

Vitamin

Vitamin: -

An essential dietary factors that is required by an organism in small amount and whose absence results in deficiency diseases.

- *Vitamins are essential because the organism cannot synthesize these compounds, which are necessary for life.
- *Many coenzymes are modified forms of vitamins.
- *Coenzymes act in concert with enzymes to catalyze biochemical reactions.
- *Coenzymes usually function as a major component of the active site on the enzyme.

Classification of Vitamins

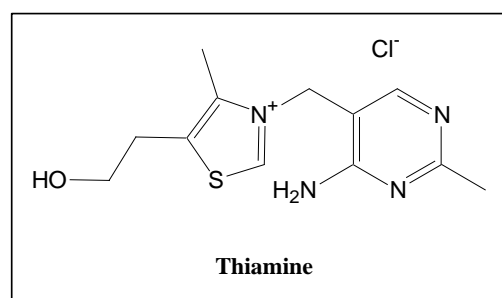
1. **Water soluble vitamins:** include vitamin B-complex and Vitamin C which act as coenzymes.
2. **Fat soluble vitamins:** include vitamin A, vitamin E,D and K.

Note: Water soluble vitamins excreted in urine therefore they are rarely accumulate in toxic concentrations.
Fat soluble vitamins excreted in stool.

1-Water soluble vitamins:

1-Vitamin B (Thiamine):

Has the following structure:
Thiamine is convert in the body to the active coenzyme thiamine pyrophosphate (TPP). (TPP) act as coenzyme in decarboxylation reactions from α -keto acids and keto-sugar.



Occurrence: Thiamin occurs in the outer coats of the seeds of any plants like cereal grains, in animal tissues and in yeast it occurs as TPP.

Deficiency: Deficiency of the vitamin in man produce the classic disease beri-beri, the symptoms of this disease are muscular weakness and loss of weight.

2- Vitamin B₂ (Riboflavin):

The vitamin occurs in nature as two forms:-

FMN: flavin mono nucleotide

FAD: flavin adenine di nucleotide

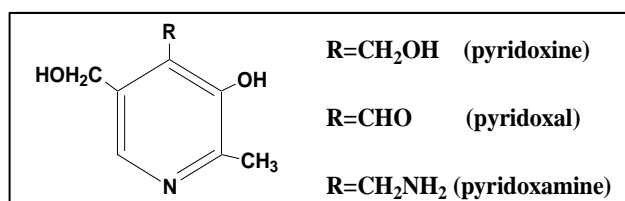
Riboflavin functions as a coenzyme because of its ability to undergo oxidation-reduction reactions

Occurrence: Riboflavin is synthesized by green plant, many bacteria and fungi.

Deficiency: The symptoms of riboflavin deficiency are skin and lips lesions and dark red tongue.

3-Vitamin group B₆ (pyridoxal):

Three compound belong to the vitamin group known as B₆



All three form of the vitamin participates in the catalysis of several important reaction of amino acid metabolism known as transamination, decarboxylation and racemization.

Occurrence: vitamin B₆ group are widely distributed in animal and plant sources like cereal grains.

Deficiency: deficiency of vitamin B₆ causes weakness of central nervous system and anemia.

4-Vitamin B₁₂ (cyanocobalamine):

Vitamin B₁₂ has a very complex structure.

Occurrence: Vitamin B₁₂ has found only in animals and micro organisms and not in plants.

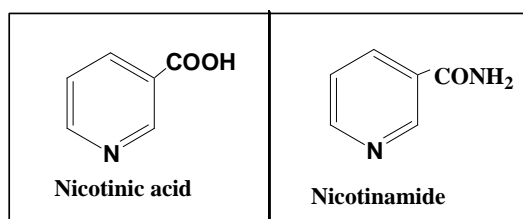
Vitamin B₁₂ was first recognized as an agent (extrinsic factor) useful in the prevention and treatment of pernicious anemia. The intrinsic factor a muco polysaccharide from gastric mucosa cell forms a complex with the extrinsic factor which is absorbed from the ileum. If the intrinsic factor is not present, vitamin B₁₂ is not absorbed.

Vitamin B₁₂ participates in the transmethylation reactions

Deficiency: deficiency of vitamin B₁₂ causes megaloblastic anemia.

