VITAMINS: STRUCTURE AND FUNCTIONS

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INTRODUCTION TO VITAMINS

- Vitamins are organic compounds required by the body in small amounts for metabolism, for protection, for maintenance of health and proper growth
- They cannot be synthesized by the body. Must be obtained by outside sources like diet, rumen of bacteria & sun.
- Vitamins also assist in the formation of hormones, blood vessels, nervous system chemicals and genetic materials
- They generally act as catalysts, combining with proteins to create metabolically active enzymes that are essential for life reactions
- Without enzymes, many of the reactions essential to life would slow down or cease

COMPOSITION OF VITAMINS

- Vitamins are of different chemical nature. These are alcohols, aldehydes, organic acids, their derivatives and nucleotide derivatives

CLASSIFICATION OF VITAMINS

- Vitamins are classified according to their ability to be absorbed in fat or water
- 1. Fat Soluble Vitamins: these are oily and hydrophobic compounds, they are stored in the liver and not excreted out of the body. Bile salts and fats are needed for their absorption. Vitamins A,D,E and K are fat soluble
- 2. Water Soluble Vitamins: Vitamin B complex and Vitamin C are water soluble. They are not stored in the body, therefore are required daily in small amounts

CLASSIFICATION OF VITAMINS CONT'D

Fat Soluble Vitamins:

stored in tissues

Examples

A

D

E

K

Water Soluble Vitamins:

not stored in tissues, must have constant supply

Examples

B, B1, B2, B6 & B12

Niacin

Folic Acid

C

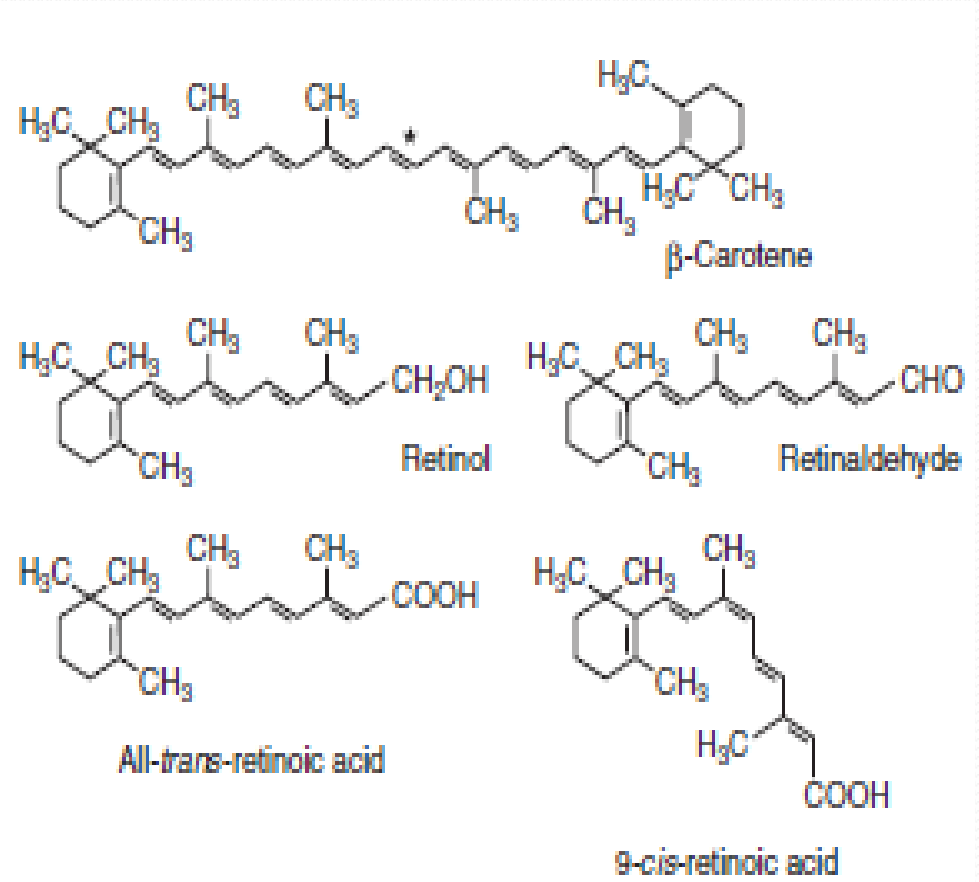
FAT SOLUBLE VITAMINS

VITAMIN A

Vitamin A is a pale yellow primary alcohol derived from carotene. It include Retinol (alcoholic form), Retinal (aldehyde form) and Retinoic acid (acidic form)

Sources, physiological functions and deficiency: refer to notes

STRUCTURE OF VITAMIN A



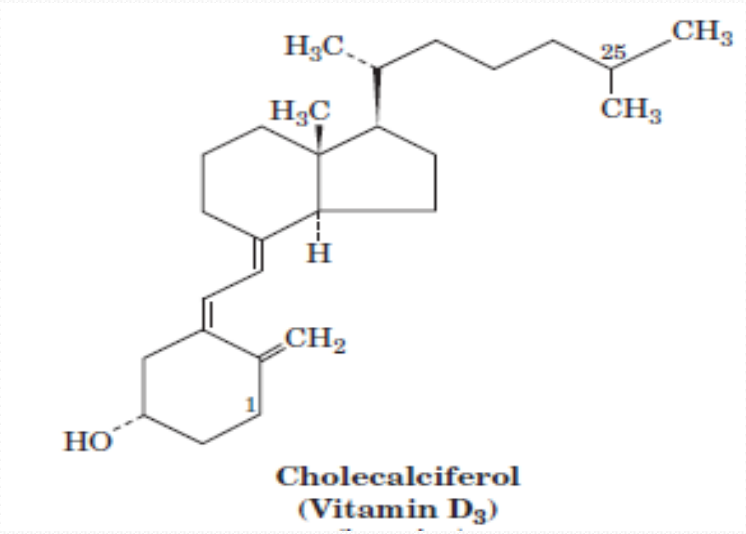
FAT SOLUBLE VITAMINS

VITAMIN D(Calciferol)

