VITAMINS

Vitamins are organic compounds required by the body in small amounts for metabolism, to protect health, and for proper growth in children. Vitamins also assist in the formation of hormones, blood cells,

nervous system chemicals, and genetic material (Vitamin B12 and Vitamin B9). They generally act as catalysts, combining with proteins to create metabolically active enzymes that in turn produce hundreds of important chemical reactions throughout the body. Without vitamins, many of these reactions would slow down or cease.

Chemical composition:

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

Classification of vitamins:

Vitamins are classified according to their ability to be absorbed in fat or water into:

1. **Fat soluble vitamins:** Vitamins A, D, E and K are fat soluble vitamins. They are oily and hydrophobic compounds. Bile salts and fats are required for their absorption. Vitamins A, D and K are stored in the liver and vitamin E is distributed throughout the body's fatty tissues. Because these vitamins can be stored, their excessive intake may have toxic effect and can result in hypervitaminosis (excess amounts of a vitamin in the body).

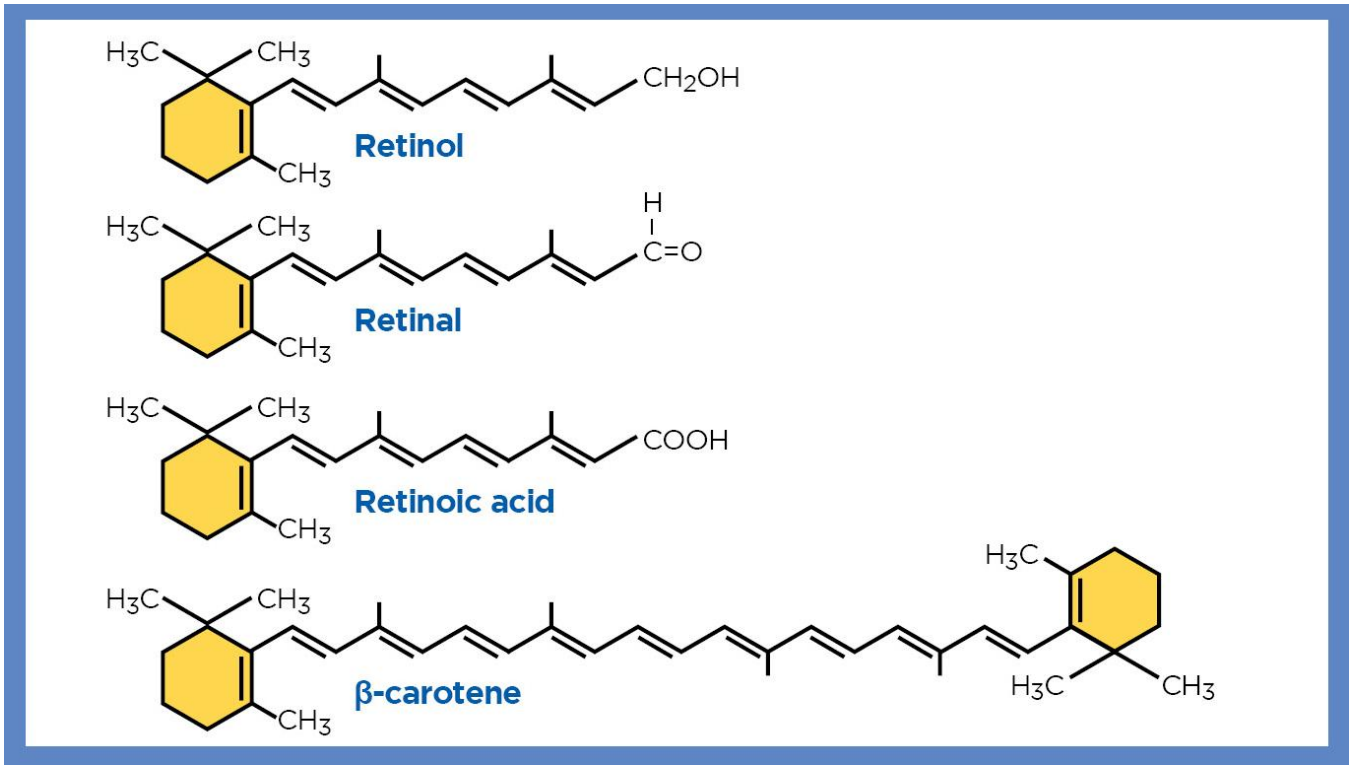
2. **Water soluble vitamins:** Vitamin B complex and vitamin C are water soluble vitamins. They are not stored in the body therefore they required daily in small amount.

