

Trace Elements

1. Essential Trace Elements

BCH 282 (Lec 8)

Present in small amounts μg , a trace element to be essential. It must fulfill the following criteria:

1. It must be present in healthy tissues.
2. Its concentration from person to person is almost contrast.
3. It has a certain vital biochemical role and no substitute mineral will do.
4. Its deficiency produce certain clinical manifestations and can be fatal.
5. Its addition to diet must prevent these deficiency manifestations.
6. Its excess can be fatal.

Iron:

- Every living cells – plant and animal – contain iron.
- Most of the iron in the body is found either in the heme component of heme proteins (mostly hemoglobin in RBCs and myoglobin in muscle cells and cytochromes) or in storage forms (ferritin and hemosiderin).
- Hb: The O_2 carrying protein of the RBCs.
- Myoglobin: The O_2 carrying protein of the muscle cells.

Functions of Iron:

1. Iron is important for compounds essential for cellular respiration as hemoglobin and tissue iron (e.g. myoglobin and cytochromes).
The iron in both (Hb and myoglobin) helps them to carry and hold O_2 and then release it.
Hb in RBCs carries O_2 from lungs to tissues. Myoglobin holds O_2 for the muscles to use when they contract.
2. Iron works as part of many enzymes e.g. cytochrome oxidase, catalase, peroxidase.
3. It is also important to make new cells, amino acids, hormones.
4. The remaining iron is present in stored form as ferritin transferring and hemosiderin and used in hemoglobin synthesis.

Excretion: Tiny amount of iron is lost mainly in faeces.

Absorption: Of the dietary iron, about 10-15% is absorbed, but if the body's need increase (pregnancy) the absorption increase.

Factors that help iron absorption are:

1. Acidity, as the low pH helps to liberate iron from organic combinations.
2. Reducing agents as vit C change iron from ferric (Fe^{3+}) state to ferrous (Fe^{2+}) state.
3. Proteins specially those containing sulfur containing amino acids also change iron from ferric to ferrous.
4. Type of iron compounds in the diet, heme iron is absorbed easily.
5. Iron deficiency enhances iron absorption.

Factors which inhibit iron absorption are:

1. Achlorhydria or hypochlorhydria.
 2. Oxalates
 3. Phytates
- The blood protein (transferrin) carries the iron to tissue throughout the body. When more iron is needed, more of these proteins are produced and more of an usual amount of iron are carried and absorbed.

Iron Deficiency

- Iron deficiency is the most common nutrient deficiency, affecting more than one billion people.
- In developing countries, 1/3 of the children and women are suffering from iron-deficiency anaemia (IDA).

Women are specially prone to IDA because of:

1. Blood losses during menstruation.
2. Pregnancy

Causes of ID:

1. Nutritional causes: inadequate intake of iron-rich food.
2. Non-nutritional:
 - a. Diminished absorption causes.
 - b. Blood loss (increased loss of iron)

Iron deficiency and anaemia:

The distinction between iron deficiency and anaemia is important:

Anaemia: is a symptom of a wide variety of disorders. Some unrelated to nutrition and some related to nutrients. Other than iron such as folate and vit. B12 (The symptoms include headaches, weakness, fatigue and pallor).

IDA:

- The new RBCs are smaller and lighter red (microcytic and hypochromic anaemia) than normal.
- These new cells cannot carry enough O₂ from the lung to the tissues, so the entire body feels the effect.

Iron Overload:

- Normally the body protects itself against absorbing too much iron by setting up a block in intestinal cells. The system can be over weakened resulting in iron overload (iron toxicity) which is due to disturbance of iron metabolism and regulation.
- Iron overload is known as hemochromatosis and is caused by a genetic disorder that enhances iron absorption.

Other causes of iron overload include:

1. Repeated blood transfusions in hemolytic anaemia.
 2. Massive doses of supplementary iron.
 3. Other metabolic disorder.
- Long-term over consumption of iron may cause hemosiderosis which is a condition characterized by the large deposits of the iron-storage protein hemosiderin in the liver, spleen, heart, pancreas and under the skin (hemochromatosis). This condition may lead to bronze diabetes.
 - Iron overload is more common in men than in women. So, in contrast to premenopausal women, adult men should not use iron supplements, because high tissue levels of iron correlate with increased risk of myocardial infarction. It has been suggested that unbound inorganic iron can promote the formation of reactive oxygen radicals, particularly the conversion of H₂O₂ to highly reactive hydroxyl radicals. The enhanced formation of oxygen radicals favours the oxidation of LDL. This oxidized LDL plays key role in development of cardiovascular disease.

Iron recommendation and source:

- For men (19 and older): 10 mg/day
- For women (19 – 50Y): 15 mg/day
- (> 50 Y): 10 mg/day

Iron occurs in two forms in foods:

1. Heme-iron
2. Non heme-iron

- ❖ Heme iron is more rapidly absorbed, while non-heme iron is less rapidly absorbed. Therefore, the total iron content of diet is not a reliable indicator of the adequacy of the diet, because the availability of dietary iron depends on whether iron is present as heme iron or nonheme iron.

Sources: Organ meats as liver, heart, kidney:

Good sources of iron:

- Egg yolk
 - Whole wheat\
 - Spinach
 - Molasses
- N.B.: Milk is a poor source of iron.