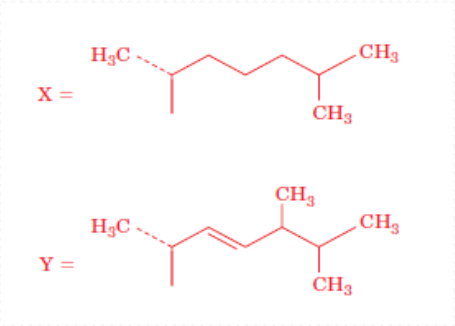
This comprises a group of fat soluble sterol founds naturally in few foods. The two major physiolgically relevant forms of vitamin D are D2 (ergocalciferol) and D3 (cholecalciferol)

- Sources, physiological functions and deficiency: refer to notes

STRUCTURE OF VITAMIN D



Cholecalciferol
(Vitamin D_3)



FAT SOLUBLE VITAMINS

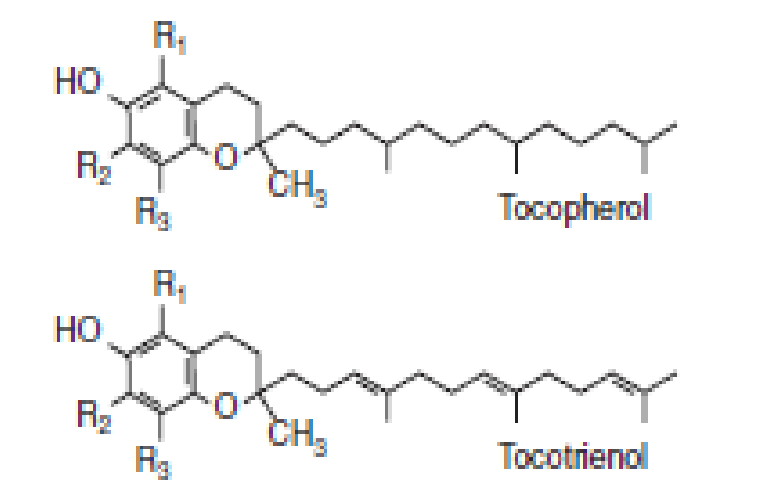
VITAMIN E

also called Tocopherol or fertility hormone

Vitamin E is required in the human diet but its deficiency is rare except in pregnancy and the new born, where it is associated with hemolytic anaemia

- **It exists in the diet as a mixture of eight closely related compounds called tocopherols**
- **Sources, physiological functions and deficiency: refer to notes**

STRUCTURE OF VITAMIN E



The vitamin E vitamers. In α-tocopherol and tocotrienol R_1, R_2, and R_3 are all —CH_3 groups. In the β-vitamers R_2 is H; in the γ-vitamers R_1 is H, and in the δ-vitamers R_1 and R_2 are both H.

FAT SOLUBLE VITAMINS

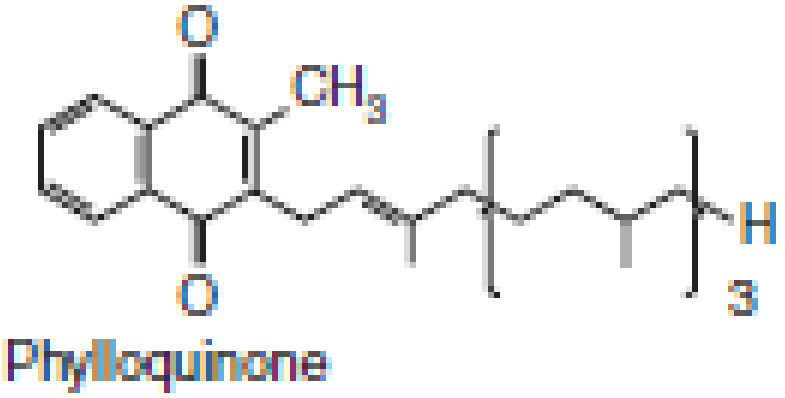
VITAMIN K

Also called phylloquinone or anti-hemorragic vitamin or coagulation vitamin. Vitamin K is a complex unsaturated hydrocarbon found in two forms, vitamin K1(phylloquinone) and vitamin K2(Menaquinone)

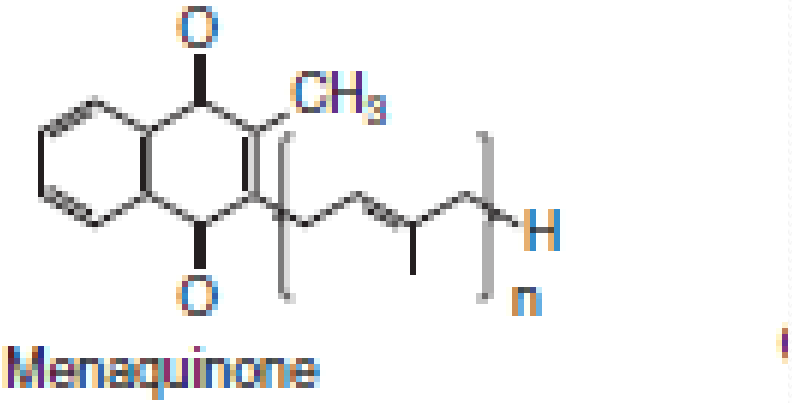
Sources, physiological functions and deficiency:

