Vitamins and trace elements

Vitamins

- Hypovitaminosis - a reduced amount of vitamins, usually without clinical manifestations

- Avitaminosis - complete lack of vitamins (clinically manifested)

Measuring the concentration of vitamins

- Directly (vit E, provitamin A = beta carotene, B12, folates).
- Indirectly by concentrations of the accumulating vitamin metabolite
- Saturation tests (administration of vit. C, if the organism is saturated with vitamin, it appears in the urine).

Fat soluble vitamins

- A (retinol) - taken in the form of provitamin A - beta-carotene. It binds to retinol binding protein (RBP). The active form = 11-cis-retinal is essential for vision and for the proper function of skin and mucous membranes. Antioxidant.

- D (cholecalciferol D3, from animal food, ergocalciferol D2, from plant food or endogenously by UV) - vitamin D is formed in the skin by UV from 7 - dehydrocholesterol, partly ingested by food (D2, D3). It affects the metabolism of Ca and P. Vit. D is formed only after double hydroxylation at position 25 in the liver (from cholecalciferol 25 hydroxycholecalciferol = calcidiol is formed) and then in the kidneys hydroxylation at position 1 (calcitriol = 1,25 dihydroxycholecalciferol is formed).

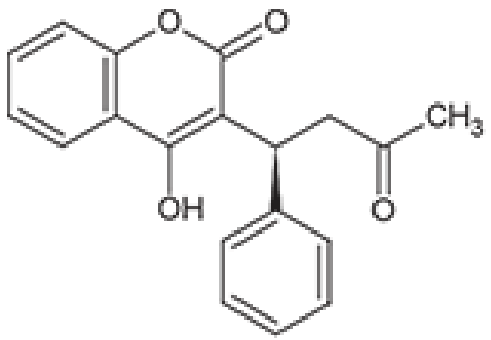
Fat soluble vitamins

- There are several E (alpha - tocopherol) isomers. Antioxidant. Protects LDL from oxidation. By scavenging radicals, it itself becomes a radical, it is renewed with the help of vitamin C.

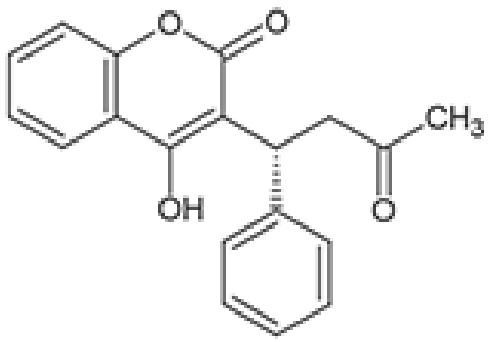
- K (menadiol) - used for post-translational modification of vitamin K-dependent coagulation factors.

Warfarin (Coumadin)

- Anticoagulant
- It binds vitamin K



(R)-(+)-Warfarin



(S)-(-)-Warfarin

Water soluble vitamins - group B

- B1 thiamine (part of enzymes, deficiency manifests as beriberi, neurological deficits)
- B2 riboflavin (part of FAD, FMN, electron transfer in the respiratory chain)
- B5 pantothenic (part of CoA)
- B6 pyridoxine - part of aminotransferases
- B12 cyanocobalamin, necessary for nucleic acid synthesis, deficiency = pernicious anemia

Water soluble vitamins

- Folic acid - deficiency = megaloblastic anemia.
- Niacin (NAD) - part of NAD, NADP
- H (Biotin) - part of the Krebs cycle
- C (ascorbic acid) - antioxidant. Deficiency = scurvy

Scurvy

Trace elements

- in the body are in trace amounts
- some elements (Pb, Hg, Cd) are the cause of chronic poisoning.

Fe metabolism

- absorption (in the form of Fe^{2+}) in the upper part of the small intestine in the presence of acidic gastric juice
- absorption is forced by apoferritin, the protein of the intestinal mucosa, which binds iron in trivalent form (Fe^{3+}) as ferritin.
- In plasma, iron as trivalent Fe^{3+} is bound to the β1 transport globulin - transferrin.
- Iron enters cells through transferrin receptors (TfRs). It is again stored in the tissues in the form of ferritin (storage form) or hemosiderin (unusable form).

Fe metabolism

- About 4 grams of Fe in the body, of which 3 grams are in hemoglobin.

- Oxygen binding and its transport in hemoglobin, for some redox processes (it is part of cytochromes).

Fenton's reaction

- formation of hydroxyl radical → lipoperodixation
- this reaction is prevented by transferrin, which binds free iron.

$$H_2O_2 + Fe^{2+} \rightarrow OH^- + \cdot OH + Fe^{3+}$$

Fe deficiency

- insufficient food intake (rarely),
- resorption disorder due to achlorhydria (decreased production of acidic gastric juice).
- increased iron loss during chronic bleeding (enterorrhagia - due to ca colorectum, metrorrhagia).

Microcytic hypochromic anemia

- increased free plasma binding capacity for iron (free transferrin = sign of chronic condition and decreased plasma ferritin concentration = sign of acute condition).
- The most sensitive indicator of iron deficiency in cells are soluble transferrin receptors (sTfR) - in the case of Fe deficiency, the cell produces up to twice the amount of transferrin receptors and releases large amounts into the blood.

Fe toxicity

Hemochromatosis

- an inherited disease caused by a defect in the regulation of iron absorption in the small intestine.
- Fe is stored in the organs.

Hemosiderosis

- it occurs iatrogenically with prolonged excessive parenteral Fe supply.

Other trace elements

- Cu - bound to albumin in the blood. In the liver, it is incorporated into ceruloplasmin, through which it is distributed to tissues. Cofactor of enzymes, antioxidant. It is excreted in the bile. Daily dose 15-30 mg for an adult. Deficiency leads to mental retardation, skeletal involvement, CNS. Excess = Wilson's disease. Tremor, ataxia, increased urinary excretion of Cu.

- Zn - most is in a meat diet. It is excreted in pancreatic juice and bile. Daily need 12-19 mg for an adult. Zn is part of metalloenzymes (carbonic anhydridase, LD, ALP, AMS, SOD, is used in the stabilization of DNA and RNA. Necessary for sperm production. Lack of Zn in catabolism, malnutrition, burns, nephrotic sy (binds to albumin). Diarrhea, vomiting.

Other trace elements

- Se - is not stored in the body. Contained in glutathione peroxidase and protects the body from oxidative damage. Selenium deficiency leads to cardiomyopathy and muscle damage. Toxicity - the smell of garlic.

- Cr - mutagen, a carcinogen (if hexavalent), as a trivalent regulates the effect of insulin, improves glucose tolerance in diabetics.

Other elements

- F - deficiency leads to dental caries
- I - necessary for the synthesis of thyroid hormones
- Co - part of vit B12.