Fat soluble vitamins

1. Vitamin A (Retinol):

Structure:

Vitamin A, commonly known as retinol, refers to a group of structurally related compounds, including retinol, retinal, retinoic acid, and carotenoids, most notably β-carotene. The active form of vitamin A is found only in animal tissues, while the provitamin (precursor) β-carotene, is present in plant sources. All compounds with vitamin A activity (retinoids) are classified as retinoids, which include three main forms: retinol (vitamin A alcohol), retinal (vitamin A aldehyde), and retinoic acid (vitamin A acid).



Sources:

• In animal form, vitamin A is found in milk, butter, cheese, egg yolk, liver, and fish-liver oil.

• In plant source it obtained from vegetables as carrots, broccoli, squash, spinach, kale, and sweet potatoes.

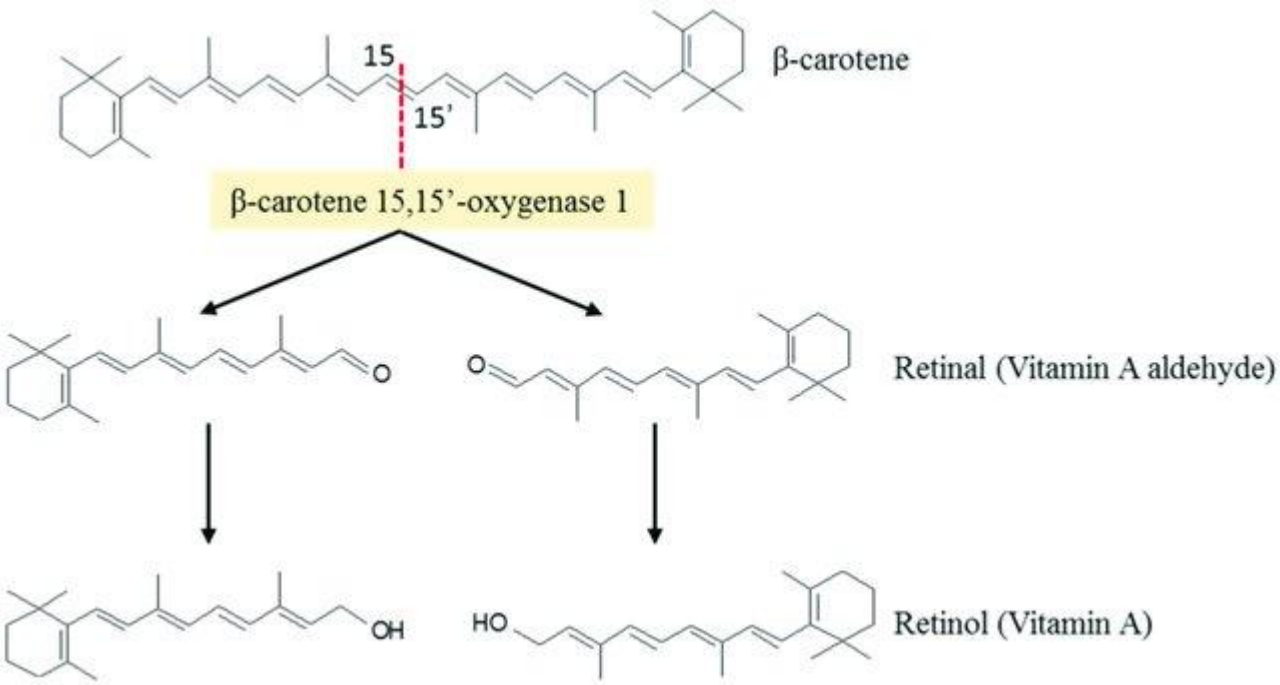
Physiological significances:

• Vitamin A is necessary for proper growth, vision, and maintenance of epithelial tissue.

