

VITAMINS

Definition:

The naturally occurring micronutrients present in food and are required for normal functioning and growth of the living organisms are called as a “vitamins”.

Classification

Fat soluble vitamins:

These are soluble in fat and are stored in liver. Their absorption requires presence of bile salts and fats. **Ex.** Vitamin A, Vitamin D, Vitamin E and Vitamin K

Water soluble vitamins:

These are soluble in water and are not stored in body. Water soluble vitamin includes B-complex group and vitamin C. **Ex**

B complex

Non B- complex: Vitamin C (Ascorbic acid)

- a) Vitamin B1- Thiamine
- b) Vitamin B2- Riboflavin
- c) Vitamin B3- Niacin
- d) Vitamin B5- Pantothenic acid
- e) Vitamin B6- Pyridoxine
- f) Vitamin B7- Biotin
- g) Vitamin B9- Folic acid
- h) Vitamin B12- Cyanocobalamine

Fat soluble Vitamins

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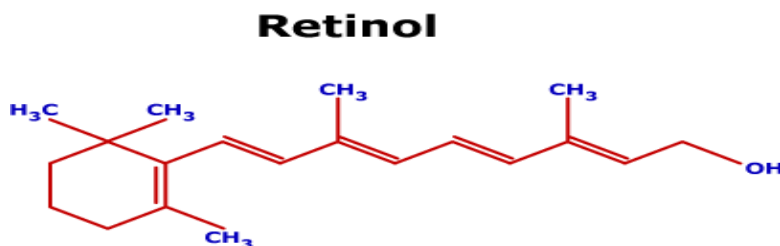
Vitamin A

Chemical Name: Retinol

Biological active form: Vitamin A₁ (Retinol) and Vitamin A₂ (Dehydroretinol)

PHYSIOLOGICAL ROLE OF VIT A IN VISION:

(VERY IMPORTANT)



The retina of the eye contains two types of receptor cells, Rod cells which are responsible for dim light vision & the cones, responsible for bright light vision. Cones are also responsible for colour perception. The deficiency of cone pigments makes the individual colour blind.

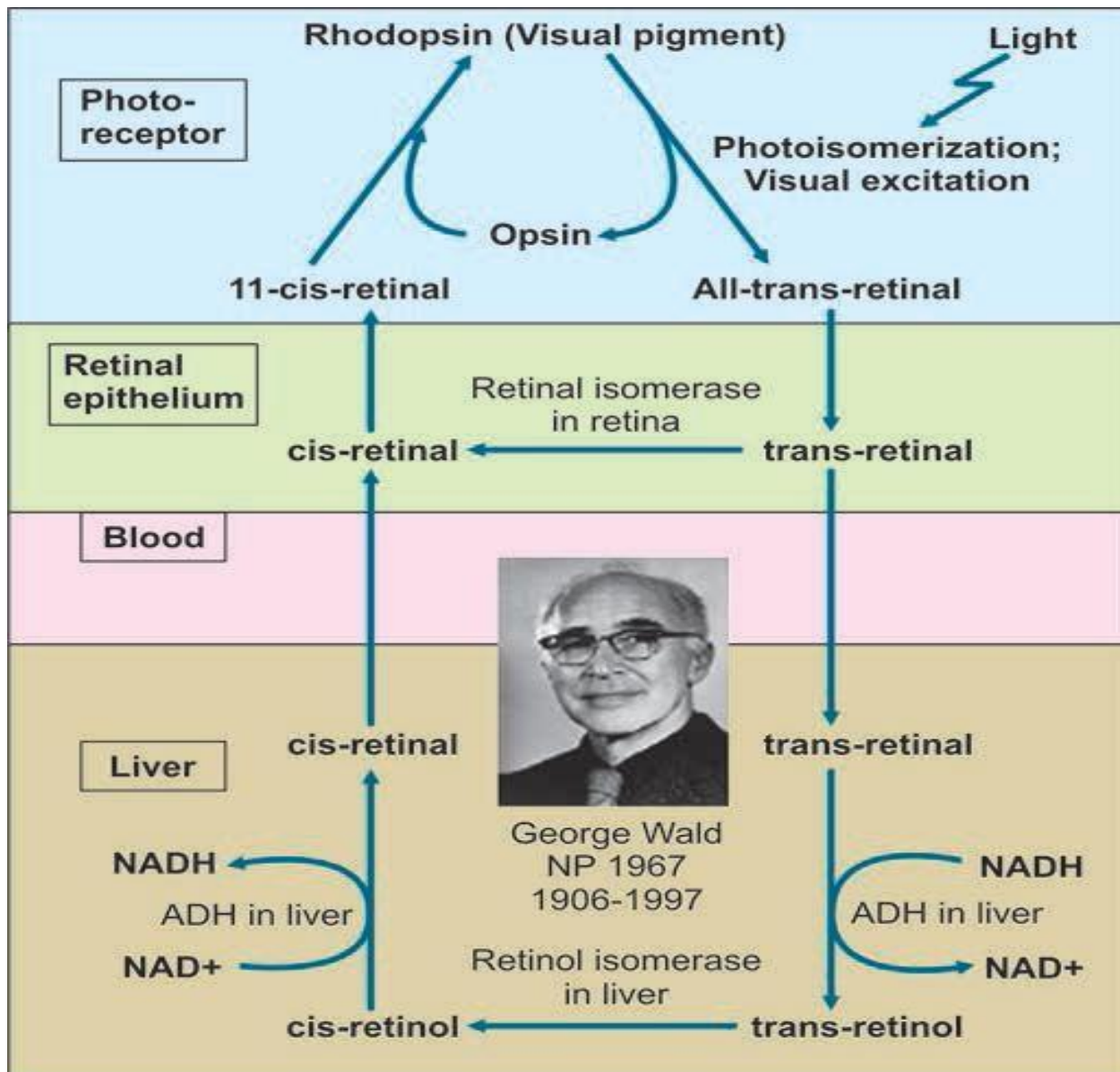
In retinal pigments, the rod cells contain rhodopsin. Under the influence of light, rhodopsin is converted to lumino rhodopsin which is further converted into metarhodopsin. Then hydrolysed to protein opsin & trans retinal. Trans-Retinal (trans- retinene) is inactive in the synthesis of rhodopsin, it must be covered to the active cis- isomer.

