Fat soluble vitamins

م . د نيران علي ثامر

Classification of vitamins

There are two main groups of vitamins:

- **Fat-soluble vitamins:**

Fat-soluble vitamins have specific functions in the development and maintenance of tissue structures.

- **Water-soluble vitamins:**

Water-soluble vitamins participate in catalytic functions or act as control mechanisms in the metabolism, e.g. as co-enzymes.

Fat soluble vitamins

- The vitamins **A, D, E, K and ß-carotene** (precursor of vitamin A) belong to the fat-soluble vitamins.
- These are stored in the body for long periods of time and generally pose a greater risk for **toxicity when consumed in excess.**

يشير إلى

- The sites of storage are inner organs such as the **kidneys and liver, the muscles, the brain and fat tissue**.

عن أعضاء داخلية

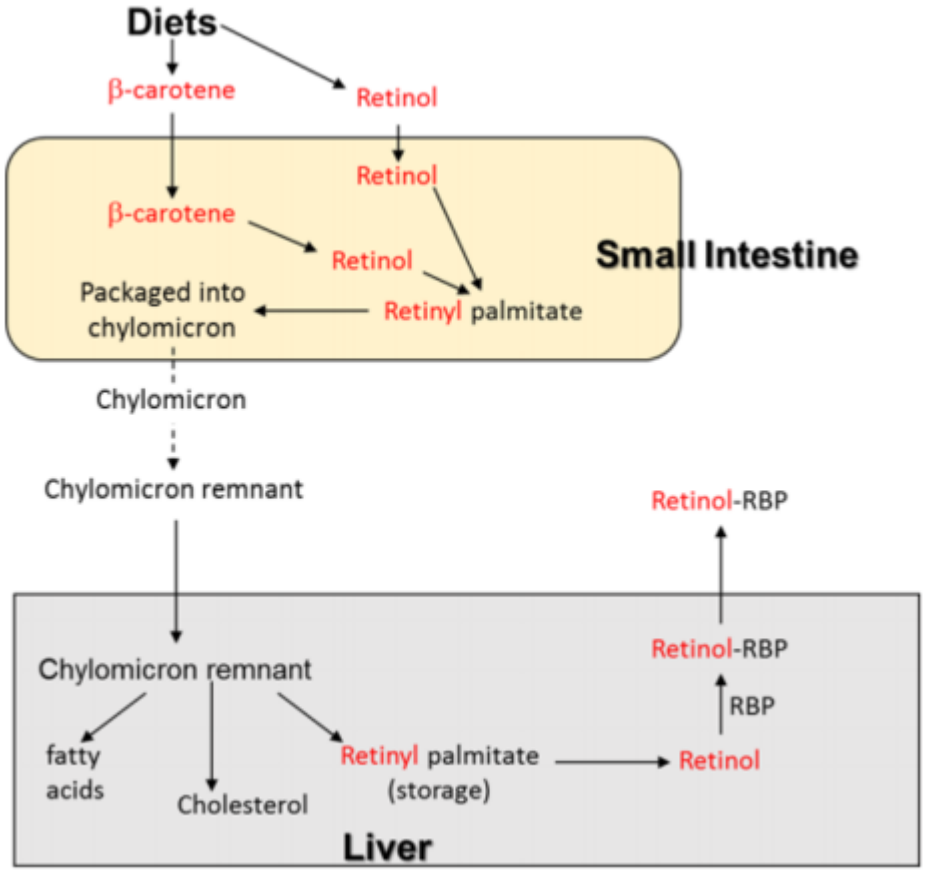
- In the small intestine, the fat-soluble vitamins are transported into the intestinal cells as part of **micelles**.

an aggregate of molecules in a colloidal solution

- Once inside the intestinal cells, fat-soluble vitamins are packaged with **fat and other lipids into a chylomicron**.

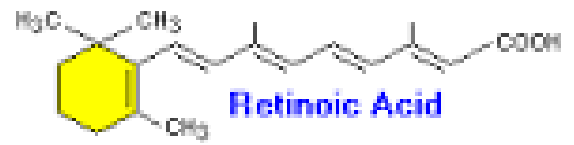
مغلّف

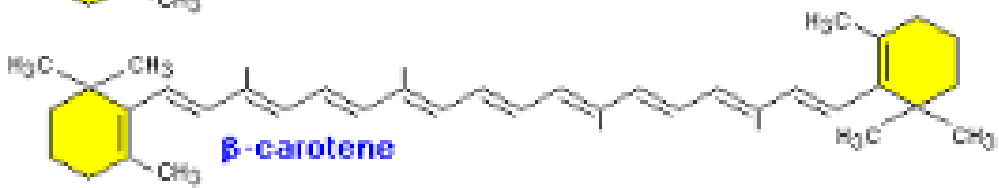
- The chylomicrons travel through the **lymph system** to the main circulation.
- Excretion normally only occurs after **transformation** during metabolism.



