→ Iron tablets are usually given along with vitamin C

Fluoride (4 mark)

Sources

→ Drinking water, sea fish, cheese, tea and gourds.

Fluorinated toothpaste contains 3000 ppm of fluoride.

Functions (4 mark)

1. Trace amounts are required ~~for~~ proper development of teeth and bones.

2. Prevents development of dental caries by forming a layer of acid resistant fluoroapatite with hydroxyl apatite of the enamel and

2)

prevent tooth decay by bacterial acids.

3. Inhibits activities of certain enzymes
- Fluoroacetate inhibits aconitase of citric acid cycle.
- Sodium fluoride inhibits enolase of glycolysis.

Fluoride toxicity

FLUOROSIS

Safe limit of fluorine = 1 ppm in water

Excess amount > 20 ppm causes Fluorosis

1. Enamel of teeth loses its colouration, chalky white patches with yellow or brown pigmentation are found over the surface of teeth.
→ Genu valgum is the characteristic feature.
→ Very high conc. of fluorine causes hypercalcification of bones of spine, pelvis and limbs.
→ Ligaments of spine and collagen of bones are calcified leading to skeletal fluorosis.
→ In advanced stages, crippling can occur.
→ Unable to work.
→ Neurological disturbances are also common.
→ Blood concentration of fluoride increases to 50 microgram/dl (normal = 4 microgram/100 ml) in fluorosis.
→ Excretion of hydroxyproline increased in urine, due to increased breakdown of bone matrix.
→ Fluorosis is highly prevalent in areas where ground water is the staple diet.

Prevention

→ Provide fluoride free water.
→ Restrict fluoride intake.
→ Supplementation of vitamin C
→ Regulate fluoride containing toothpaste.

Copper

Body distribution:
→ Total body copper = 100 mg.
→ Seen in muscles, liver, bone marrow, brain, heart and hair.
→ 95% in RBC (as colourless Erythrocuprein)
→ Plasma contains Cu containing glycoprotein CERULOPLASMIN

Ceruloplasmin (4 mark)

→ Synthesized in liver.
→ Contains 6-8 Cu atoms tightly bound per molecule.
→ Serum ferroxidase
→ Promote oxidation of ferrous ion to Ferric form
→ Normal level = 25-50 mg/dL.
→ 90% of Cu content of plasma is bound to ceruloplasmin and the 10% to albumin

copper RDA

adult - 1.5 - 3 mg/day.

Source

cereals, meat, liver, nuts, green leafy vegetables

Functions:

1. Necessary for iron absorption and incorporation of iron into Hb.
2. Required for tyrosinase activity
3. Co factor of vitamin C requiring hydroxylations
4. Increase HDL protects heart.
5. Cu containing enzymes:
   - ceruloplasmin
   - cytochrome oxidase
   - cytochrome c
   - tyrosinase
   - lysyl oxidase.
   - ALA synthase.
   - Monoamine oxidase
   - superoxide dismutase.
   - Phenol ~~oxydase~~ oxidase.

→ Cu dependant non-enzymatic proteins
- Hepatocuprein in liver.
- cuprothionine in liver.
- Hemocuprein in RBC.
- Cerebrocuprein in brain
- Erythrocuprein in bone marrow

Abnormal metabolism of Copper

(1.) Wilson's disease (Hepatolenticular degeneration): (4 mark)

→ Rare ~~heart~~ hereditary disease of Cu metabolism
→ Basic defect is in a gene code for Cu binding ATPase in cells.
→ This is required for normal excretion of Cu from liver cells.

characterized by

(i) Cu deposition in abnormal amounts in liver and lenticular nucleus of brain which cause Hepatic Cirrhosis and Necrosis of brain.

(ii) Cu deposition in kidney causes renal tubular damage and affects glomerular filtration.

(iii) low levels of Cu and ceruloplasmin in plasma.

Clinical features

→ accumulation of Cu in liver → hepatocellular degeneration and cirrhosis.

→ deposition in brain basal ganglia → lenticular degeneration and neurological symptoms

→ Cu deposits as green or golden pigmented ring around cornea → KAYSER FLEISCHER RING

Treatment

→ Diet containing low Cu

→ Injection of D-penicillamine which excretes Cu through urine

→ Zn decreases Cu absorption, hence useful.