In the eye, the trans-retinal is isomerised to 11-cis-retinal by the enzyme retinal Isomerase. This reaction is taking place in retinal pigment epithelium. The 11-cis retinal can recombine with opsin to regenerate rhodopsin. Alternatively, the trans retinol which is too inactive in rhodopsin synthesis is passed into blood stream, then all-trans-retinal is transported to liver and then reduced to all-trans-retinol by alcohol dehydrogenase (ADH), an NADH

Vitamins

dependent enzyme. The all-trans-retinol is isomerized to 11-cis-retinol and then oxidised to 11-cis-retinal in liver. This is then transported to retina. This completes the Wald's visual cycle.

The individual having vitamin A deficiency are unable to resynthesise rhodopsin and thus unable to see in the dim light and the condition is called night blindness.



Physiological role of Vit A:

Vitamin A in Vision:

- ✓ Helps to maintain the cornea
- ✓ Conversion of light energy into nerve impulses at the retina
- ✓ Rhodopsin is a light-sensitive pigment of the retina that contains a protein called opsin.

Vitamin A in Protein Synthesis and Cell Differentiation:

Through cell differentiation, vitamin A allows cells to perform specific functions i.e Epithelium of skin and mucus membrane (outside of the body form the skin and on the inside of the body form the mucous membrane).

Vitamin A in Reproduction and Growth

- ✓ Sperm development in men
- ✓ Normal fetal development in women
- ✓ Growth in children
- ✓ Remodeling of the bone involves osteoclasts, osteoblasts, and lysosomes.

Vitamin A in Immunity

Vita A has been shown to induce production of regulatory T cells that help dampen the immune response to self and foreign antigen.

Beta-Carotene as an Antioxidant

Beta-carotene helps protect the body from diseases, including cancer.

Deficiency Manifestations of Vitamin A...

- ✓ Poor adaptation to darkness - **night blindness**
- ✓ **Keratomalacia** (thinning and ultimately ulceration of the cornea - colliquative necrosis).
- ✓ Conjunctival dryness, corneal dryness, **xerophthalmia**
- ✓ **Bitot's spots** (areas of abnormal squamous cell proliferation and keratinisation of the conjunctiva, causing oval, triangular or irregular foamy patches on the white of the eye).
- ✓ Blindness due to structural damage to the retina.
- ✓ Vit A Deficiency may leads to histological changes in taste buds and may leads to change in taste perception.
- ✓ Vit A Deficiency may leads to decrease production of steroids, growth fail/ retardation.