• Vitamin A accelerates normal formation of bone and teeth.

Absorption and metabolism:

- The intestine is the major site of vitamin A absorption.
- Beta carotene is cleaved by a dioxygenase, to form retinal. The retinal is reduced to retinol by retinal reductase present in the intestinal mucosa.



- Retinol absorbed from the intestine is secreted as a component of chylomicrons into the lymphatic system, to be taken up by, and stored in, the liver.
- When needed, retinol is released from the liver and transported to extra-hepatic tissues by the plasma retinol-binding protein (RBP).

- The retinol-RBP complex attaches to specific receptors on the cell surface, permitting retinol to enter; then acts on nuclear receptors.

Deficiency:

• An early deficiency symptom is night blindness (difficulty in adapting to darkness).

• Other symptoms are excessive skin dryness

• Lack of mucous membrane secretion, causing weakness to resist bacterial attack

• Dryness of the eyes due to a malfunctioning of the tear glands.

Hypervitaminosis:

Excess vitamin A can interfere with growth, stop menstruation,

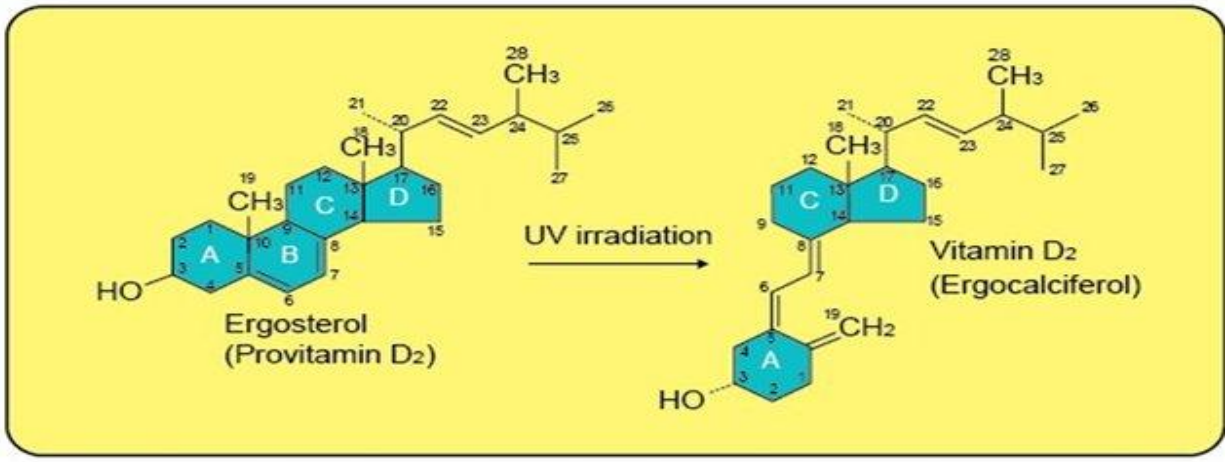
damage red blood corpuscles, and cause skin rashes, headaches, nausea, and jaundice.