Refer to notes

STRUCTURE OF VITAMIN K



Phylloquinone



Menaquinone

WATER SOLUBLE VITAMINS

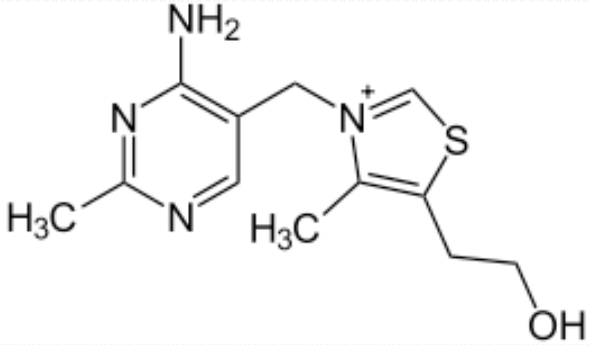
- These include the B-vitamins and vitaminC
- They are soluble in water and can therefore be excreted in the urine
- They share few common properties besides their solubility characteristics
- Most of these vitamins act as coenzymes
- Examples include thiamine (Vit B1), Riboflavin (B2), Niacin, Pantothenic acid (Vit B5), Vitamin B6 (Pyridoxine), Biotin, Vitamin B12 (Cobalamin) and folic acid

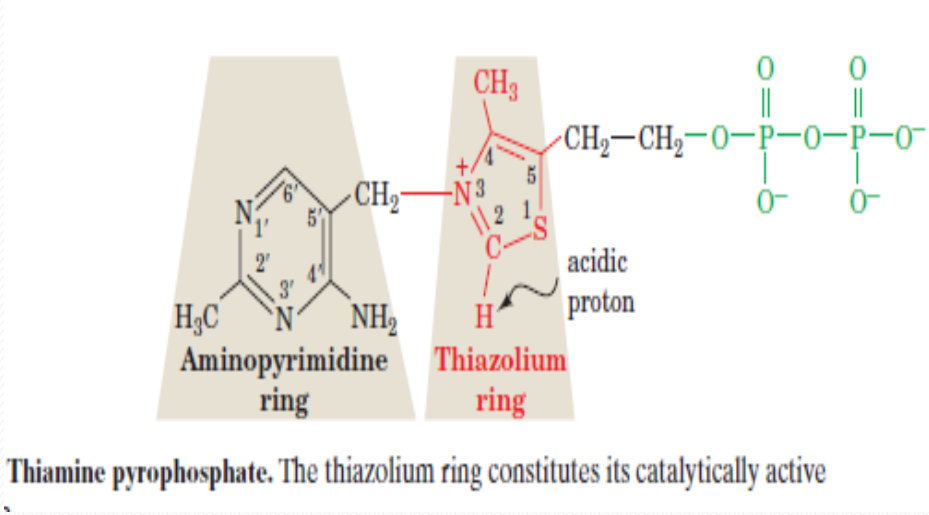
WATER SOLUBLE VITAMINS

VITAMIN B1(Thiamine)

- It is a colourless and crystalline substance
- It is readily soluble in water and slightly in ethyl alcohol
- Addition of a pyrophosphate(ppi) from ATP converts it to thiamine pyrophosphate (TPP), the coenzyme for all decarboxylation of alpha keto acids
- Source, physiological functions and deficiency: refer to notes

STRUCTURE OF VITAMIN B1





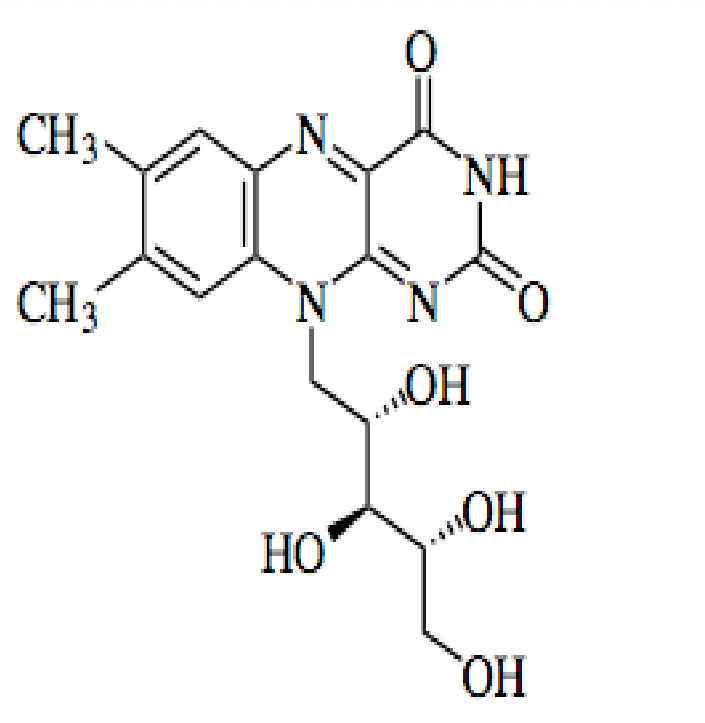
Thiamine pyrophosphate. The thiazolium ring constitutes its catalytically active