Vitamin A Toxicity

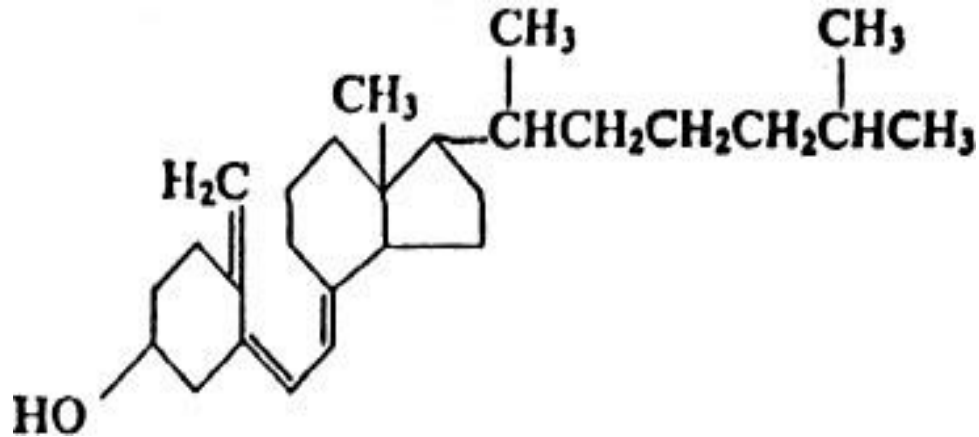
Birth Defects

- **Teratogenic** risk is possible, resulting in abnormal fetal development and birth defects.
- Vitamin A supplements are not recommended the first trimester of pregnancy.

Vitamin D

Chemical Name: Chole calciferol

Biological active form: Vit D₃ (Cholecalciferol)



Chole calciferol (Vitamin D₃)

Physiological role of Vit D :

- ✓ Helps to maintain blood levels of calcium and phosphorus from intestine.
- ✓ It stimulates calcification of bones; it is necessary for the development of teeth and bones.
- ✓ It produces hydrolysis of Phytate and thus prevents it from Rickets.
- ✓ It decreases the PH level of small intestine which helps in increasing the absorption of calcium and phosphorus.

Deficiency Manifestations of Vita D ...

1) Rickets :

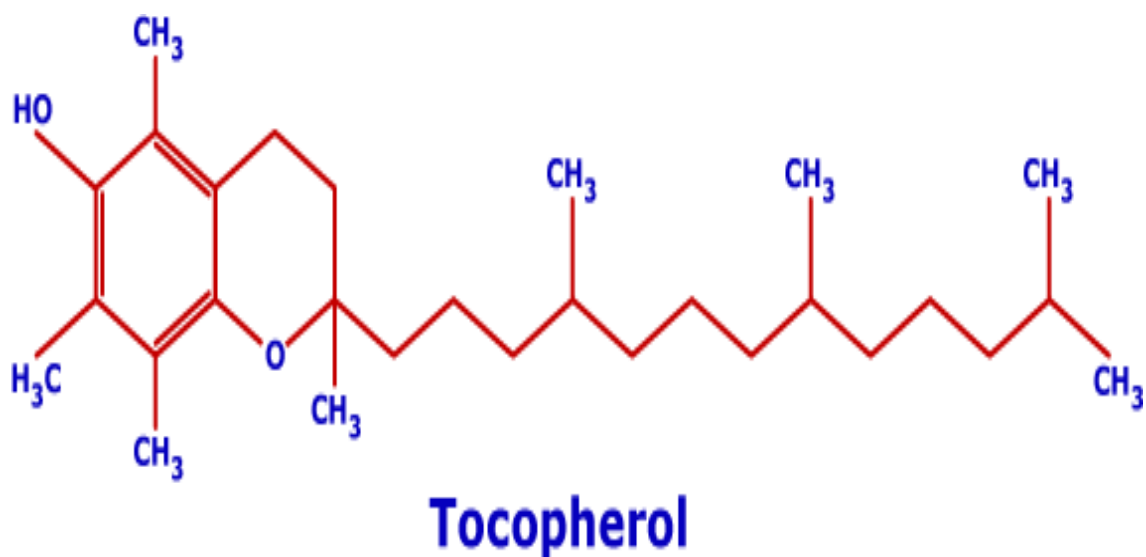
1. Inadequate calcification of bones
2. Growth retardation
3. Misshapen bones- bowing of the legs
4. Enlargement of the ends of long bones.

- 2) Osteoporosis
- 3) Osteomalacia

Vitamin E

Chemical Name: Tocopherol (Anti- sterility)

Biological active form: d-alpha tocopherols



Physiological role of Vit E:

- 1) Anti-oxidant action: It protects Vita A and carotene from destruction by oxidation in the body.
- 2) Anti- Sterility: It is necessary for the growth and maintenance of seminiferous tubules and ovary. Thus prevents sterility.

