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Water soluble Vitamin

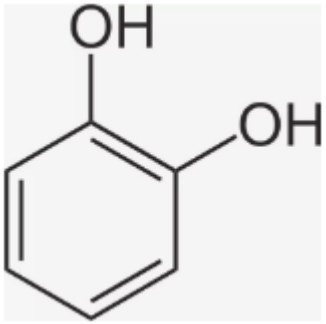
Vit C (Ascorbic Acid)

Synonyms:- Antiscorbutic vitamin.

The active form of vitamin C is ascorbic acid

Sources:- Fresh green vegetables , lemons, orange (the citrus fruit), berries, melons are particularly rich in vit C, tomatoes, potatoes. Gooseberry is one of the richest sources of the vit , spinach and cucumber.

Stability:-



1- It is stable in solid form, in acidic solution and stable to freezing .

2- Rapidly destroyed in alkaline solutions, presence of copper and largely destroyed by cooking.

3- Vit C is probably the least stable of the water-soluble vitamins.

Chemistry:-

1-Ascorbic acid is an "enediol lactone"(alkene enol with a hydroxyl group attached to both carbon atoms of the carbon double bond) with a configuration similar to glucose.

2-Strong reducing property.

Metabolism

1-The vit is rapidly absorbed from GIT.

2- There is very little storage (in pituitary glands, adrenal cortex, thymus glands).

3- It is excreted in the urine partly unchanged and partly as diketogulonic acid and further break down products like oxalic acid.

Metabolic role and function :-

1- Role in cellular oxidation –reduction :- ascorbic acid $\rightleftharpoons$ dehydro ascorbic acid suggest that it may be involved in cellular oxidation-reducation reaction, perhaps serving as hydrogen transport agent.

2- Role in collagen synthesis :- Hydroxyl proline and hydroxylysine are important constituents of mature collagen fibres . Pre- collagen molecules contain the amino acid proline and lysine . They are hydroxylated by corresponding hydroxylases in presence of vit C, Fe and molecular O2 thus:

Proline $\xrightarrow[\text{vit C, Fe+2 , O2}]{\text{proto collagen proline hydroxylase}}$ Hydroxyl proline

Lysine $\xrightarrow[\text{vit C , Fe +2 , O2}]{\text{proto collagen lysine hydroxylase}}$ Hydroxyl lysine

In scurvy, failure of conversion of pre-collagen to collagen due to the failure of hydroxylation may lead to a rapid destruction of the collagen intermediates.

3- Ascorbic acid is required for functional activities of fibroblasts, and osteoblasts and consequently for formation of connective tissues, osteoid tissues, dentine.

4-Vit C required as a cofactor for hydroxylation of tryptophan to form serotonin and hydroxylation of tyrosine to form homogentisic acid.

5- Ascorbic acid in combination with folic acid helps in maturation of the RB cells. Vit C by maintaining folic acid reductase active keeps folic acid in reduced form, tetrahydrofolate.

6-Ascorbic acid is necessary for the formation of tissue ferritin.(storage form)
7- Necessary for absorption of Fe

A- Ascorbic acid in food helps in the absorption of Fe by converting the inorganic ferric iron to the ferrous form.

B - Also helps in mobilization of Fe form its storage form (ferritin). Disturbances of these function may contribute to the development of hypochromic microcytic anemia in scurvy.

8- Action on certain enzyme (activation or inhibition).
9- Role in electron transport systems.
10- Role in stress :- the adrenal cortex contains a large quantity of vit C and this is rapidly depleted when the gland is stimulated by ACTH (adrenocorticotrophic hormone).

11- Relation of ascorbic acid with hypocholesterolaemia .
12- Acts as strong antioxidant .
13- It has been used for rheumatic fever.

14- It prevents the conversion of nitrates (from tobacco, smoke, smoge, bacon, lunch meats, and vegetables) into cancer-causing substances. Vit C will decrease the risk of getting certain cancer by 75%.

