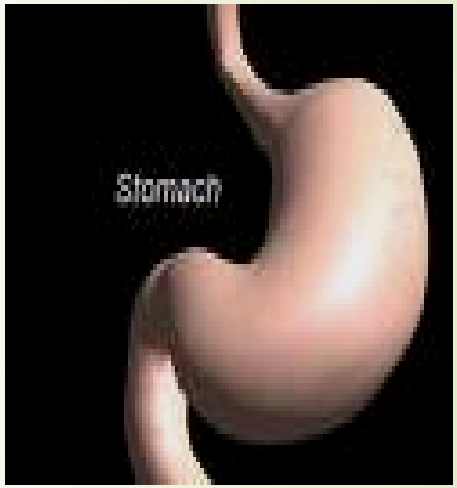
D-Carbonic acid

E- malabsorption

F- calcium ions

Mechanism of iron absorption and storage

A- In the stomach: ferric ions is reduced to ferrous ions



This reduction is favored by:

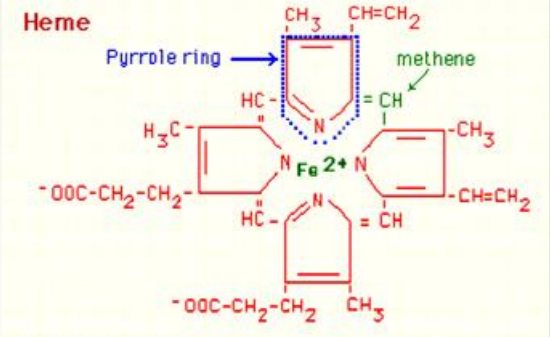
low pH, Reducing agents, such as ascorbic acid

Reduction is important because:

ferrous ions dissociate from Ligands more easily than ferric ions

Mechanism of iron absorption and storage

B- in the duodenum



Hame is absorbed directly by:
The mucosal cells.

Then within the cells:
1- the iron released from heme by (hame oxidase)
2- then reduced to ferrous Ions ions

Mechanism of iron absorption and storage

- Iron is bound and transported in the body via transferrine and stored in ferritin molecules.

- Once iron is absorbed, there is no physiologic mechanism for excretion of excess iron from the body other than blood loss i.e. pregnancy, menstruation or intestinal mucosal desquamation.

Nutritional Iron Requirements

1- In newborn infants:

there is **more** hemoglobin in their blood by:

A- high Hb concentration in the RBC.

B- high erythrocytes count of blood

Few weeks later:

cell **destruction** exceeds **erythropoiesis** and Iron accumulates:

which will be **reused** in later months for synthesis of Hb.

Nutritional Iron Requirements

2- During growth:

the Requirements of Iron increase markedly.

3- In adult life: Iron turnover:

A- Hb is metabolized into heme + globin.
Heme is then utilized into Iron and reused.

B- The Daily hemoglobin turnover is equivalent to 0.3 – 0.7 mg per dl of blood. Or about 25 mg per day for an adult.

C- The iron produced by this process is bound to transferrine and stored or reutilized again for the formation of new Hb in the RBC.

D- 1-3mg /d is only required to restore losses.

Nutritional Iron Requirements

4- Menarche:

females need iron 30 to 90 percent > than males.
Until menopause 50% of the females iron is used in the replacement of Hb lost in menses.
The average menstrual loss is about 35ml of blood per cycle. Replacement of this amount of blood alone requires 0.6 mg of iron per day.
This is not so important since the average diet contains enough iron to meet these requirements.

Nutritional Iron Requirements

5- DURING PREGNANCY AND LACTATION:

A- the requirements for iron is about 60% greater than the amount lost in menstrual cycle during a similar period.

B- MOTHER FOOD MUST THEREFORE PROVIDE: large quantities of Iron especially during the last 3 months of gestation.

C- IF NOT PROVIDED THIS MAY RESULT IN:

anemia with Hb values between 11-12 g/dl. ***Which are physiological during pregnancy.***

Abnormal Iron Metabolism

A - Iron deficiency:

this is a common condition affecting mainly ***growing children, pregnant women and lactating mothers***.

THE MAIN CAUSES OF IRON DEFICIENCY ARE:

1. **Deficient intake : low iron in diet.**
2. **Decreased absorption.**
3. **Increased requirement for iron.**
4. **Iron loss from the body:**

   a - Abnormal menstrual cycle.

   b- GIT bleeding:

   Esophageal Varices, Gastric and Duodenal Ulcers.

   c- Urinary tract bleeding

Consequences Of Iron Deficiency

1. Iron plasma falls.
2. Plasma ferritin falls.
3. Plasma transferrin and (TIBC) increase
4. Anemia becomes evident.

IRON DEFICIENCY ANEMIA

Causes: ***iron deficiency*** decreases the rate of both erythrocyte formation and hemoglobin synthesis leading to what is called:

hypochromic microcytic anemia.

signs and symptoms:

A- pallor of face and mucous membranes.