Vitamins

- 3) It protects enzymes in muscles, nerves or gonads from destruction.
- 4) It prevents formation of peroxides by polyunsaturated fatty acids and also pigmentation of adipose tissue And also acts as co-factor in steroid metabolism.
- 5) The free radicals would attack bio-membranes. Vitamin E protects RBC from hemolysis. By preventing the peroxidation, it keeps the structural and functional integrity of all cells.

Deficiency Manifestations of Vita E ...

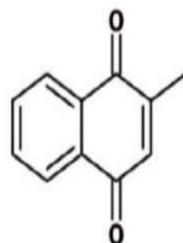
- 1) Sterility and intrauterine death of fetus has been shown in rats
- 2) Muscle dystrophy
- 3) Hepatic Necrosis
- 4) Increased oxygen consumption by skeletal muscle.
- 5) **Neuromuscular problems**-such as [spinocerebellar ataxia](#) and [myopathies](#).
- 6) [Anemia](#)-due to oxidative damage to red blood cells.

Vitamin K

Chemical Name: Menadione (Anti- Haemorrhagic factor)

Biological active form: Menaquinone

Vitamin K3
(menadione)



Physiological role of Vit K :

- 1) It is necessary for blood coagulation , clotting factors such as 2,7 ,9, 10 are activated by Vit K through liver.
- 2) It acts as a co-factor in oxidative phosphorylation.
- 3) It shortens prothrombin time.
- 4) It is used as antidote to the anti coagulants like Warfarin.

Deficiency Manifestations of Vita K ...

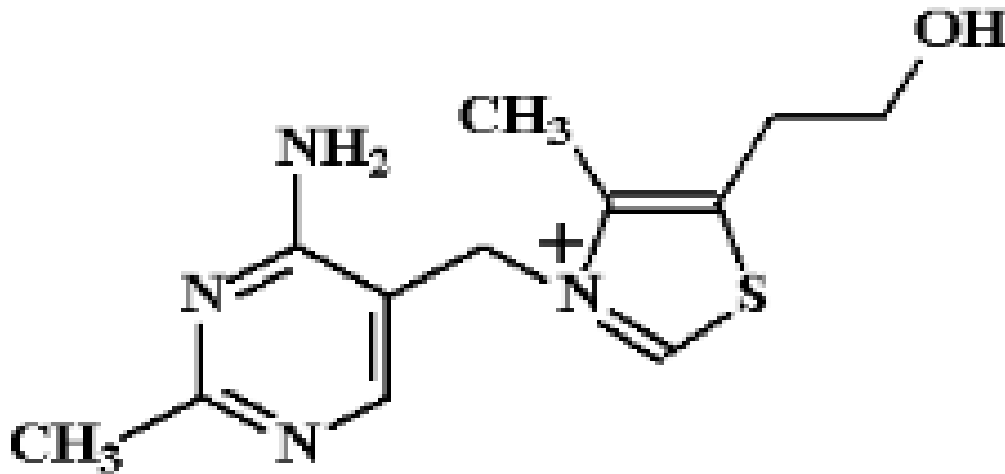
- 1) Lowering of prothrombin level in which blood coagulation time is increased.
- 2) Uncontrolled bleeding and haemorrhage may occur. Bleeding of the gums or nose in both sexes, and heavy menstrual bleeding in women.

Water soluble Vitamins

These are soluble in water and are not stored in body. Water soluble vitamin includes B-complex group and vitamin C.

Vitamin B 1

Chemical Name: Thiamine



Physiological Role of Thiamine :