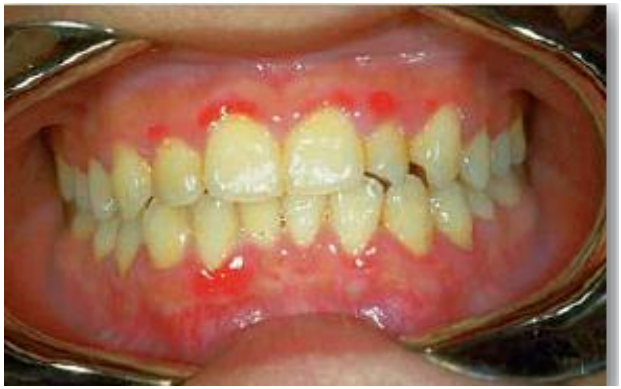
Deficiency manifestations

In humans its deficiency produces a disease called (scurvy) characterized by sore and spongy gums, loose teeth, fragile blood vessels, swollen joints, and anemia

a) Mild deficiency :- capillary fragility with easy bruising and pinpoint hemorrhaged in the skin, as well as decreased immune function.

b) Sever deficiency causes scurvy , its symptoms:-

1- Capillaries are fragile and there is tendency to hemorrhages.
2- Poor dentine formation in children, leading to poor teeth formation.
3- Wound healing is delayed due to deficient formation of collagen.
4- Gums are swollen and becomes spongy and bleeds on slightest pressure.
5- Osteoid of bone is poorly laid and mineralization of bone is poor. The bones are weak and readily fractures.
6- Anemia may be associated which is hypochromic microcytic type.



Prevention of chronic disease

Vitamin C is one of a group of nutrients that includes vitamin E and β-carotene which are known as antioxidants. Consumption of diets rich in these compounds is associated with a decreased incidence of some chronic diseases, such as coronary heart disease and certain cancers. However, clinical trials involving supplementation with the isolated antioxidants have failed to determine any convincing beneficial effects.

Hypervitaminosis :-

In humans, vit C converted to urinary oxalate, the calcium salt of oxalate is no soluble and forms kidney or bladder stones (caculi). That is why vit C intake for long time may causes stones.

Requirements:-

30 mg of vit C for infants and 70 mg for adult. More is required during pregnancy and lactation.

B- complex vitamins

Thiamine (vit.B1)

Synonyms:- anti beriberi factor, anti-neuritic vitamin.

sources:-

A- Plant sources:- in cereal grain. It is concentrated in outer germ\bran layers (e.g. rice polishing).Other sources are peas, beans, nuts, whole white bread is a good source.

B- Animal source :- present in most animal tissues, liver, meat and eggs supply considerable amount, milk has low concentration.

Chemistry:-

1- Free thiamine is a basic substance and contains:-

a) A pyrimidine ring (dimethyl-6-amino pyrimidine)

b) A thiazole ring (methyl hydroxy ethyl thiazole)

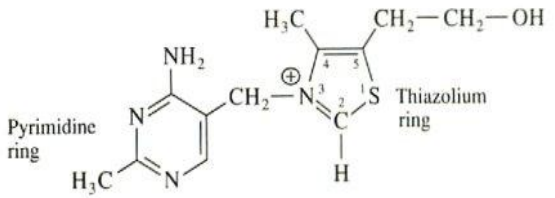
The two ring connected by methylene bridge.

2- It contains sulfur.

3- Generally

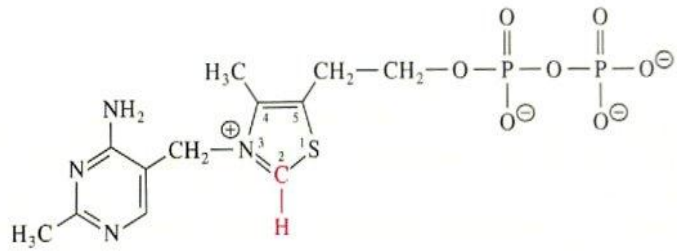
The –OH of the hydroxy ethyl group in the thiazole can be esterified rapidly with two molecules of phosphric acid to form thiamine pyrophsphate (TPP) in the brain and liver by specific enzyme so (TPP) is the active form (active coenzyme) of this vitamin.

(a)



Thiamine (Vitamin B_1)

(b)



Thiamine pyrophosphate (TPP)

Stability

Resistant to heat (boiling) and in solution PH 3.5 but loses activity at PH 5.5 .Thiamine content of vegetables well preserved by freezing and storage below 0C. Rapidly destroyed in alkaline medium.

Metabolism :-

Free thiamine ⟶ readily absorbed by the small intestine ⟶ Liver ⟶ (phosphorylated to TPP) varying amounts of the CO enzyme TPP are present in all tissues. There is no storage of vit .B1, hence regular supplies are needed in diet; about 10% of the ingested vitamin is normally exerted in urine.