2. Vitamin D (Calciferol):

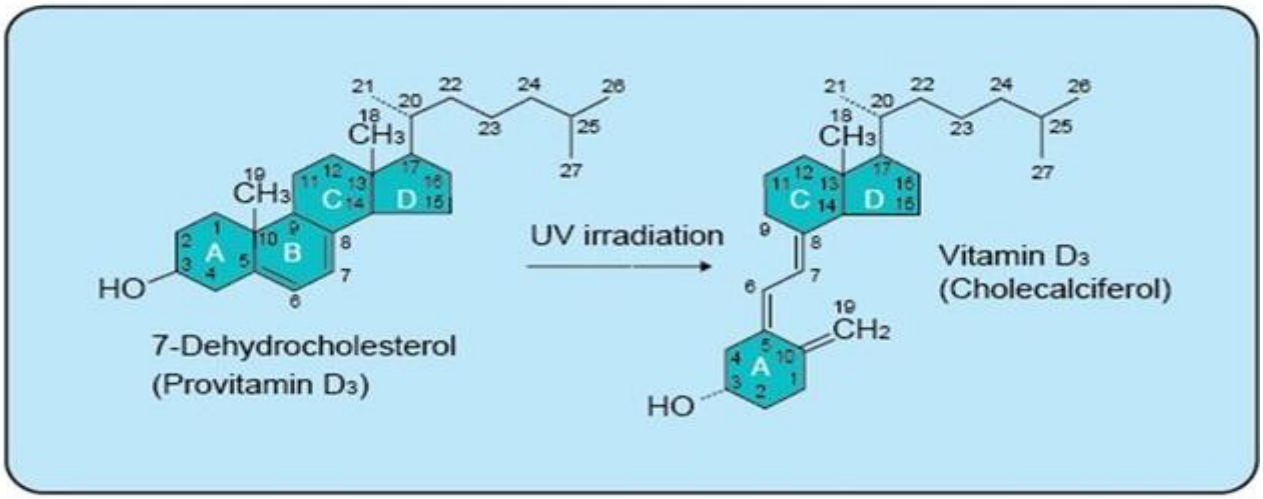
Structure:

Vitamin D comes in two forms:

1. Ergocalciferol (D2): this is obtained by irradiating the plant sterol ergosterol with UV light.



2. Cholecalciferol (D3): this is formed by irradiating the animal sterol, 7-dehydrocholesterol.



Sources:

- **Diet:** D2 in plants (mushrooms) and D3 in animals (egg yolk, fortified milk, butter, liver and fish like sardines, tuna, and salmon).
- **Endogenous precursor:** 7-dehydrocholesterol is converted to D3 in the dermis and epidermis of humans exposed to sunlight.

Physiological significances:

• It protects the teeth and bones against the effects of low calcium intake by making more effective use of calcium and phosphorus.

• It increases absorption of calcium in intestine.

• It stimulates the reabsorption of calcium and phosphorus from the renal tubules in the kidney.

• It helps treat multiple sclerosis تصلب متعدد (disease involving damage to the sheaths of nerve cells) in the nervous system.