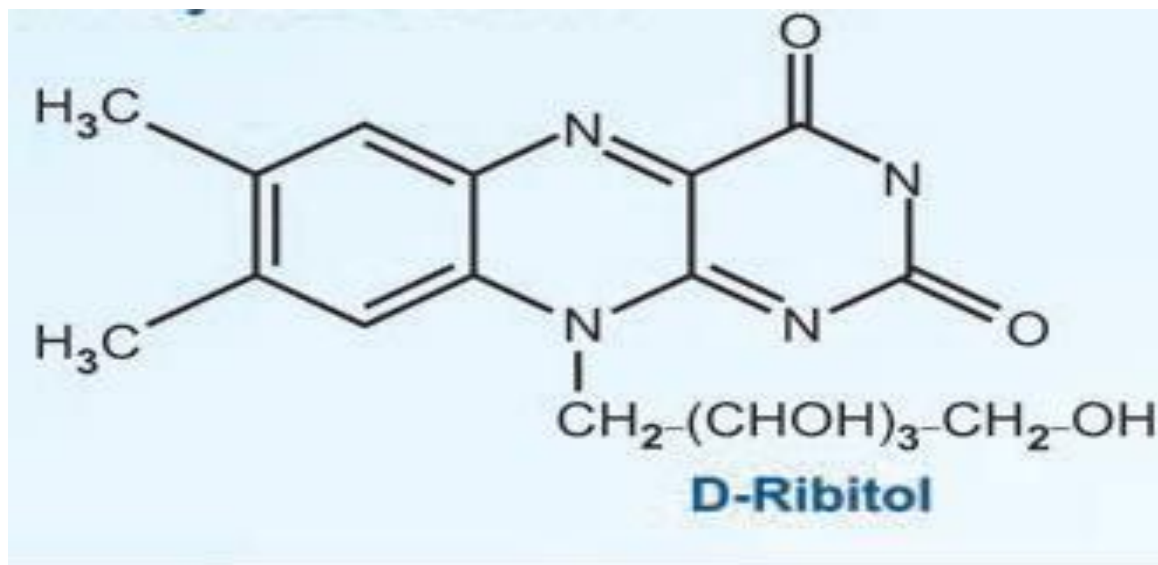
- 1) The co-enzyme form is thiamine pyrophosphate (TPP). It is used in oxidative decarboxylation of alpha keto acids.
- 2) Transketolase: The second group of enzymes that use TPP as co-enzyme are the transketolases, in the hexose monophosphate shunt pathway of glucose.

Deficiency Manifestations of Vita B 1...

1. Beriberi
2. Wet beriberi
3. Dry beriberi
4. Infantile beriberi

Vitamin B 2

Chemical Name: Riboflavin.



Physiological Role of RIBOFLAVIN

1) Riboflavin exists in tissues tightly bound (but not covalently) with enzymes. Enzymes containing riboflavin are called **flavoproteins**. The two coenzymes are **FMN (flavin mono nucleotide)** and **FAD (flavin adenine dinucleotide)**.

2) **FMN** is the constituent of various enzymes like Cyto C reductase and L- Amino acid dehydrogenase.

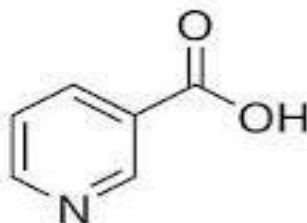
3) **FAD** is the constituent of various enzymes Xanthine oxidase.

Deficiency Manifestations of Vita B 2...

- 1) Symptoms are confined to skin and mucous membranes.
 - i. Glossitis (Greek, glossa = tongue).
 - ii. Magenta colored tongue
 - iii. Cheilosis (Greek, cheilos = lip)
 - iv. Angular stomatitis (inflammation at the corners of mouth).

Vitamin B 3

Chemical Name: Niacin.



Niacin

Physiological Role of NIACIN

- 1) Niacin is converted to its co-enzyme forms, viz. Nicotinamide adenine dinucleotide (**NAD⁺**) and Nicotinamide adenine dinucleotide phosphate (**NADP⁺**)
- 2) It helps in the formation of fats from carbohydrates.
- 3) It is used therapeutically for lowering plasma cholesterol.
- 4) NADH produced is oxidized in the electron transport chain to generate ATP. NADPH is also important for many biosynthetic reactions as it donates reducing equivalents

Deficiency Manifestations of Vita B 3...

1) Pellagra

Symptoms are confined to skin and mucous membranes.

Deficiency of niacin leads to the clinical condition called pellagra. Pellagra is an Italian word, meaning "rough skin". Pellagra is caused by the deficiency of Tryptophan as well as Niacin.

Pellagra is seen more in women;

The symptoms of pellagra are:

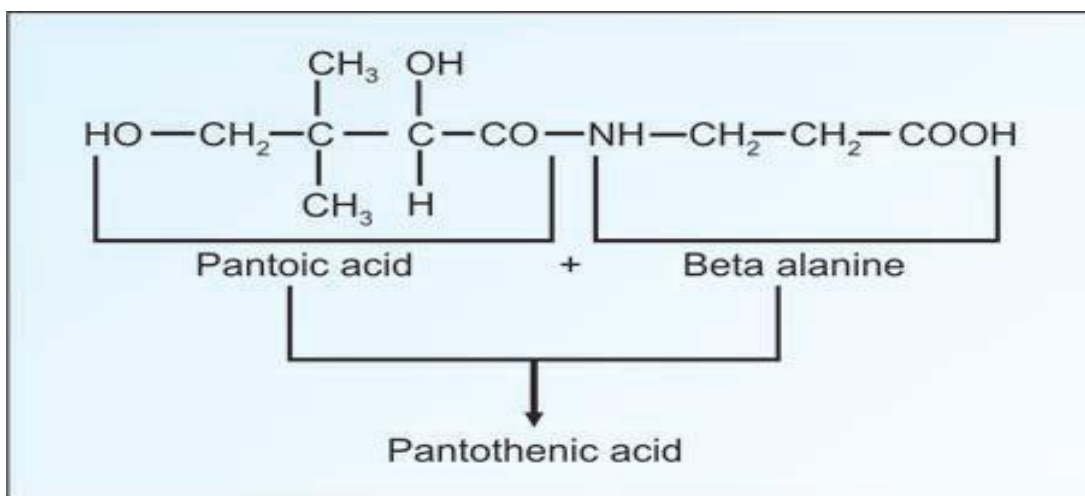
Dermatitis

Dementia

Diarrhea

Vitamin B 5

Chemical Name: Pantothenic acid



Physiological Role of Pantothenic acid:

1) The functions of pantothenic acid are exerted through coenzyme A or CoA (A for acetylation).

Coenzyme A is a central molecule involved in all the metabolisms (carbohydrate, lipid and protein). It plays a unique role in integrating various metabolic pathways. More than 70 enzymes that depend on coenzyme A are known.

2) The important CoA derivatives are:

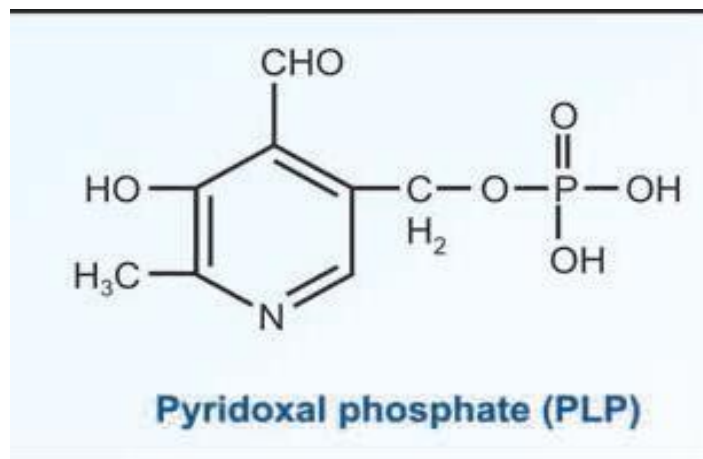
- a. Acetyl CoA
- b. Succinyl CoA
- c. HMG CoA
- d. Acyl CoA.

Deficiency Manifestations of Vita B 5...

Burning Foot Syndrome is manifested as paresthesia (burning, lightning pain) in lower extremities, staggering gait due to impaired coordination and sleep disturbances.

Vitamin B 6

Chemical Name: Pyridoxine.



Physiological Role of Pyridoxine:

1) The pyridoxal phosphate (PLP) acts as co-enzyme for many reactions in **amino acid metabolism**.

2) Pyridoxal phosphate participates in reactions like transamination, decarboxylation, deamination, transsulfuration, condensation etc.

3) transamination:

Alanine + Alpha keto glutarate → Pyruvate +

Glutamic acid (Enzyme Alanine transaminase).

4) Decarboxylation :

All decarboxylation reactions of amino acids require PLP as co-enzyme.

i. Glutamate → GABA (gamma amino butyric

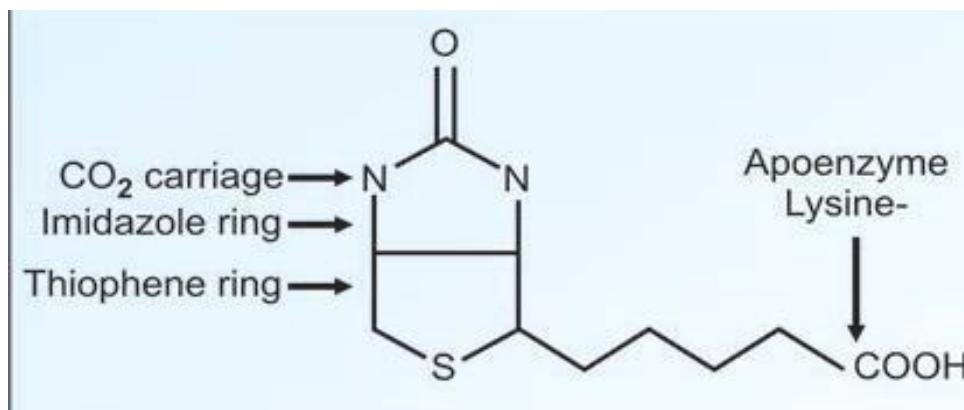
acid) GABA is an inhibitory neurotransmitter, and hence in B6 deficiency, especially in children, **convulsions may occur**.