Metabolic role (function)

TPP function as the Mg+2 coordinated coenzyme for so called active aldehyde transfers in the oxidative decarboxylation of α-keto acid catalyzed by dehydrogenase complexes and the formation of α-ketols (ketoses) as catalyzed by transketolase (in the mainstream of carbohydrate metabolism in all cells of the body).

1- acts as coenzyme to the enzyme pyruvate dehydrogenase complex (PDH) which converts pyruvic acid to acetyl-CoA (oxidative decarboxylation)

$$\text{Pyruvate} \xrightarrow[\text{TPP}]{\text{PHD}} \text{acetyl-CoA} + CO_2$$

2-Similarly acts as a coenzyme to α-ketoglutarate dehydrogenase complex and converts α-ketoglutarate to succinyl –CoA (oxidative decarboxylase).

$$\alpha\text{- ketoglutarate} \xrightarrow[\text{TPP}]{\alpha\text{-ketoglutarate dehydrogenase}} \text{Succinyl –CoA}$$

3- TPP also acts as a coenzyme with the enzyme transketolase in transketolation reaction in hexosmonophsphate shunt (HMP) of glucose metabolism (pentose phosphate pathway to synthesize NADPH); and the pentose sugars: deoxyribose and ribose are involved in nucleic acids biosynthesis.
4- Also acts as a coenzyme for the oxidative decarboxylation of branched chain amino acids valine, leucine and isoleucine . The enzyme concerned is branched chain α- keto acid dehydrogenase.

5-B1 is also required in amino acid tryptophan metabolism for the activity of the enzyme tryptophan pyrrolase.

Deficiency manifestation:-
The deficiency of thiamine produces a condition called beriberi which occurs in three stages :-
A) Early :- loss of appetite, constipation and nausea, peripheral neuropathy, irritability and fatigue.
B) Moderately severe :- Wernick-Korsakoff syndrome which includes mental confusion ataxia (unsteady agitation , and poor coordination), and ophthalmoplegia (loss of eye coordination).
C) Severe :-
1- Dry beri-beri includes all of the signs and symptoms in A and B plus more advanced neurologic symptoms, with atrophy and weakness of the muscles.
2- Wet beri-beri includes the symptoms of dry beri-beri in combination with edema, high-output cardiac failure, and pulmonary congestion.

Biochemical features in thiamine deficiency:-

1- decreased level of thiamine and carboxylase TPP in blood and urine.
2- Accumulation of pentose sugar in RB cells due to retardation of transketolation reaction
3- Increased level of pyruvic acid (PA) and lactic (LA) in blood, due to retardation of oxidative decarboxylation of pyruvic acid.
LA /PA ratio:- abnormal blood LA / PA ratio is said to be more specific indicator of B1-deficiency.

Daily requirements:-

Adults – 0.5 mg for each calories .

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Requirements increase in :-

Anoxia, shock, hemorrhage, serious illness, injury, increased alcohol intake, and in pregnancy and lactation.

Riboflavin Vit. B2

Synonyms-lactoflavin

Source :-

widely distributed in nature, present in all plant and animal cells, beans and peas, nuts, green vegetables.

Animal source :-liver, kidney and milk .

Chemistry :-

1- It is a yellow green compound containing :-

a- A ribose alcohol (D-ribitol).

b- A heterocyclic parent ring structure isoalloxazine (favin nucleus) the carbon of ribityl group is attached at the 10- position of iso-alloxazine nucleus.

Biological active forms:-

The biological active forms in which riboflavin serves as the prosthetic group as coenzyme of a number of enzymes are the phosphorylated derivatives.

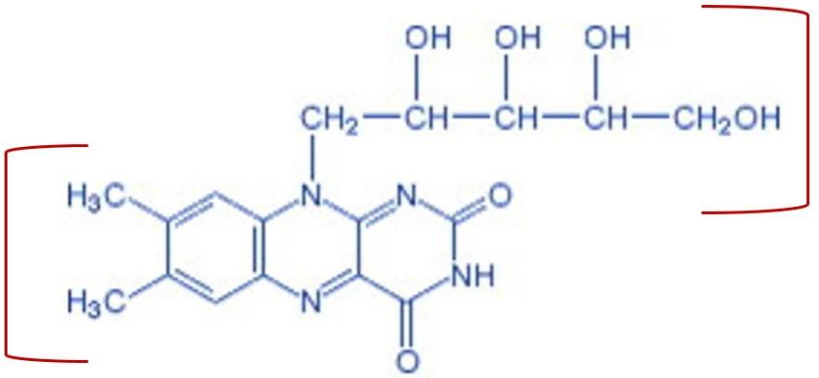
These enzymes are called flavoproteins. Two main derivatives (active forms) are:-

a-**FMN-** flavin mononucleotide:- in this phosphoric acid is attached to ribityl alcoholic group in position 5. FMN is an electron carrier in the electron transport chain.

