

Copper

BCH 282 (Lec 10)

Distribution:

- The body contains about 100 mg of copper in adult:
 - 1/4 in the muscle
 - 1/4 in the brain, liver, blood
 - Remaining in the bones, kidneys, other tissues.
- Ceruloplasmin: is the copper binding protein in the plasma and it is also called ferroxidase (as it oxidize $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$).
- Plasma level: 50-150 $\mu\text{g}/\text{dl}$
 - 80-90% are tightly bound to protein ceruloplasmin.
 - 10-20% loosely bound to serum albumin.
- So albumin is more important in Cu^{2+} transport to the tissue than ceruloplasmin, because albumin donates Cu^{2+} more easily to tissue, while ceruloplasmin not easily give Cu^{2+} to tissue.

Functions:

1. Cu^{2+} is present in some enzymes e.g. cytochrome C oxidase, superoxide dismutase, tyrosinase, amine oxidase, dopamine hydroxylase.
2. Cu^{2+} is important in hemoglobin biosynthesis as it is important in iron metabolism (it acts as ferroxidase).
3. Cu^{2+} is important for pigment formation.
4. Cu^{2+} is important for normal bone formation.
5. Cu^{2+} catalyze manufacture the protein collagen.
6. Cu^{2+} assist in the healing of wounds.

Excretion:

Cu^{2+} is mainly excreted through the bile.

Cu^{2+} Deficiency:

- Cu^{2+} deficiency is rare but known. High intake of vit C and iron interfere with Cu^{2+} absorption and can lead to deficiency.
- Cu^{2+} deficiency is characterized by:
 1. hypochromic anaemia
 2. bone disorder (thin and fractures)
 3. discolored hair.

Cu²⁺ Toxicity:

Cu²⁺ toxicity from foods is unlikely occur, however, some genetic disorders creates a copper toxicity.

Wilson's Disease: (Hepatolenticular degeneration)

- This is an inborn error of metabolism inherited as autosomal recessive character.
- This condition is due to defective formation of ceruloplasmin which is important for the mobilization of copper from the tissues.
- The disease is characterized by excessive accumulation of copper in the liver, brain, kidneys → hepatitis and cirrhosis of liver, neurologic syndromes, excessive urinary Cu²⁺ excretion.
- Frequent clinical finding in Wilson's disease is the Kayser Fleischer ring which is a green or gold pigment ring around the cornea due to deposition of copper in the eye (around descemet's membrane).

Sources:

The best food sources of copper include shell fish (sea foods), liver, legumes, whole grain, seed.

Fluoride

Distribution:

- Fluoride is present mainly in bone and teeth.
- High fluoride diets during the growing years, crystalline deposits in bones and teeth are larger and more perfectly formed.
- When bones and teeth become mineralized, first a crystal called hydroxyapatite crystals form from Ca^{2+} and phosphorous. Then fluoride replaces the hydroxyl portion of hydroxyapatite, forming fluorapatite, which makes the bones and teeth more resistant to decay.

Excretion:

Excess fluoride is excreted by the kidney in the urine.

Functions:

1. It is important for normal growth of bones and teeth.
2. Fluorides prevent dental caries especially in children.
3. Fluorides prevent osteoporosis especially in menopausal women.

Abnormal levels:

1. Low fluoride levels, where fluoride is lacking in the water supply, the incidence of dental decay and dental caries are high, also lead to osteoporosis.
2. High levels of fluoride (fluorosis) can lead to mottling and discoloration of the enamel of the teeth and also cause damage of the teeth.

Source:

All normal diets include some fluoride, but drinking water is the usually most significant source.

3. Acute fluoride toxicity is very rare, and this may lead to inhibition of glycolysis and citric acid cycle (CAC) as fluoride inhibits enolase and aconitase enzymes.

Cobalt

- Cobalt is a constituent of vitamin B12 which is important in preventing pernicious anaemia.
- So cobalt is important for enzymes requiring vit B12 e.g. ribonucleotide reductase, methyl tetrahydrofolate.

Non-Essential Trace Elements

These elements may produce toxic effects in man due to air, water and diet pollution or during treatment of certain diseases.

Aluminum:

- High aluminum levels may be ingested by man through food cooked in aluminum utensils or by addition of aluminum sulfate in the baking powder.
- However, aluminum toxicity is very rare and it usually occurs in hemolysed patients with tap water contaminated with aluminum.
- Aluminum toxicity may lead to osteoporosis and mental dementia (→ Alzheimer).

Cadmium;

- Air pollution and smoking are the main sources of cadmium toxicity in man.
- Cadmium ingested by oral way may interfere with zinc, iron and copper absorption, so lead to deficiency of these elements.
- Cadmium toxicity may lead to hypertension.

Boron

- The treatment of burns with boric acid may lead to depression of central nervous system.

Lead

- Lead toxicity may occur due to air pollution by high motor traffic densities or due to water pollution due to use of lead pipes, or due to polluted ingested food especially canned baby foods.
- Chronic lead poisoning is characterized by neurological defects e.g. behavioral disorder, intellectual impairment and anaemia and renal failure.

Lithium

- There is no known vital function of lithium in living organisms.
- The interest in lithium study arose from its role in treatment of psychosis and may be its protective effect against atherosclerotic heart disease.
- Lithium is present in diet mainly apples, beets, cabbage and onions.

- It is used as therapeutic agent in psychosis and mania.
- For the drug monitoring, it is measured 12 hours after administration. Its level should not exceed 1.5 mmol/l.
- Lithium toxicity may occur during treatment of mania and psychosis when patients given uncontrolled doses.
- The symptoms of lithium toxicity are:
 - polyuria, atoxia, hypothyroidism and weight gain.
- The mechanism of its action is by suppression of noradrenaline release.