Essential and Trace Minerals

- Iron, Copper, Iodine, Zinc, Selenium, Magnesium

Essential and Trace Minerals

- Needed in much smaller amounts
- Are essential
- Essential ions have specialized biochemical functions, although not found in the general electrolyte replacement preparations.
- Ions with biochemical functions and have deficiency syndrome are Iron and Iodide

Essential and Trace Minerals

Iron

Types of Proteins associated with Iron:

1. Hemoproteins (Cytochrome C, Myoglobin & Hemoglobin)
2. Iron-storage and Transport proteins (Ferritin, Hemosiderin, transferrin)

1. Hemoproteins: iron-containing proteins responsible for respiration and carrying oxygen.

(a) Cytochrome – c :

- An **respiratory enzyme**, where iron is complexed covalently with the protein portion in a **porphyrin** ring (heme ring) .
- Iron act as **electron carrier** by changing from ferrous to the ferric form and reversibly .
- Cytochrome –c role is in **oxidation – reduction** process of iron .

$$Fe^{+2} \rightleftarrows Fe^{+3} + e^{-}$$

(b) Hemoglobin and myoglobin

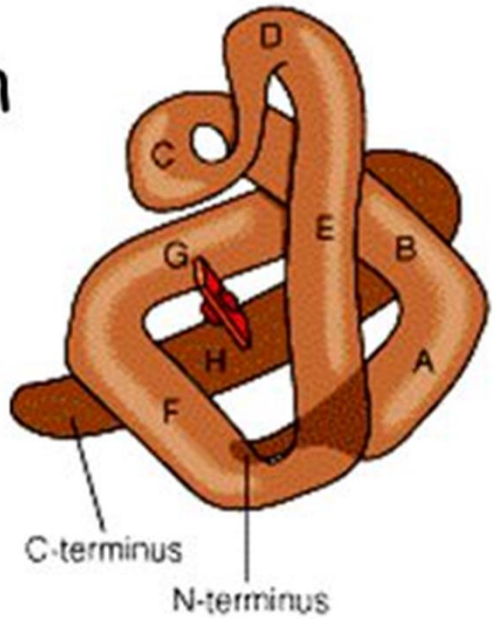
- responsible for storing and transporting oxygen

- **Myoglobin**
  - A single polypeptide with **one** oxygen binding site
  - Binds and releases oxygen through changes in oxygen conc. in sarcoplasma of skeletal muscle cells.

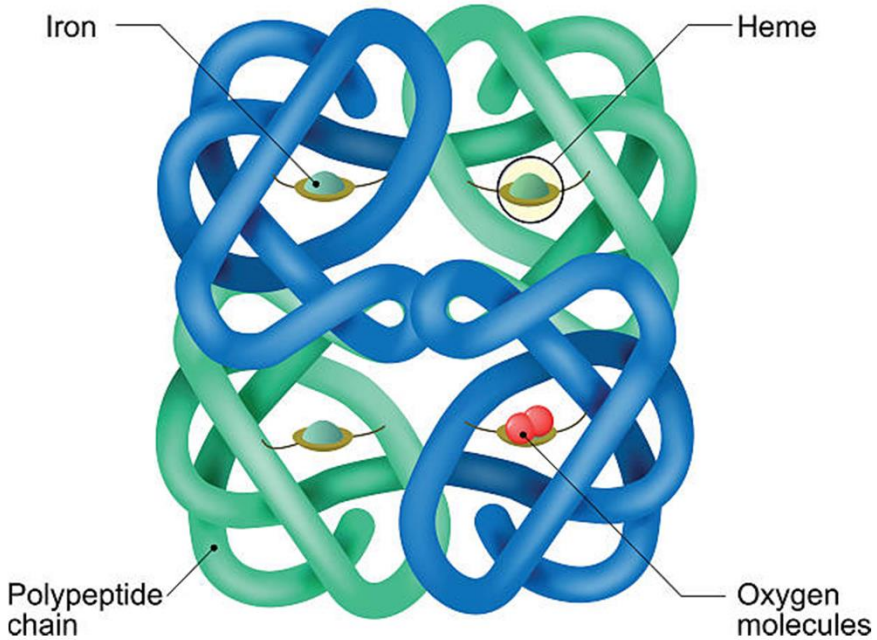
- **Hemoglobin**
  - consists of four protein chains (porphyrin ring and ferrous ion)
  - Found in high conc. in red blood cells