WATER SOLUBLE VITAMINS

VITAMIN B2 (Riboflavin)

- It is a component of the flavin coenzymes, FAD and FMN.
- it is composed of an isoalloxazane ring system linked to ribitol
- It is mainly used in energy metabolism of sugars and lipids
- The activation of FMN and FAD is an ATP-dependent reaction
- Source, physiological function and deficiency: refer to notes

STRUCURE OF VITAMIN B2

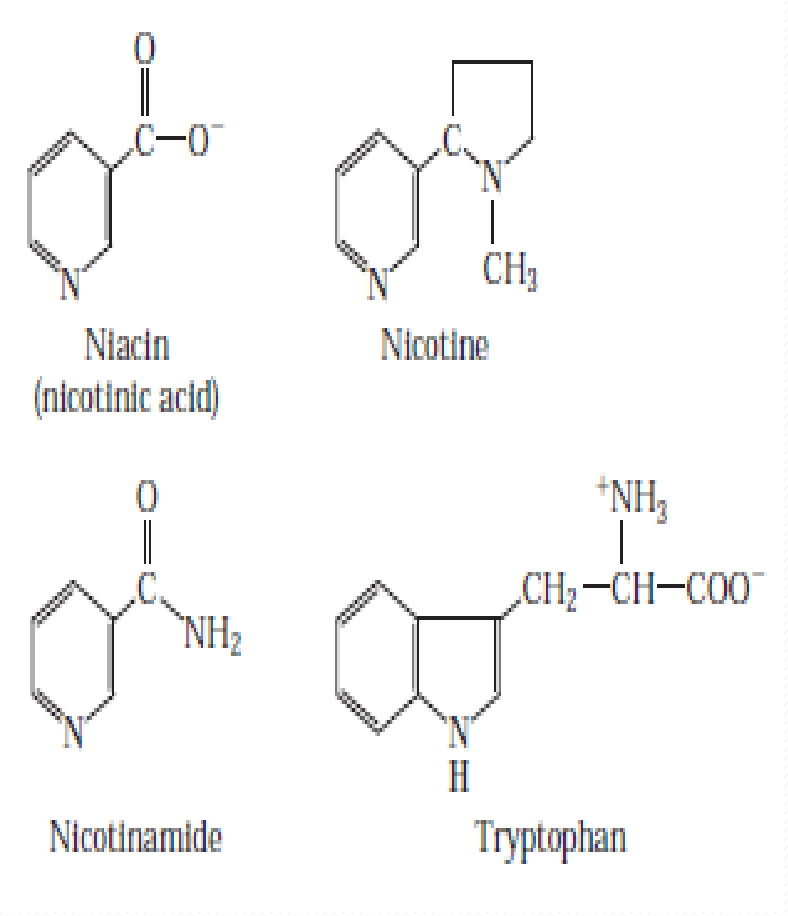


WATER SOLUBLE VITAMINS

VITAMIN B3(NIACIN OR NICOTINIC ACID)

- Niacin can be synthesized from tryptophan
- Niacin contains a substituted pyridine ring and when NAD+ activated forms NAD+ and its phosphorylated derivative NADP+, which are coenzymes of many dehydrogenases
- Sources, physiological functions and deficiency: refer to notes