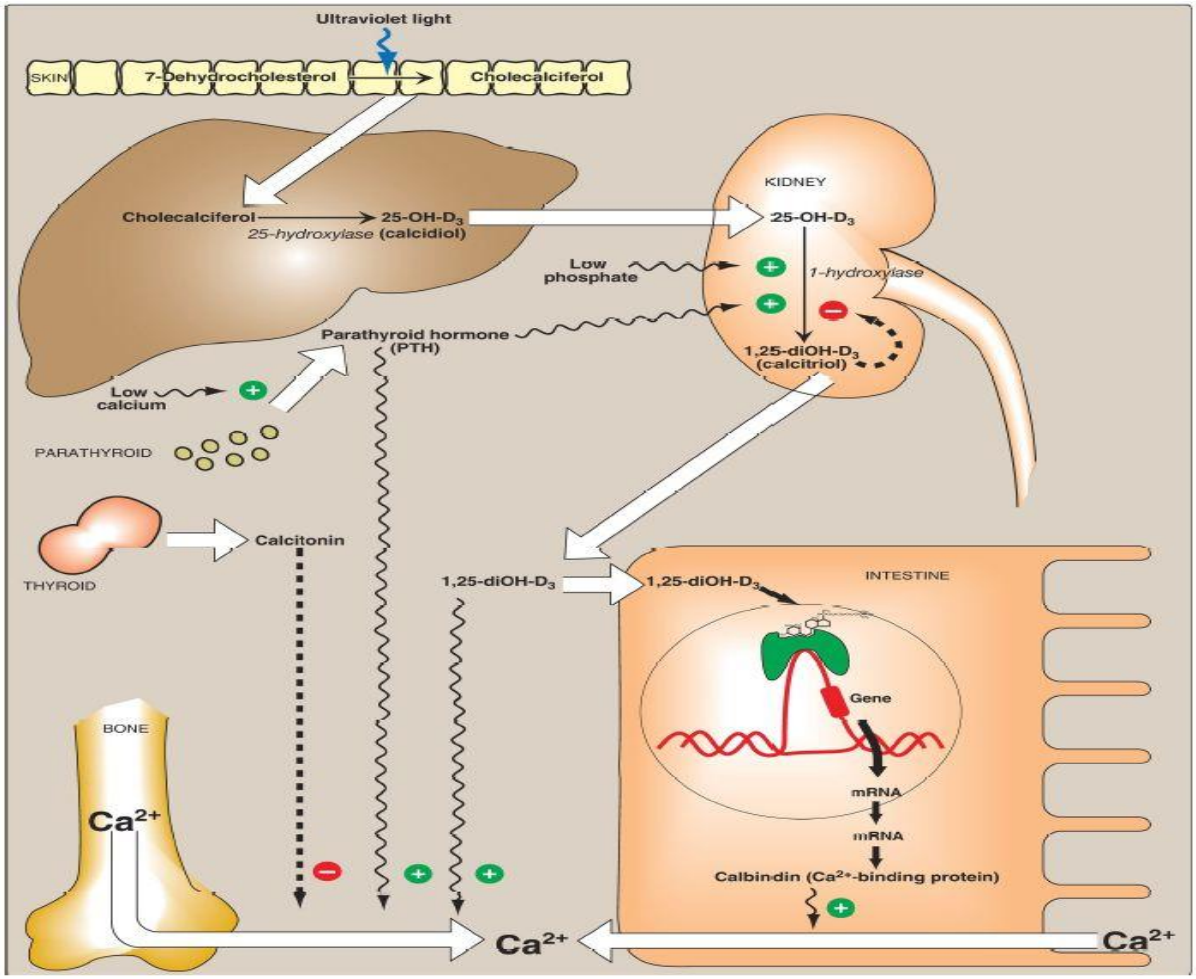
Absorption and metabolism:

- Vitamin D is absorbed from the intestine and is secreted as a component of chylomicrons into the lymphatic system, to be taken up by, and stored in the liver.
- Both D2 and D3 are not biologically active, but are converted in vivo to the active form of vitamin D by two sequential hydroxylation reactions:

1. Hydroxylation at 25 position is catalyzed by a specific hydroxylase in the liver resulting in 25-hydroxycholecalcoferol (25-OH-D3, calcidol) which is the predominant form in plasma and the major storage form of vitamin D.

2. Another hydroxylation at 1 position by 1-hydroxylase in the kidney, resulting in the formation of (1,25-diOH-D3, calcitriol). Calcitriol is the most potent vitamin D metabolite.

- The addition of the hydroxyl group by the kidney is regulated by serum calcium level, with low levels accentuating the function while high levels inhibit the reaction.



Deficiency:

Vitamin D deficiency produces rickets كساح in children and osteomalacia لين العظامin adults.

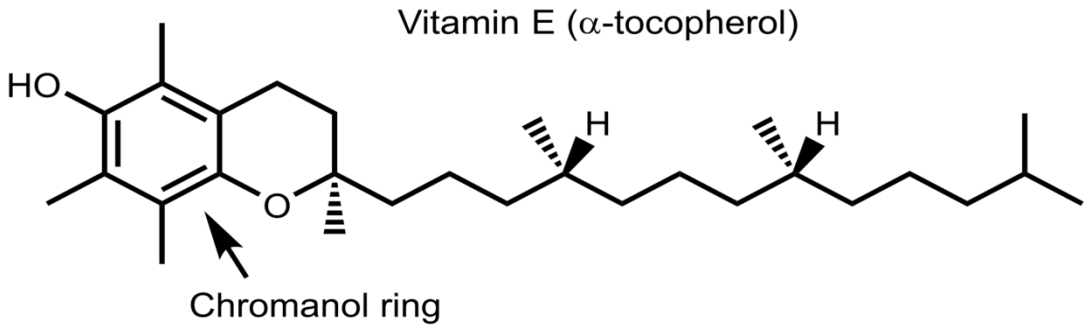
Hypervitaminosis:

Excessive consumption of vitamin D causes poisoning, kidney damage, lethargyالخمول, and loss of appetite فقدان الشهية .