Heme C
(in *c*-type cytochromes)

myoglobin



HEMOGLOBIN



Uptake and release of oxygen is influensed by :-

- The oxygen tension, PH, Presence of 2,3 diphosphoglycerate (produced during glycolysis and found in the red blood cell, promoting Hb oxygen release), and CO_2 concenteration.

Patients with iron-deficiency anemia have : -

a) Decreased capability for oxygen transport
b) Decreased in hemoglobin synthesis .

2- Iron storage and transport proteins

a) The iron storage proteins

- **Ferritin**

  water soluble crystallizable protein, stored in ferric form

- **Hemosiderin**

  water insoluble, dehydrated ferritin

Both are found in the liver, spleen, and bone marrow

b – Iron transport proteins

- **transferrin**

  glycoprotein, major iron transport of blood plasma

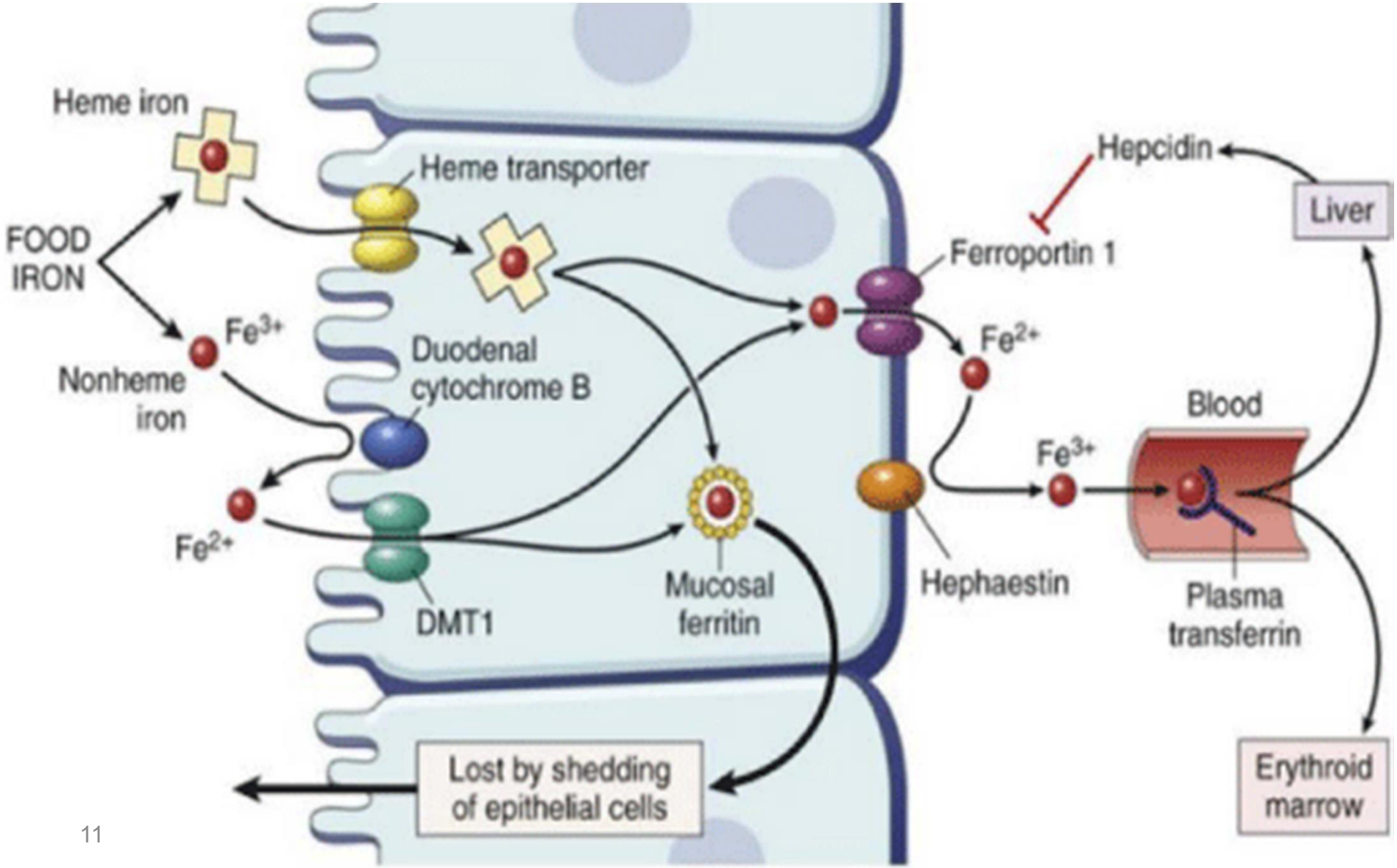
Absorption of Iron

- Body requirement: from recycling the iron (broken RBCs)
- Absorption determined by body's need
- Heme iron Vs. Nonheme iron
  - Heme iron is better absorbed than nonheme (Iron in hemoglobin is still bond to porphyrin ring).
  - 40% of iron in animal flesh is heme iron
  - Dairy and eggs are non-heme.
  - Plant foods are non-heme only.

Iron absorption and metabolism

- Upper small intestine is absorption site.
- heme iron is absorbed by **endocytosis** of the intact iron–protoporphyrin complex at the enterocyte brush border.
- Depending on the iron status of individuals it is either stored as ferritin in the enterocyte or exported from the enterocyte via the ferroportin transporter on the basal side of the cell.
- Ferroportin transports ferrous iron which is immediately oxidized to Fe^{+3} and picked up by transferrin to be transported to cells expressing transferrin receptors

Iron absorption and metabolism