STRUCTURE OF VITAMIN B3

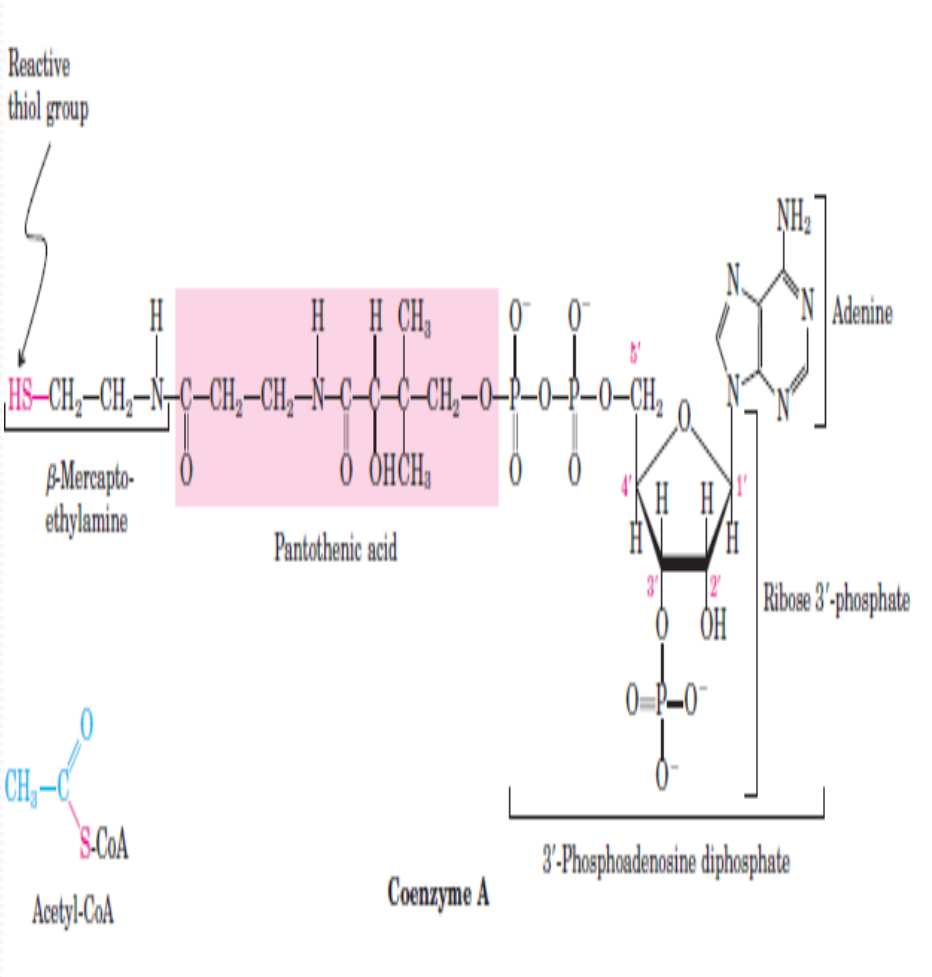


WATER SOLUBLE VITAMINS

PANTOTHENIC ACID (VIT.B5)

- Also called coenzyme, pantothenic acid is a vitamin that forms an essential part of acyl groups in general, including the acetyl group derived from pyruvate
- The coenzyme is derived metabolically from ATP, the vitamin pantothenic acid and β-mercaptoethylamine
- Sources, physiological functions and deficiency: refer to notes

STRUCTURE OF VIT .B5

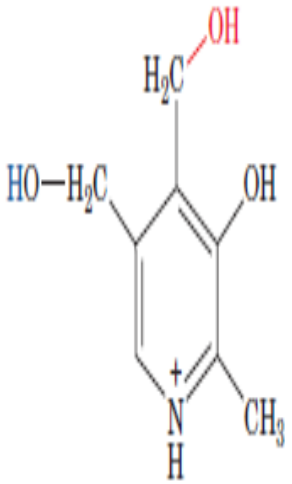


WATER SOLUBLE VITAMINS

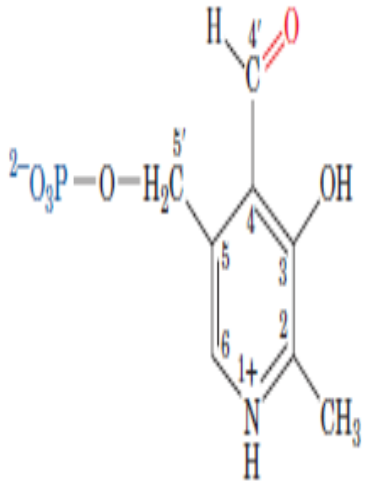
VITAMIN B6(PYRIDOXINE)

- Vit.B6 exists in three forms: Pyridoxine, Pyridoxal and Pyridoxamine and their corresponding phosphates
- Pyridoxal phosphate participates in transaminations, decarboxylations, racemizations and numerous modification of amino acid sequence side chains
- Sources, physiological functions and deficiency: Refer to notes

STRUCTURE OF VIT.B6



(a) Pyridoxine (vitamin B_6)



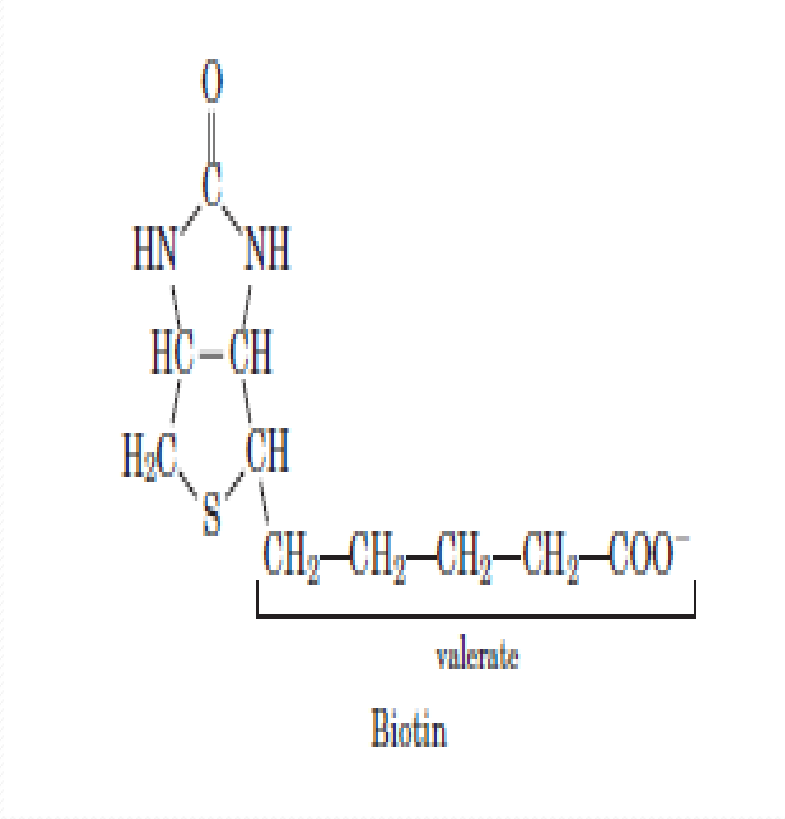
(b) Pyridoxal-5'-phosphate (PLP)

WATER SOLUBLE VITAMINS

VITAMIN B7 (BIOTIN)

- Biotin is a vitamin and a coenzyme commonly associated with enzyme performing carboxylation reactions
- Biotin is also known as “anti-egg white injury factor” or as H-factor
- Sources, physiological functions and deficiency: refer to notes