3. Vitamin E (Tocopherol):

Structure :

α-tocopherol is the predominant isomer in plasma and the most active form of vitamin E.



Sources:

• It is found in vegetable oils, wheat germ, liver, and leafy green vegetables.

• It is also present in little amount in meat, milk and eggs.

Physiological significances:

- Vitamin E acts as antioxidants.
- It plays a role in forming red blood cells, muscles and other tissues.
- It is also associated with cell maturation and differentiation.
- It prevents the oxidation of vitamin A and fats.

Absorption and metabolism:

- It is absorbed along with other fats and needs the help of bile salts.
- Tocopherol is absorbed and transported as chylomicrons.
- It is stored in adipose tissue.
- During catabolism, the chromane ring and side chain may be oxidized and excreted in bile after conjugation with glucuronic acid.

Deficiency:

• A deficiency of vitamin E causes sterility in both males and females.

• It causes muscular dystrophy ضمور العضلات .

• In children it causes haemolysis and creatinuria.

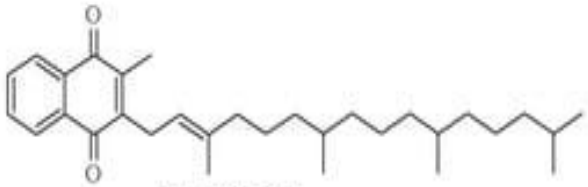
Hypervitaminosis:

Vitamin E toxicity is rare, but occasionally high doses cause a risk of bleeding, as well as muscle weakness, fatigue, nausea, and diarrhea.

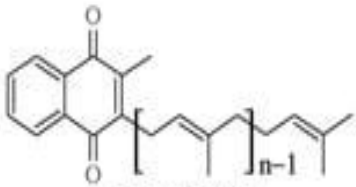
4. Vitamin K (Phylloquinone and Menaquinone):

Structure :

Vitamin K is a complex unsaturated hydrocarbon found in two forms vitamin K1 (Phylloquinone) and vitamin K2 (Menaquinone).



Vitamin K1
(phylloquinone)



Vitamin K2
(menaquinone)

Sources:

• The richest sources of vitamin K are fish livers, leafy green vegetables, egg yolks, soybean oil, and liver.

• It is also produced by bacteria in human intestine.

Physiological significances:

• This vitamin is necessary mainly for the coagulation of blood.

• It aids in forming prothrombin, an enzyme needed to produce fibrin for blood clotting.

• Acts as an inducer for the synthesis of RNA.

Absorption and metabolism:

- Absorption of vitamin K occurs in the intestine along with chylomicrons.
- Bile salts are required for the normal absorption.
- It is stored in the liver and transported in plasma along with beta lipoproteins.

Deficiency:

• Digestive disturbances may lead to defective absorption of vitamin K and hence to mild disorders in blood clotting.

Hypervitaminosis:

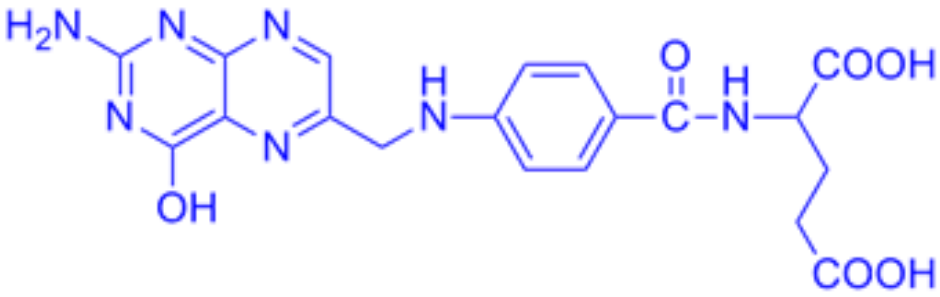
• Administration of large doses of vitamin K produces haemolytic anemia due to of breakdown of red blood cells.