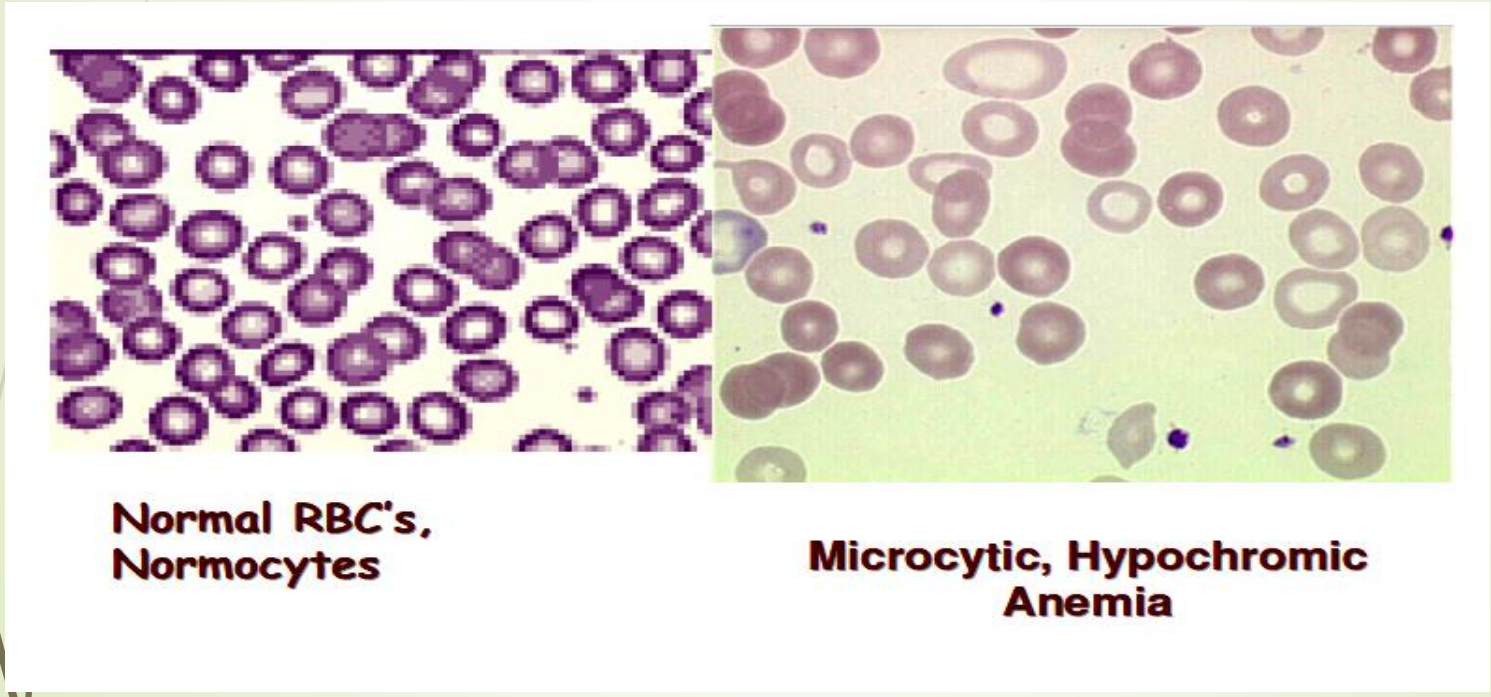
B- excessive tiredness and fatigability.

C- poor resistance to infections.

DIAGNOSIS OF IRON DEFICIENCY ANAEMIA

1- signs and symptoms.

2- blood film examination under microscope.



3- measuring iron containing proteins:

B - Iron over load: (Haemochromatosis)

1- *IDIOPATHIC HAEMOCHROMATOSIS*

Is a rare hereditary disorder leads to an increased absorption of dietary iron due to a defect in the *mechanism controlling absorption* from the intestine.

Leads to Excessive deposits of *Haemosiderin* in several tissues with high plasma ferritin and highly saturated transferrine levels.

It is a slowly progressing and even affecting more than one member in the family.

Acute iron intoxication

Is caused by accidental ingestion of large amounts of medicinal iron supplement especially by children.

It is the most common cause of childhood poisoning.

Symptoms : Vomiting, diarrhea or constipation and black stool.

Complications: Excess deposits in liver, heart, muscles and brain.

Death if not treated.


Thank
you!