5-Niacin (Nicotinic acid):

The biochemical active form of this vitamin is nicotinamide or niacinamide



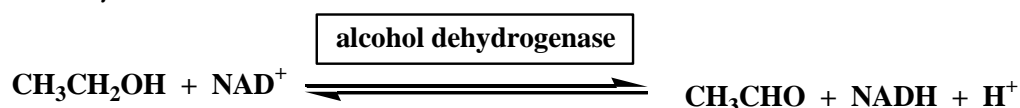
Nicotinamide is part of the coenzymes:

- 1- NAD^+ : nicotinamide dinucleotide
- 2- NADP^+ : nicotinamide dinucleotide phosphate.

Occurrence: Niacin is widely distributed in plant and animal tissues.

The nicotinamide nucleotides are coenzymes for enzymes known as dehydrogenases that catalyze oxidation-reduction reactions. These coenzymes should rather be named co-substrate than coenzyme, because they undergo reduction process when the substrate is oxidized.

Example:



Deficiency: A deficiency of niacin causes pellagra in man and black tongue in dogs. The symptoms of pellagra are dermatitis especially of skin areas exposed to light, a sore, dark colored tongue, an inability to digest and assimilate food.

6-Pantothenic acid:

Pantothenic acid occurs in nature as a component of coenzyme A which participate in the transfer of acetyl group $\text{CH}_3\text{CO}-$ reactions and transfer of acetyl group in the biosynthesis of fats and steroids.

Deficiency: A deficiency of pantothenic acid causes weakness of adrenal cortex.

Occurrence: Eggs, liver, fresh vegetables.

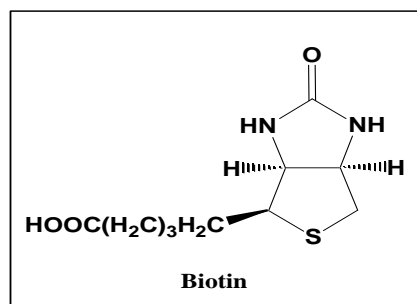
7-Biotin:

Occurrence: Biotin is widely distributed in nature with yeast and liver as excellent sources.

The vitamin occurs mainly in combined form bound to protein through the N-lysine moiety called biocytin.

Biochemical function: Biotin bound to its specific enzyme protein is associated with carboxylation reactions.

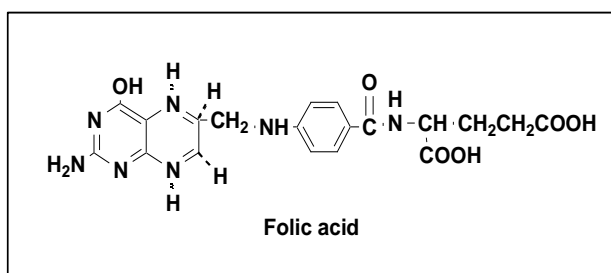
Deficiency: Deficiency of biotin causes weakness, depression and loss of appetite.



It was noticed that eating fresh egg albumin causes deficiency of biotin, the reason is that fresh egg albumin contains protein called avidin which reacts with biotin forming an insoluble complex that cannot be absorbed by the intestines, also sulpha drugs cause deficiency of biotin.

8-Folic acid:

Occurrence: Although folic acid is the vitamin, its reduction product THF or FH_4 is the actual coenzyme form.



Folic acid is found in liver, vegetables and yeast. It is difficult to produce folic acid deficiency, because intestinal bacteria provide the small amount necessary for growth.

Biochemical function: the central role of FH_4 is that of a carrier of a one-carbon unit as formate ($-\text{CHO}$). The formate unit is used in the biosynthesis of pyrimidines, purines, serine and glycine.

Folic acid derivatives play an important role in the formation of normal erythrocytes.

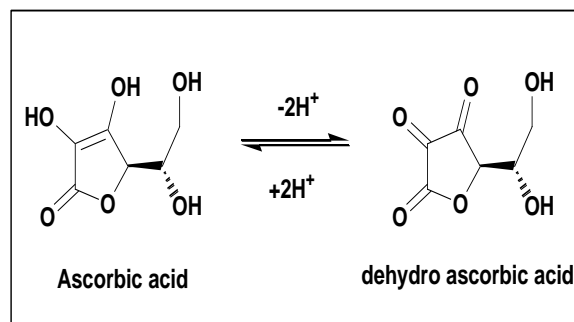
Deficiency: the deficiency of folic acid causes anemia and accumulation of immature erythrocytes in bone marrow.

9-Vitamin C (Ascorbic acid):

Occurrence: Plants and animals except guinea pigs and man cannot synthesize ascorbic acid from D-glucose due to the presence of L-glucon oxidase.