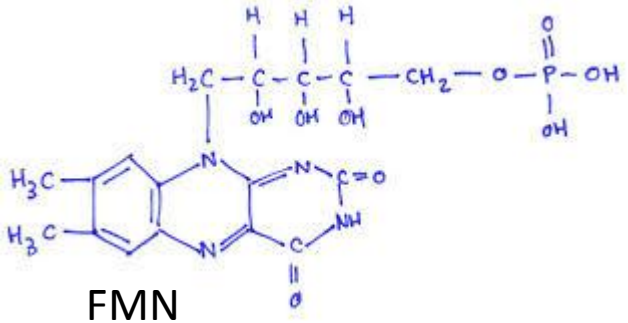
Riboflavin: vitamin B^2

Ribitol side chain

Riboflavin



Flavin



FMN

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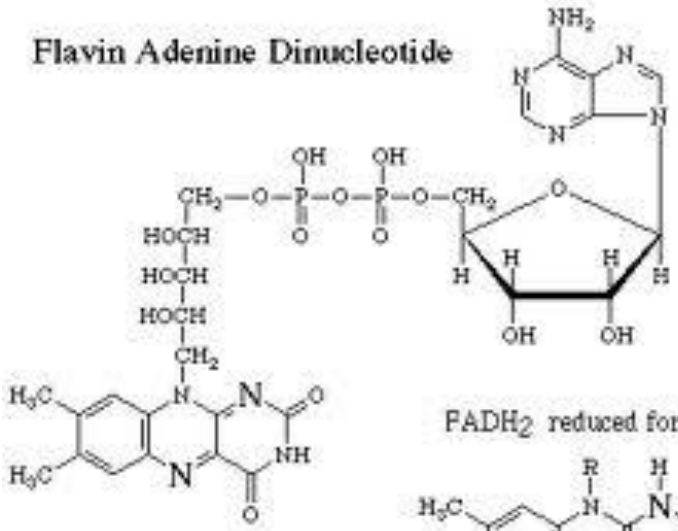
B-FAD :-

Flavin adenine dinucleotide FAD is cofactor for pyruvate dehydrogenase complex (PDC), and succinate dehydrogenase in TCA cycle



Stability :-

Riboflavin is relatively heat –stable but destroyed by exposure to visible light and is reduced to colorless product

Metabolic role (function)

FMN and FAD act as coenzymes in various H- transfer reactions in metabolism. The hydrogen is transported by reversible reduction of the coenzyme by two hydrogen atoms added to the “N” thus forming dihydroflavin . The principal enzyme reactions catalyzed as shown below:-

FMN :-

1-Cytochrome- C- reductase.

2- D- amino acid oxidase.

FAD:-

1- Xanthine oxidase.

2-D- amino acid oxidase.

During the enzymatic reaction involving the flavo-proteins, the reduced forms of FMN and FAD are formed, FMNH2 and FADH2 respectively.

Deficiency manifestation

Deficiency is usually associated with deficiencies in other B- vitamins. In humans beings, lesions of the mouth, tongue, skin and eyes with weakness and lassitude reported. They include:-

a-Cheilosis-lesions at the mucocutaneous junction at the angles of the mouth leading to painful fissures are characteristic.

b-Lips-redness and shiny appearance of lips.

c-Tongue-painful glossitis (red-purple tongue).

d-Seborrheic dermatitis: scaly, greasy, desquamation chiefiy about the ears, nose.

e- Eyes :may lead to corneal vascularization and inflammation with cloudness of cornea.

Daily requirement:

Exact human requirement is not known, related to degree of protein utilization.
For adult: 1.5-1.8 mg
Children : 1-1.8 mg

Requirement increases after severe injury, burns, during acute illness and during convalescence, etc.