Blood, Lymph & Immunology

For 1st Year Medical Students

Water Soluble Vitamins

2022

Water Soluble Vitamins

Their common properties are

1. Water solubility.

2. Except Vitamin B12, others are not stored.

3. Unstable to normal cooking conditions.

4. Excreted in urine.

They include the following:

I. Vitamin C " L-ascorbic acid" or "Anti-scurvy vitamin"
II. Vitamin B complex:
   a. Thiamine "B_1" or Anti-beri beri"
   b. Riboflavin "B_2"
   c. Nicotinic acid or Niacin "B_3" or pellagra preventing factor
   d. Pantothenic acid "B_5"
   e. Pyridoxine "B_6"
   f. Biotin "Vitamin H" or coenzyme R.
   g. Folic acid "Folacin" or peteroyl glutamic acid
   h. Cyanocobalamin "B_{12}" or anti-pernicious anemia.

The B complex vitamins

General properties:

1-All are soluble in water.

2-Heat stable except B1.

3-Destroyed by light except B_{12} and niacin.

Sources :

Plant sources :Yeast, whole grain cereals and green leafy vegetables.

Animal sources : Liver, meat, milk, egg yolk and fish.

Intestinal bacteria .

Due to their presence in the same foods, their deficiencies are multiple rather than singular.

Functions of vitamin B complex:

1- All B complex vitamins serve as coenzymes or cofactors in enzymatic reactions.
2- Folic acid and B_{12} act as coenzymes in hemtopoiesis.

Absorption of vitamin B complex:

1- Readly absorbed in the intestine and transported in the portal circulation.
2- The tissue stores of most vitamin B are minimal.

Toxicity of vitamin B complex:

Toxic effects are relatively uncommon as excess vitamins are lost in the urine.

Thiamine (vitamin B1)

Sources

Rich Sources. Outer coatings of food grains like rice, wheat and yeast.

Function

Thiamin pyrophosphate (TPP or TDP) is the active form of thiamine.

1. TPP is the prosthetic group of enzymes involved in oxidative decarboxylation of ketoacids like pyruvate dehydrogenase, α-keto glutarate dehydrogenase.

2. TPP is also prosthetic group of transketolase reaction of HMP pathway.

Deficiency

Thiamine deficiency results in a disease called beriberi.

Early signs of beri beri are insomnia, headache, dizziness, loss of appetite, muscle weakness, numbness and pricking sensation in lower limbs and fatigue. If not treated it leads to

(a) Wet beri beri. In which cardiovascular system is affected and it is characterized by edema

(b) Dry beri beri. In which central nervous system is affected. In addition to early signs severe muscle wasting occurs

Riboflavin (vitamin B2)

Sources

Whole grains, legumes, dhals, green leafy vegetables, yeast, eggs, milk and organ meats are good sources.

Functions

Active forms of riboflavin are flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD). FMN or FAD act as carriers of hydrogen atoms in oxidation-reduction reactions.

Deficiency

(a) Angular Stomatitis. Lesions of mouth particularly at corners of mouth.

(b) Cheilosis: Red swollen and cracked lips.

(c) Dermatitis of nasolabial region.

(d) Vascularization of cornea and conjunctiva and blood shot eyes.

(e) Glossitis: Inflamed magenta coloured tongue.

Nicotinic acid (B_3 or Niacin)
"Pellagra preventing factor"

Sources

Whole grains, peanuts, legumes, yeast, liver, fish and meat are good sources. From tryptophan - needs vitamin B_6. (60 mg of tryptophan produces one mg of niacin)

Functions

Nicotinamide is component of two coenzymes; nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP).

- Both NAD and NADP are co-enzymes of several dehydrogenases which catalyzes oxidation reduction reactions. NAD and NADP act as carriers of hydrogen groups in such reactions.
- NADH+ H^+ is oxidized mainly by the respiratory chain with production of water and ATP.
- NADPH+H^+ is an important coenzyme for:
    - Hydroxylases as phenylalanine hydroxylase.
    - Reductases as retinal reductase.

Deficiency

Niacin deficiency causes pellagra in which skin, gastrointestinal tract and nervous system are affected. Hence dermatitis, diarrhea and dementia are characteristic symptoms of pellagra.

Pyridoxine (vitamin B6)

Sources

Whole grains, legumes, liver and yeast are good sources.

Functions

Pyridoxal phosphate is active form.

1- Pyridoxal phosphate (PLP) acts as coenzyme of enzymes which are involved in transamination reactions as glutamate-pyruvate transaminase (GPT) and glutamate-oxaloacetate transaminase (GOT).

2- Decarboxylation reactions:

- Decarboxylation of amino acids to gives amines.
  - * Tyrosine ⟶ Tyramine
  - * Histidine ⟶ Histamine
  - * Glutamic acid ⟶ gamma amino butyric acid (GABA)

3- Conversion of tryptophan into nicotinic acid.

4-Sphingosine base synthesis (condensation of Serine with palmitoyl-CoA).

5-Glutathione synthesis.

6- PLP is coenzyme for enzymes that are involved in the synthesis of heme, serotonin, catecholamines and coenzyme A synthesis.

7- PLP is essential for absorption of amino acids from the small intestine.

Deficiency

1. Microcytic hypochromic anemia due to decreased heme synthesis.
2. Pellagra manifestations due decreased conversion of tryptophan to nicotinic acid.
3. Depression and mental disturbances.
4. In children vitamin B6 deficiency causes epileptic form convulsions (seizures) due to decreased formation of neurotransmitters like GABA, serotonin and catecholamines

Biotin (Vitamin H)

Sources

Whole cereals, legumes, groundnuts, milk, meat and fish are good sources.

Function

Biotin is prosthetic groups of several carboxylases like pyruvate carboxylase, acetyl-CoA carboxylase, propionyl-CoA carboxylase

Deficiency

Causes of deficiency

1- Intake of antibiotics and sulpha drugs which inhibit the bacteria of intestine.

2 - Intake of raw egg white which contains avidin. A basic protein in raw eggs known as avidin was found to cause deficiency of biotin because of formation avidin -biotin complex and this prevent absorption of biotin this property impairs the value of biotin and causes what is called *Egg White Injury Syndrome*.

Manifestations of deficiency

1. Biotin deficiency is rare in humans because it is present in most of the common foods.

2. However experimentally induced biotin deficiency, symptoms in man are dermatitis, alopecia, depression, muscular pain and anemia.

Pantothenic acid (vitamin B5)

Function:

- It enters in the formation of CoASH which has the following metabolic functions

- It combines with acetic acid to form active acetate which may be oxidised to give energy or enter in the synthesis of cholesterol, steroid hormones and acetylcholine.
- It combines with succinic acid to give active succinate which enters in the synthesis of heme.
- CoA is important in fatty acid oxidation.

2-Pantothenic acid enters in acyl carrier protein structure (ACP). It is a coenzyme necessary for synthesis of fatty acid.

Deficiency:

- It is a lipotropic factor (prevents fatty liver), in its deficiency, fat utilization and transport is impaired, this lead to increase deposition of fat in the liver cells.