Deficiency Manifestations of Vita B 6...

1. Retarded growth
2. Problems in weight gain
3. Anemia
4. Skin lesion
5. Convulsions in Infants.

Vitamin B 7

Chemical Name: Biotin.



Structure of Biotin

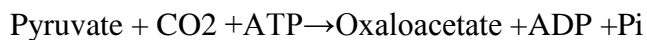
Physiological Role of BIOTIN.

- 1) Biotin acts as co-enzyme for carboxylation reactions. Biotin captures a molecule of CO₂ which is attached to nitrogen of the biotin molecule. The energy required for this reaction is provided by ATP.
- 2) Biotin Requiring CO₂ Fixation Reactions:

1. Acetyl CoA carboxylase

This enzyme adds CO₂ to acetyl CoA to form malonyl CoA. This is the rate limiting reaction in biosynthesis of fatty acid.

2. Pyruvate carboxylase



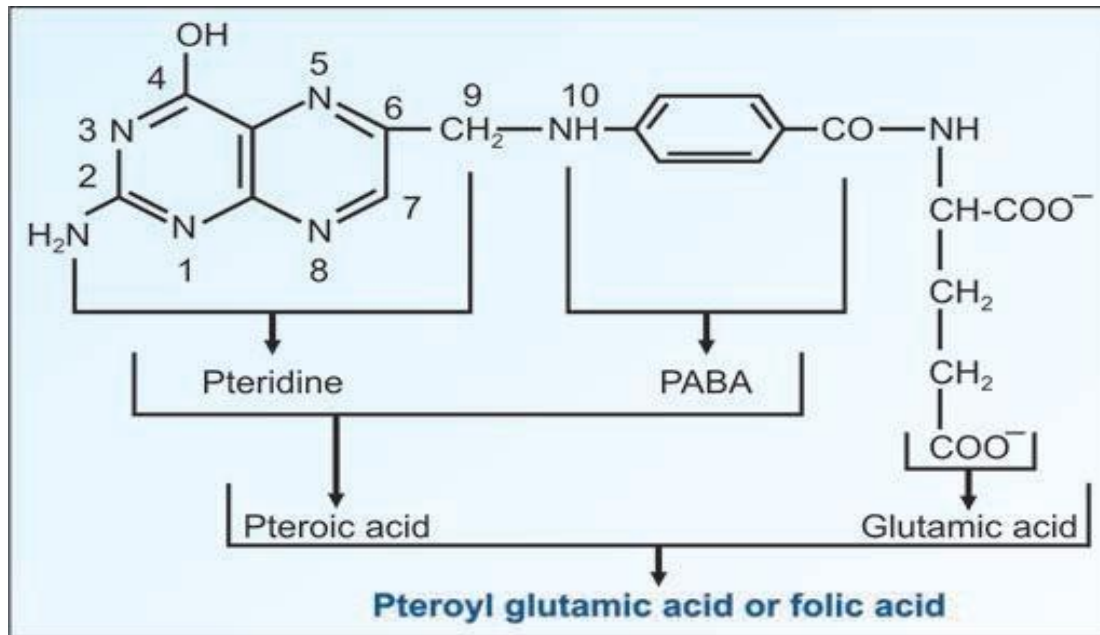
This is important in two aspects. One, it provides the oxaloacetate, which is the catalyst for TCA cycle. Second, it is an important enzyme in the gluconeogenic pathway.

Deficiency Manifestations of Vita B 7...

Dermatitis, atrophic glossitis, hyperesthesia, muscle pain, anorexia and hallucinations.

Vitamin B 9

Chemical Name: Folic Acid.



Physiological Role of Folic Acid :