(2) Cu deficient Anemia.

→ Cu essential for Hb formation.

→ Cu containing ceruloplasmin helps in iron transport

→ Cu is the integral part of RCA synthase (key enzyme in heme synthesis)

→ Deficiency leads to anemia like microcytic normochromic anemia

~~Hypopigmented~~

(3) Menke's Kinky Hair Syndrome (Steely hair disease):

→ Absence of intracellular Cu binding ATPase

→ Dietary Cu is absorbed but not transported to blood.

→ Hence Cu is unavailable for tissues.

• Defective cross linking of connective tissue.

→ (X linked, affects only male children

→ child dies usually in infancy.

• Hypopigmentation and graying of hair.

→ Cu present in Tyrosinase is necessary for melanin formation is deficient

→ Sometimes alternate patches of white hair called flag type hair

Toxicity.

→ Cu toxicity manifested as diarrhea and blue-green coloration of saliva.

→ Cu poisoning leads to hemolysis, hemoglobinuria, proteinuria, renal failure.

Zinc (4 marks - fn of zinc)

→ Zn dependant enzymes - Carbonic anhydrase, LDH, ALP, RNA polymerase, alcohol dehydrogenase etc

→ Some RNA polymerase is Zn containing enzyme, it is required for protein synthesis

→ Important Antioxidant (Zn dependent SOD)

→ Gustin, Zn containing protein is important for taste sensation

→ Zn stabilize insulin when stored in beta cells of pancreas.

Zn Deficiency (1 mark)

Acrodermatitis Enteropathica

→ Zn absorption is defective.

→ characterized by acrodermatitis (inflammation around mouth, nose, fingers etc), diarrhea

Selenium (1 mark)

Functions:

1. Component of enzymes:
   - Glutathione peroxidase. (free radical scavenge enzyme)
   - 5' De Iodinase.

Thyroxin T4 ⟶ T3

2. Intracellular antioxidant
3. Selenocysteine as the 21st aa

Selenium toxicity :- Selenosis

SULPHUR.

Major source - S containing amino acids.

Functions:

1. Important constituent of body proteins
2. Constituent of cartilage and bone (chondroitin sulphate)
3. Keratin present in hair, nail.
4. Role in detoxification.
5. PAPS, considered as active sulphate, inserts sulphur into several compounds.
6. Mitochondrial cellular respiration.
7. -SH active site for enzyme eg: GSH. (glutathione) SH containing molecules thiamine, biotin, lipoic acid coenzyme A.

Iodine

world's ocean and iodized salt are least sources.

sources: Seafoods, drinking water, vegetables etc

RDA

Adults - 100 - 150 µg/day

Normal level in blood:

5 - 10 µg/dL

Biochemical functions:

Synthesis of thyroid hormones (T_3, T_4).

Disorder: Simple goitre and toxic goiter.

- Helps in formation of thyroid hormones (T_3 & T_4)
- Substance which prevent utilisation of iodine called Goitrogens

eg: 1. Thiocyanate in tapioca and cabbage, which inhibit iodine uptake by thyroid.

2. Thiourea in mustard seed, inhibit iodination of thyroglobulin

Manganese

Sources

- Cereals, nuts, leafy vegetables and fruits
- Tea is a rich source.

RDA

Adult - 2 - 9 mg/day.

Biochemical functions

1. Mn serves as a cofactor for several enzyme. Eg. Pyruvate carboxylase, phosphoglucomutase, isocitrate dehydrogenase, arginase, superoxide dismutase etc.
2. Mn is necessary for synthesis of mucopolysaccharide and glycoprotein.
3. Hb synthesis involved Mn.
4. Mn plays a role in maintaining normal reproductive functions.
5. Mn is required for RNA polymerase activity.

Molybdenum

Functions:

- Xanthine oxidase, aldehyde oxidase contains molybdenum
- deficiency causes depression of xanthine oxidase activity
- Toxicity → Molybdenosis

Cobalt

- Component of vit B12 (cobalamin).
- Production of erythropoietin that promotes maturation of RBC → Excess to causes polycythemia