Vitamin A

- Vitamin A was discovered in 1909 in **fish liver oil**
- The term vitamin A refers to a family of fat-soluble **retinoids** that include **retinol, retinal,** and **retinoic acid.**
- They contain a ring with a **polyunsaturated fatty acid** tail. Attached at the end of the fatty acid tail is either an **alcohol group (retinol), an aldehyde group (retinal), or an acid group (retinoic acid).**

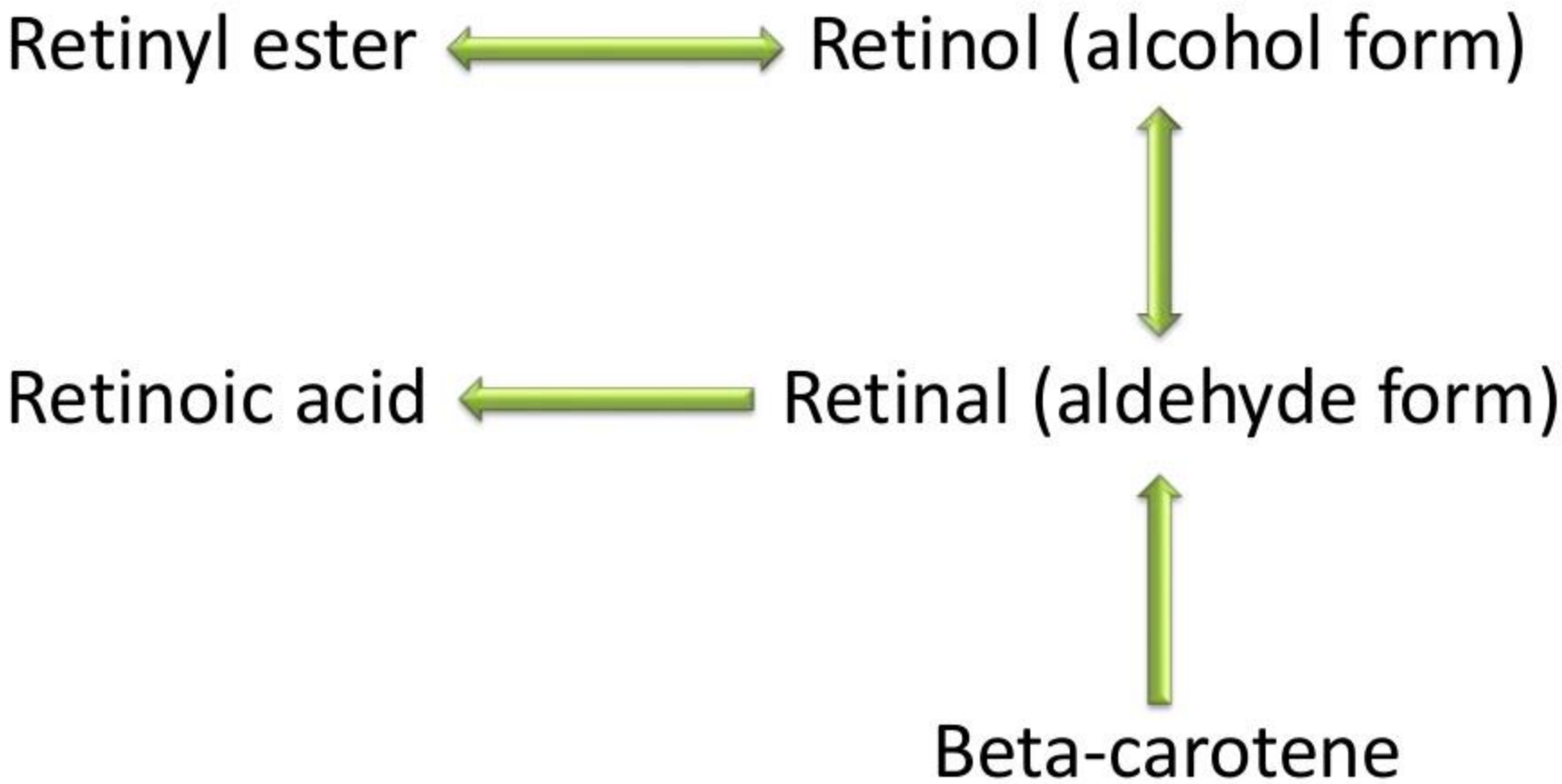




Vitamin A terms

- **Retinoids** The term used to describe the family of preformed vitamin A compounds.
- **Retinol** The alcohol form of preformed vitamin A.
- **Retinal** The aldehyde form of preformed vitamin A.
- **Retinoic acid** The acid form of preformed vitamin A.
- **Retinyl ester** The ester form of preformed vitamin A found in foods and stored in the body.
- **Beta-carotene** One of the provitamin A carotenoids.