STRUCTURE OF B7



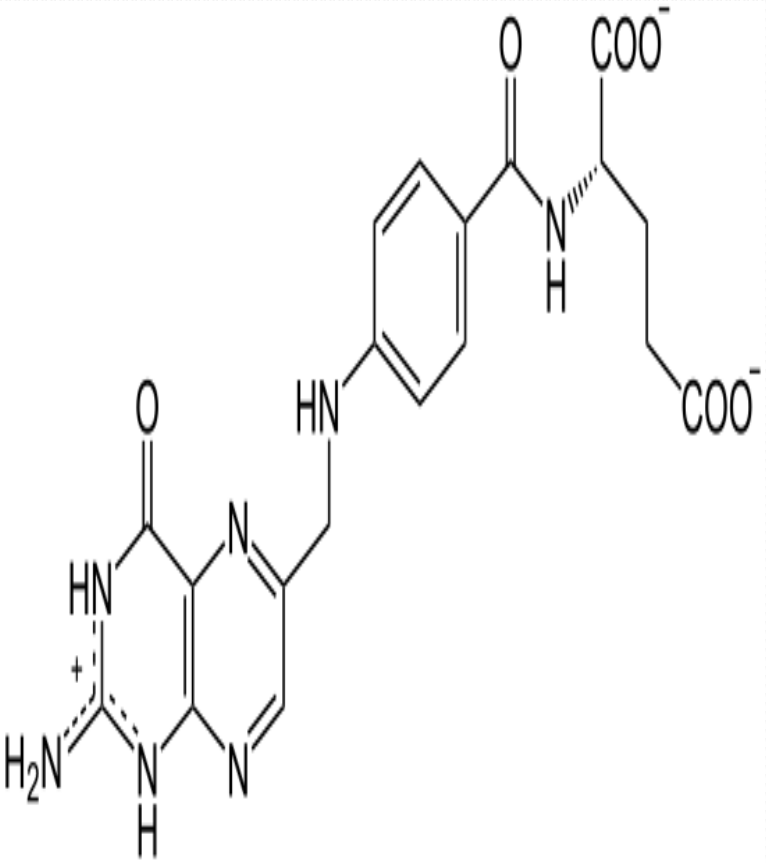
Biotin

WATER SOLUBLE VITAMINS

VITAMIN B9 or M or Bc (folic acid)

- The active form acid is tetrahydrofolate (THF)
- Coenzymes derived from the vitamin folic acid participates in the generation and utilization of single – carbon functional groups, methyl, methylene and formyl
- Sources, physiological functions and deficiency:Refer to notes

STRUCTURE OF VIT.B9

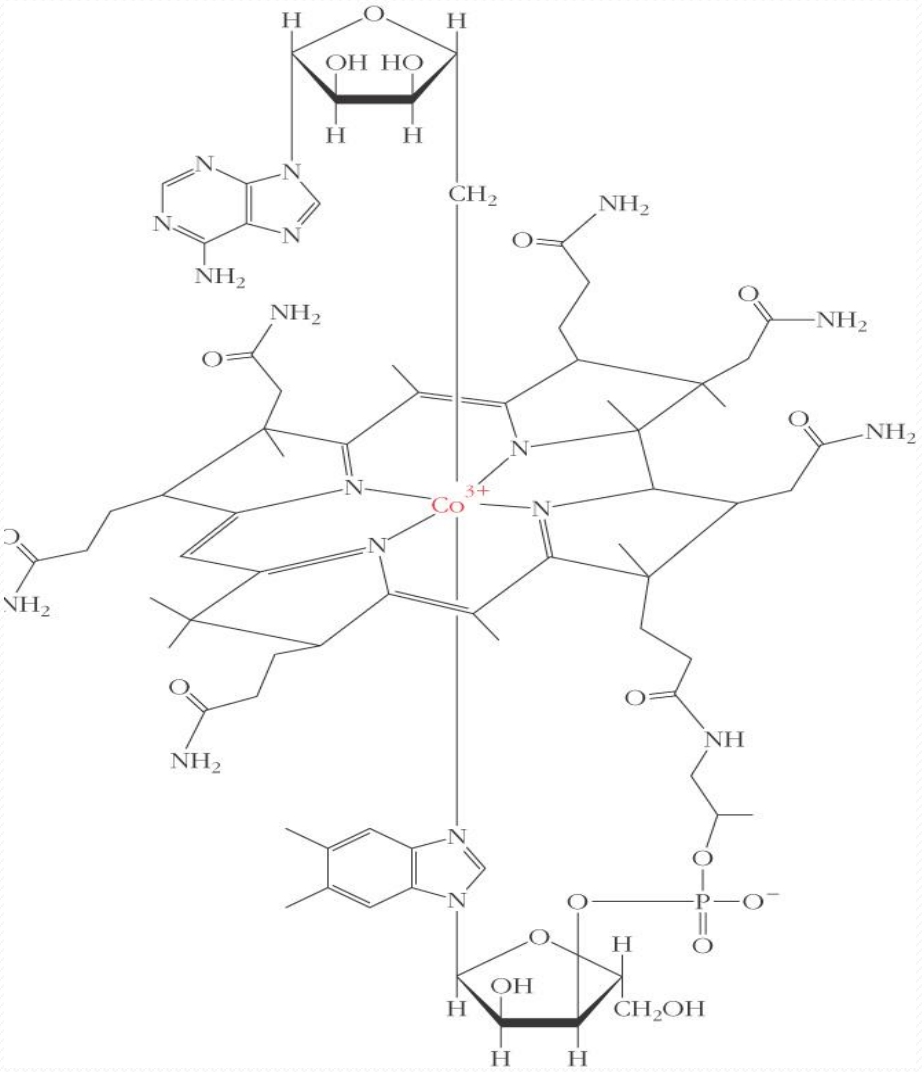


WATER SOLUBLE VITAMINS

VITAMIN B12 (Cyanocobalamin)