Water soluble vitamins

1. Vitamin B complex:

They include vitamin B1 (Thiamine), vitamin B2 (Riboflavin), vitamin B3 (Niacin), vitamin B6 (Pyridoxine), vitamin B7 (Biotin), vitamin B9 (Folic Acid) and vitamin B12 (Cynocobalamin).

- **Vitamin B9 (Folic Acid):**



Folic acid (Vitamin B_9)

Sources:

• Folic acid is found in yeast, liver and kidney.

• Fish meat and green leafy vegetables, milk and fruits also provide folic acid.

Physiological significances:

• Folic acid acts as a coenzyme and help in synthesis of purine and thymine during DNA synthesis.

• It helps in formation and maturation of red blood cells.

Absorption and metabolism:

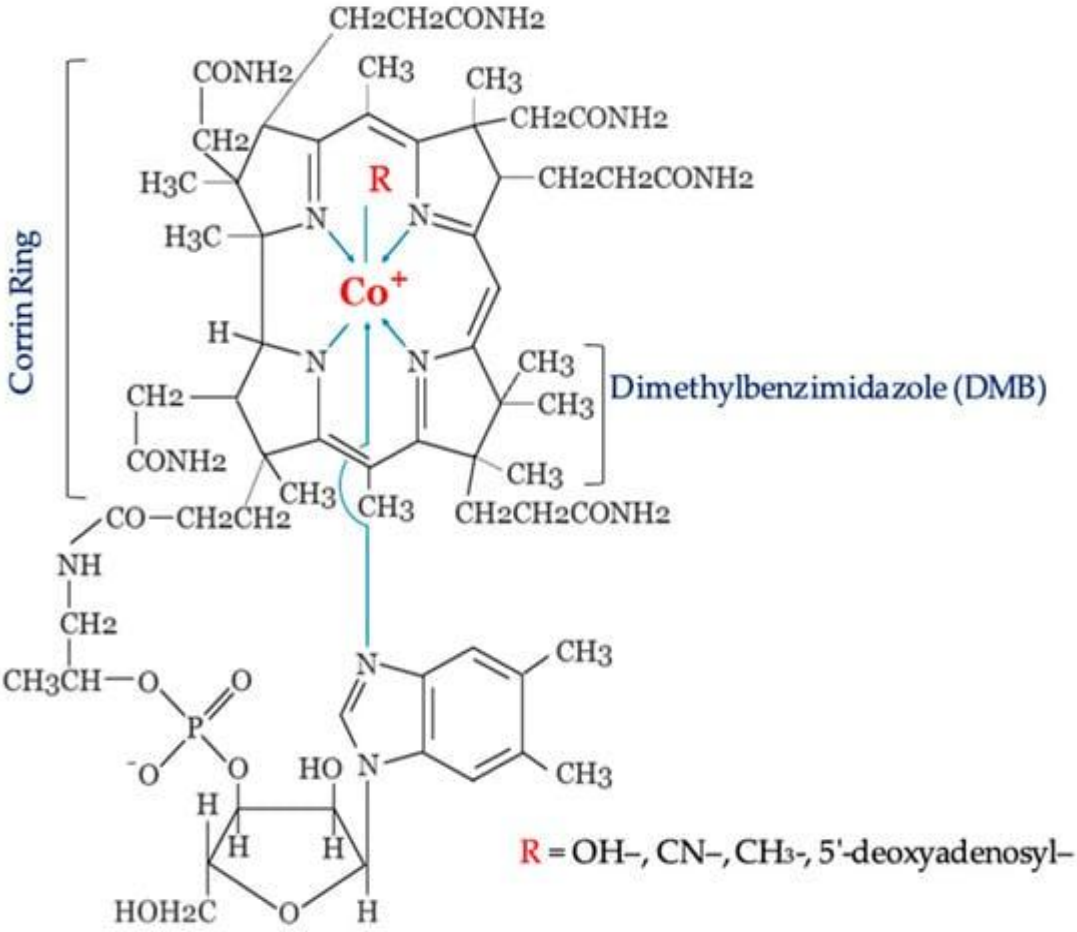
- Folic acid is readily absorbed by the upper part of the jejunum.
- In the blood, it is transported by beta globulins. Folic acid is not stored in tissues.