Absorption of Iron

- Vitamin C enhances absorption
- Acidic environment
- Hindered by phytates, tannins, oxalic acid, high fiber, high calcium, polyphenols
- Zinc competes with iron for absorption
- Released **iron** complexed with sugars ,ascorbic acid,citric acid and amino acids (forms soluble iron complexes)/ or , in their abscence, complexed by gastric mucopolysacharide.

Iron absorption and metabolism

- The new born infant has a total of about 250 mg in the body.
- The total body iron in an adult male is 3000 to 4000 mg.
- The average adult woman has only 2000-3000 mg of iron in her body.
- This difference may be attributed to lesser iron reserves in women, lower concentration of hemoglobin and a smaller vascular volume than men.
- Approximately two-thirds are utilized as functional iron such as that in hemoglobin (60%), myoglobin (5%) and various heme and nonheme enzymes (5%). The remainder is found in storage as ferritin (20%) and hemisoderin (10%)

Iron-Deficient Anemia

- a general term for a condition which:
  - deficient in number of circulating red blood cells.
  - or deficient in total Hb content per unit of blood volume.
- The net result is lower oxygen carrying capacity by the blood.
- Caused by excessive loss of blood or due to decreased blood formation.
- Decreased blood formation can be caused by:
  - deficiencies of key materials (cobalamine, folic acid, pyridoxine and iron)
  - malignancy, and marrow failure.

Iron-Deficient Anemia

- The earliest stage of iron deficiency is characterized by
  - loss of storage iron (indicated by ferritin) and is called iron depletion or prelatent iron deficiency.
  - The concentrations of serum iron and the iron-carrying serum protein transferrin are normal at this stage.