- The metal cobalt in vitamin B12 is coordinated with a tetrapyrole ring system, called a corin ring, which is similar to the porphyrin ringof heme compounds
- B12 requiring reactions involve methyl group transfer and adenosylcobalamin-dependent isomerizations.
- Sources, physiological functions and deficiency:
- Refer to notes

STRUCTURE OF B12

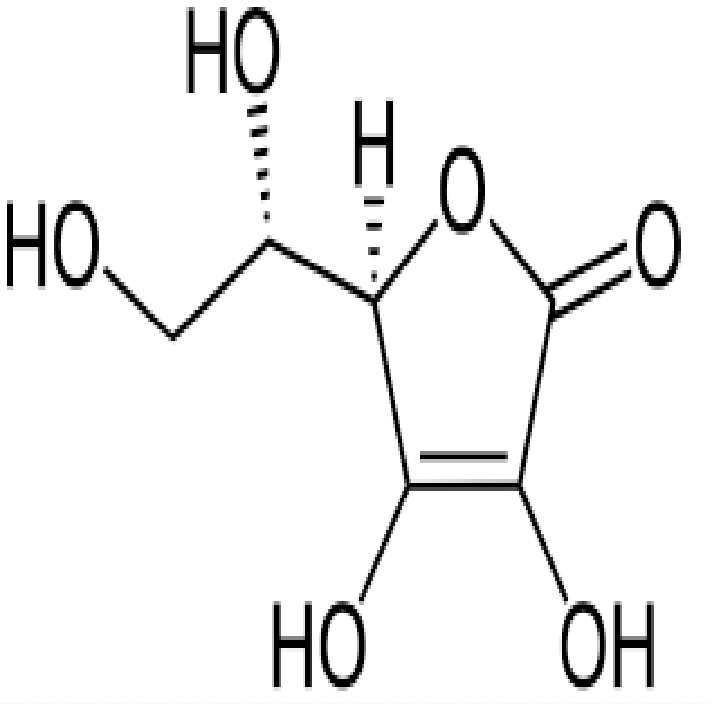


WATER SOLUBLE VITAMINS

VITAMIN C (Ascorbic acid)

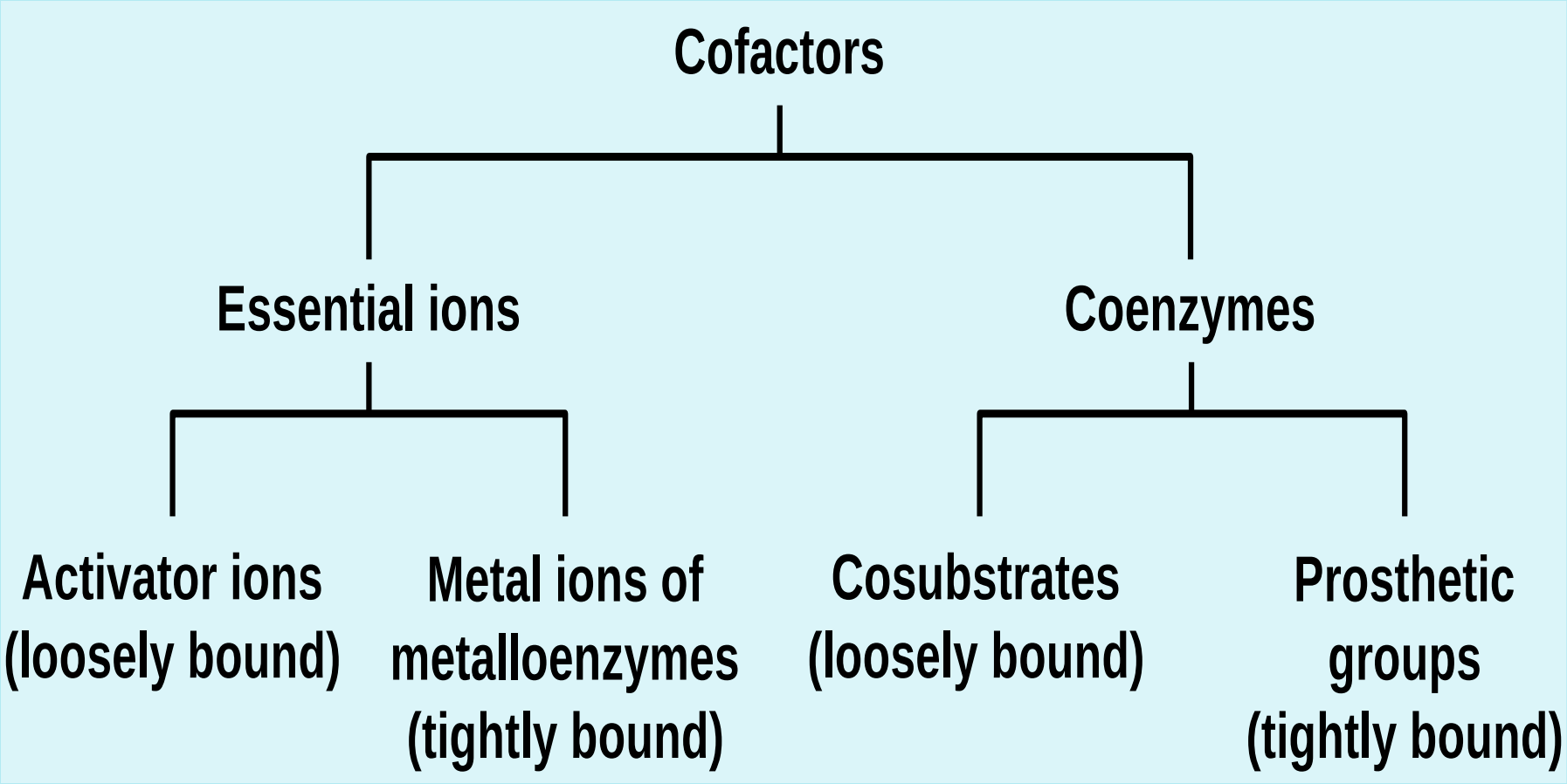
- It is a water soluble vitamin
- It is essential for the hydroxylation of proline and lysine in the formation of collagen
- Collagen is a fibrous protein with myriad connective and supportive functions
- Sources, physiological functions and deficiency:
- Refer to notes