Deficiency:

Folic acid deficiency gives rise to megaloblastic anemia (a form of anemia characterized by very large red blood cells and a decrease in the number of those cells).

- **Vitamin B12 (Cynocobalamin):**

Vitamin B12 and contain cobalt in a corrin ring.



Sources:

• It is obtained only from animal sources as liver, kidneys, meat, fish, eggs, and milk.

❖ Vegetarians are advised to take vitamin B12 supplements.

Physiological significances:

• It is necessary in minute amounts for the formation of nucleoproteins, proteins, and red blood cells.

• It is necessary for the functioning of the nervous system.

Absorption and metabolism:

- In the stomach, gastric acid (HCl) and pepsin release B12 from dietary proteins. The freed B12 binds to haptocorrin (R-protein), a glycoprotein secreted in saliva and gastric juice, protecting B12 from stomach acid.
- In the small intestine, pancreatic enzymes digest haptocorrin, releasing B12. Free B12 binds to intrinsic factor (IF), a glycoprotein secreted by gastric parietal cells. The B12-IF complex is resistant to digestion and is essential for absorption. The B12-IF complex binds to specific receptors in the terminal ileum, leading to endocytosis.
- Inside enterocytes, IF is degraded, and B12 binds to transcobalamin II (TCII) for transport into the bloodstream and then to tissues.

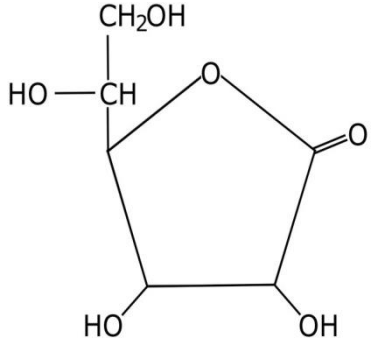
Deficiency:

• Its deficiency causes pernicious anemia (a decrease in red blood cells that occurs when the intestines cannot properly absorb vitamin B12).

• Its deficiency decreases myelin synthesis.

2. Vitamin C (Ascorbic acid):

It is water soluble and is easily destroyed by heat, alkali and storage.



Ascorbic acid

Sources:

• Sources of vitamin C include citrus fruits, fresh strawberries, cantaloupe, pineapple, and guava.

• Good vegetable sources are broccoli, tomatoes, spinach, green peppers, cabbage, and turnips.

Physiological significances:

• Vitamin C is important in the formation and maintenance of collagen, the protein that supports many body structures.

• It enhances the absorption of iron from foods of vegetable origin.

• It plays a major role in the formation of bones and teeth.

• It play important role in wound repair.

• It protects body against stress.

Absorption and metabolism:

- Vitamin C is readily absorbed in the small intestine, primarily in the jejunum and ileum. It is absorbed via active transport (sodium-dependent vitamin C transporters, SVCT1 & SVCT2) and passive diffusion at higher doses.
- Once in the bloodstream, it is transported freely in plasma.
- Inside cells, ascorbic acid acts as a strong antioxidant and participates in various biochemical reactions. It undergoes oxidation to dehydroascorbic acid (DHA), which can be reduced back to ascorbic acid or further metabolized. DHA is further broken down into diketo-L-gulonic acid, which leads to the formation of oxalic acid and other metabolites.
- Some of the oxalates found in urine originate from vitamin C metabolism.

Deficiency:

Its deficiency leads to a disease known as scurvy الاسقربوط. Scurvy disease symptoms are loss of the cementing action of collagen and include hemorrhages which lead to the loosening of teeth and cellular changes in the long bones of children.