Vitamin C is converted in the body to the active reduced form by glutathione (GSH).

Biochemical function: The function of the active reduced form is to participate in hydroxylation reaction such as hydroxylation of proline and lysine to hydroxyproline and hydroxy lysine.

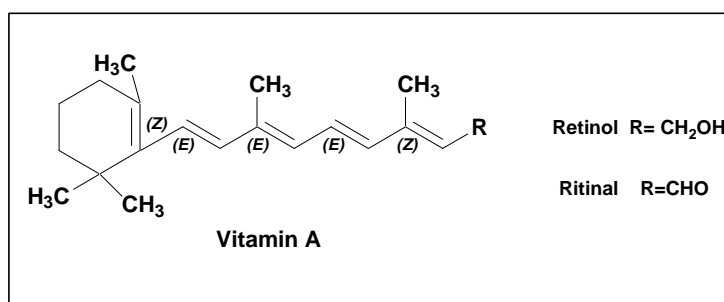


Deficiency: deficiency of vitamin C causes scurvy. The symptoms of the disease are bleeding gums and disorder of the teeth.

2-Fat soluble vitamins:

1-Vitamin A (Retinol):

These compounds are formed from their parent substance β -carotene, which is called a pro vitamin.



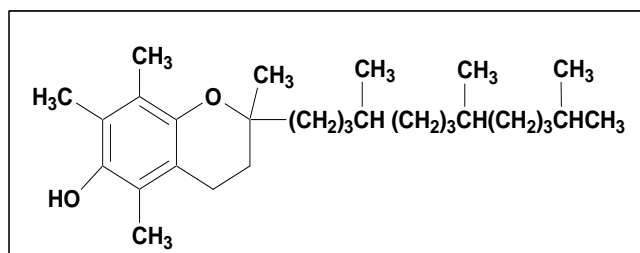
Occurrence: β -carotene is distributed in green leafy vegetables, milk, animal fat and liver, liver oil from fish.

Biochemical function: Retinal combines with opsin protein to form rhodopsin, which is a sensitive protein to light (vitamin A plays an important role in vision).

Deficiency: deficiency of vitamin A causes night blindness and anemia.

2-Vitamin E (α -Tocopherol):

Occurrence: Tocopherols occur in plant oil in varying amounts.



Biochemical functions:

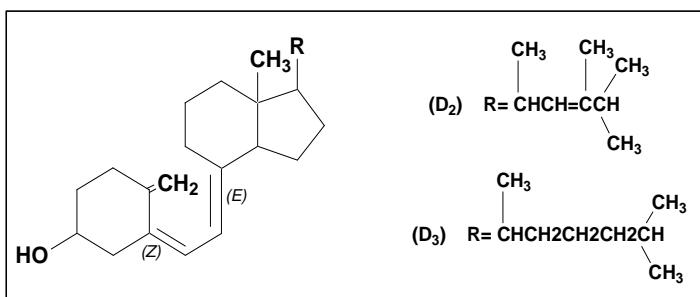
- 1- As antioxidant to protect mitochondrial membranes from oxidation by lipid peroxides which causes damage to the membranes.
- 2- As antioxidant to treat premature infants from the damage of blood vessels of skin and eyes.

Deficiency: deficiency of vitamin E caused dystrophy and impaired fertility in humans.

3-Vitamin D (calciferol):

Vitamin D is produced by the irradiation of the plant steroid, ergosterol.

In animal tissues 7-dehydrocholesterol which occurs naturally in the



epidermal layers, can be converted by UV irradiation to vitamin D₃ which also present in fish oil.

Biochemical functions:

- 1- Absorption of Ca^{+2} from the intestines by stimulation of calcium binding protein (CaBp)
- 2- Transport of Ca^{+2} to bones.
- 3- Absorption of renal Ca^{+2} and phosphate.

Deficiency: deficiency of vitamin D caused depletion of calcium Ca^{+2} and phosphate levels in the body and rickets in children.

4-Vitamin K:

Found in three forms vitamin K₁, K₂ and K₃

Occurrence: vitamin K₁ was first isolated from a plant source and plant foods remain a good source of the vitamin.

Vitamin K₂ is formed by bacteria

Biochemical functions: vitamin K is important in blood clotting, it stimulates the synthesis of clotting factors (in active proteins) but vitamin K converts them to active forms.

Deficiency: deficiency of vitamin K causes hemorrhage disease.