STRUCTURE OF VIT.C



COENZYMES AND COFACTORS

- **Cofactors essentially act as enzymes' CHEMICAL TEETH**



MANY VITAMINS ARE COENZYME PRECURSORS

Coenzyme	*Examples of chemical groups transferred*	*Dietary precursor in mammals*
Biocytin	CO_2	Biotin
Coenzyme A	Acyl groups	Pantothenic acid and other compounds
5′-Deoxyadenosylcobalamin (coenzyme B_{12})	H atoms and alkyl groups	Vitamin B_{12}
Flavin adenine dinucleotide	Electrons	Riboflavin (vitamin B_2)
Lipoate	Electrons and acyl groups	Not required in diet
Nicotinamide adenine dinucleotide	Hydride ion ($:H^-$)	Nicotinic acid (niacin)
Pyridoxal phosphate	Amino groups	Pyridoxine (vitamin B_6)
Tetrahydrofolate	One-carbon groups	Folate
Thiamine pyrophosphate	Aldehydes	Thiamine (vitamin B_1)

MINERALS

- Minerals are inorganic elements needed for the functioning of the body
- They make up about 4%of body weight of adults, they cannot be changed or broken down
- Some which are needed in high quantities are referred to as macro-elements, examples include Na, K, Mg, Cl etc.
- Others are needed in smaller quantities and are termed microelements, they include Fe, Cu, F, I etc.

MACRO-ELEMENTS

- The body requires relatively large amounts of about 7 minerals (macro-elements)

1 Calcium (Ca)

2 Phosphorus (P)

3 Sulphur

4 Magnesium

5 potassium

6 Chlorine

7 Sodium

MACRO-ELEMENTS

- **Calcium (Ca)**

Functions: Calcium plays myriad of functions that includes

Bones and teeth formation, membrane transport, nerve transmission, muscle contraction, hearth rhythm, blood clotting and enzyme cofactor

Sources: milk, milk products and leafy vegetables

Deficiencies : Osteoporosis and Bone fractures

Excesses: Nausea, vomiting, loss of appetite, kidney toxicity, irregular heart beat, reduced absorption of iron and zinc

MACRO-ELEMENTS

- **Phosphorus (P)**

Functions: in bone and teeth formation, ATP formation, creatine phosphate, DNA and RNA, phospholipids and active transport

Source: Cheese, milk, nuts and eggs

Deficiencies: hypophosphatemia with symptoms similar to calcium deficiency

Excesses: Reduce body stores of calcium

MACRO-ELEMENTS

3. **Sulphur (S):** needed by most proteins

4 **Magnesium (Mg):** it acts as coenzymes for enzymes

Sources: vegetables, cereals, beans, potatoes, cheese and animal tissues

Deficiencies: can result in poor calcium absorption

Excesses: Heart problems and difficulty in breathing

5 Potassium (K), 6 Chlorine (Cl) and 7 Sodium (Na)

Functions: Osmotic Balance, Nerve impulse, Muscle contractions

MICRO-ELEMENTS

- The body requires only trace amounts of others (micro-elements). These includes
- 1. **Flouride** (F)

Functions: it strengthens bones

Excesses: Browning of teeth, brittle bones, fatigue and muscle weakness

- **2. Iodine (I)**

Functions: Synthesis of thyroid hormones

Deficiences: Goiter, mental and physical retardation (cretinism)

MICRO-ELEMENTS

- **3. Iron (Fe)**

Functions: Heamoglobin synthesis

Excesses: has been linked to arthritis, heart disease, diabetes, infectious disease and cancer

- 4 Cobalt, 5 Chromium and 6 Manganese

Functions: Cofactors for enzymes

- 7 Copper

Functions: Cofactors for enzymes

Deficiency: Anemia, impaired immunity, altered iron metabolism

MICRO-ELEMENTS

- **8 Zinc**

Functions: Cofactors for enzymes, synthesis of testosterone and sperm development

Deficiencies: Reduced immune functions, Vomiting, gastric upset and slow absorption of copper

- **9 Molybdenum:**
- Functions: Cofactors for enzymes
- Excesses: Increased secretion of copper
- **10 Selenium**

Functions: Cofactors for enzymes

Deficiencies: muscle pain or weakness and impaired immunity

Excesses: Fragile nails, hair loss, fatigue, abdominal pain, nausea and nerve damage