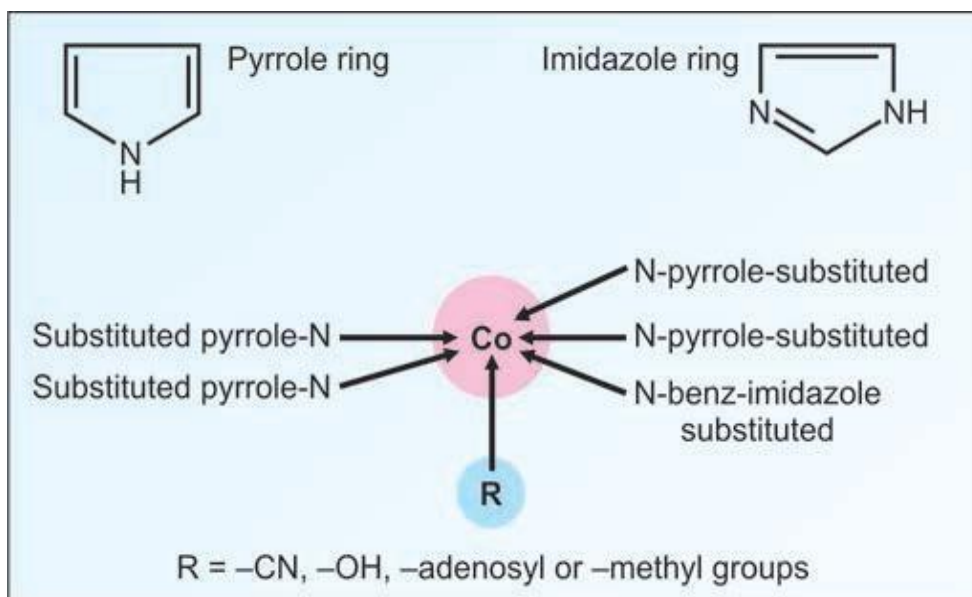
- 1) It is required in one carbon metabolism reaction.
- 2) It is involved in DNA synthesis.
- 3) It helps in the formation and maturation of red cells.
- 4) It is used in treatment of megaloblastic anaemia.

Deficiency Manifestations of Vita B 9...

1. Reduced DNA synthesis
2. Macrocytic Anemia
3. Reticulocytosis
4. Birth Defects

Vitamin B 12

Chemical Name: Cyanocobalamin



Physiological Role of Vita B 12 :

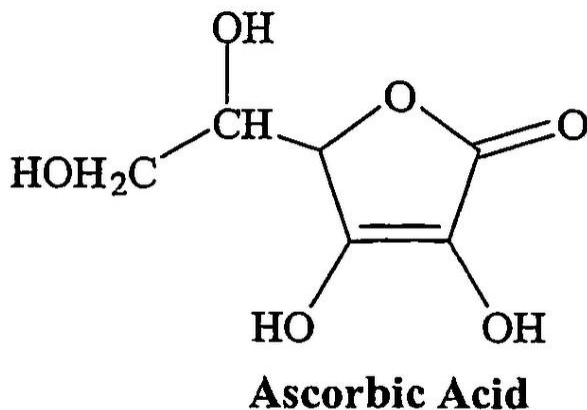
1. It is required in the formation and maturation of red cells.
2. It is required in the synthesis of nucleic acid.
3. It is required for normal activity of nervous system.
4. It helps in Synthesis of methionine from homocysteine
5. Formation of lipids from carbohydrates is influenced by Vita B12

Deficiency Manifestations of Vita B 12...

1. Pernicious anemia and decreased bilirubin level in body.
2. Abnormal homocysteine level
3. Demyelination
4. Achlorhydria

Vitamin C

Chemical Name: Ascorbic Acid.



Physiological Role of Vita C:

- 1) It regulates redox potential inside the cell.
- 2) It is involved in the Tyrosine metabolism.
- 3) It helps in the wound repair.
- 4) It is required in the formation and maturation of red cells.
- 5) It helps in absorption of iron from intestine.

Deficiency Manifestations of Vita C...

Vita C deficiency leads to **Scurvy** and symptoms are

- 1) Internal Hemorrhage
- 2) Gums swollen and bleeding
- 3) Malformation of bones
- 4) Poor wound healing

Vitamins

Coenzymes

These are organic molecules, often derived from the B-complex group vitamins that participate directly in enzymatic reactions.

OR

Co-enzymes may be defined as substance necessary for the activity of certain enzymes. Many enzymes catalyze the reactions only in presence of specific non protein organic molecules called the “co enzyme”

Vitamins	Deficiency disease	Co-enzymes
Vita A / Retinol	Nightblindness, Xerophthalmia	-----
Vita D / Calciferol	Rickets, osteoporosis	-----
Vita E / Tocopherol	Sterility	-----
Vita K / Menadione	Blood clotting disorder	-----
Vita B 1/ Thiamine	Beri-beri	Thiamine Pyrophosphate.
Vita B 2 / Riboflavin	Dermatitis	FMN and FAD
Vita B 3/ Niacin /nicotinic acid	Pellagra	FAD and NADP
Vita B 5 / Pantothenic acid	Burning Foot Syndrome	Co- A
Vita B 6 / Pyridoxine	Anemia	Pyridoxal phosphate
Vita B 7 / Biotin	Dermatitis	Biotin
Vita B 9 / Folic acid	Macrocytic Anemia	Terahydrofolate
Vita B 12/ Cynocobalamine	Pernicious anemia	Deoxyadenosine cobalamine
Vita C /Ascorbic acid	Scurvy	Ascorbic acid