Conversion of Vitamin A Compounds



Metabolic Functions of Vitamin A

- Each form of retinoid plays a specific role in the body. **Retinal (the aldehyde form) participates in vision**.
- The hormone like action of **retinoic acid (the acid form)** is essential for **growth and development of cells, including bone development**.
- **Retinol (the alcohol form) supports reproduction and a healthy immune system**. In addition to these critical roles, vitamin A may help **prevent cancer**.

Physiological role of vitamin A

- Formation, protection and regeneration of skin and mucous membranes
- Promotion of fertility
- Control of growth and differentiation processes of the cellular metabolism
- Increased resistance to infectious diseases

Interaction with other nutrients

Vitamins Synergistic to Vitamin A

تآزري

- **Vitamin E & Vitamin C :** Due to their antioxidant activity. And vitamin E aids in stabilization of cell membranes.
- **Vitamin B6 :** Because of its synergistic effect upon the mineral zinc.
- Besides B6, **vitamin B1, B2, B3, and B5** have been specifically described as vitamin A synergists.

على وجه التحديد

Vitamins Antagonistic to Vitamin A

- Fat soluble vitamins compete for absorption and transport so all other fat soluble vitamins are antagonistic In nature.
- **Vitamin E :** The antagonistic effects are also indicated by the opposite effects on **prostaglandin E1 and E2 (PGE2 PGE2) synthesis.**
- **Vitamin C :** Due to its **copper lowering effect**, causes **oxidation of vitamin A** by increasing tissue iron accumulation.
- **Vitamin B1, B12, B6.**

Minerals Synergistic to Vitamin A

- **Zinc :** Required for the **mobilization of vitamin A** from liver. Zinc is involved in **maintaining the plasma retinal binding protein (RBP),** a specific transporter for vitamin A.
- **Iron :** Vitamin A facilitates the **mobilization of stored iron** for incorporation into erythrocytes.
- **Selenium :** Involved in antioxidant activity.
- **Magnesium, Manganese, Potassium, and Phosphorus.**

Deficiency symptoms

التقرن

- Cornification of skin and mucous membranes.
- Retarded maturation of the ova and embryo mortality.
- Increased risk of infections.
- Nervous lesions.
- Night blindness.

جفاف الملتحمة .

- Xeropthalmia.

- In commercial supplement of vitamin A The active substance of these products is **vitamin A acetate**.

The standard vitamin A content is normally 500 000 IU/g.

Excretion:

Most in urine as **Oxo retinoic acid**, small amounts in expired air, some in feces.

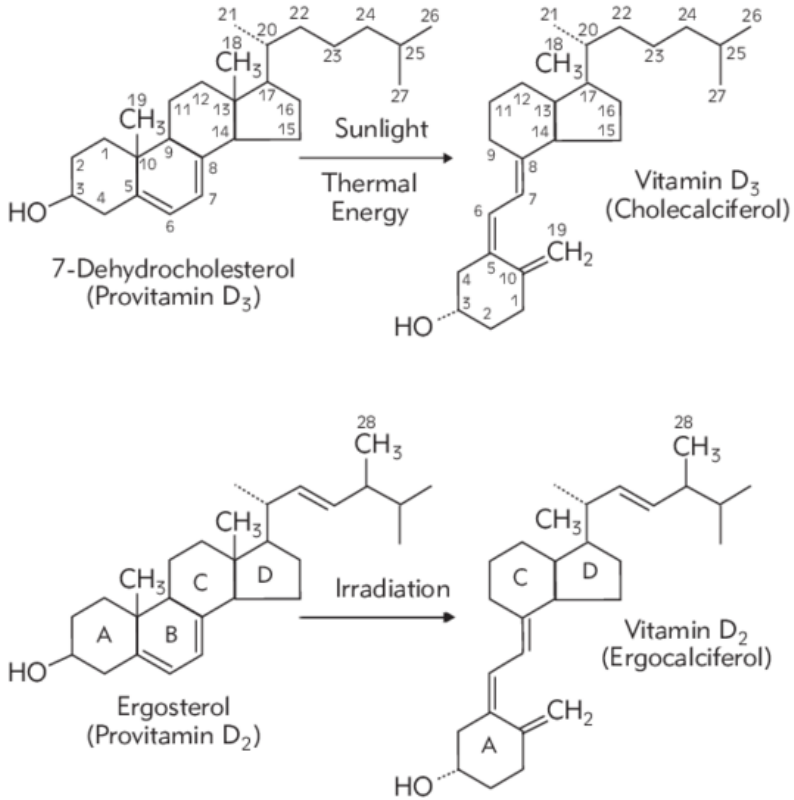
Toxicity:

Birth defects, Central nervous disorders, Liver abnormalities, Loss of bone density.

Vitamin D

- Vitamin D3 was discovered in 1918 in **fish liver oil**
- Vitamin D (**calciferol**) is called the **"sunshine vitamin"** because it is derived from the reaction between ultraviolet (UV) rays and a form of **cholesterol** found in the skin.

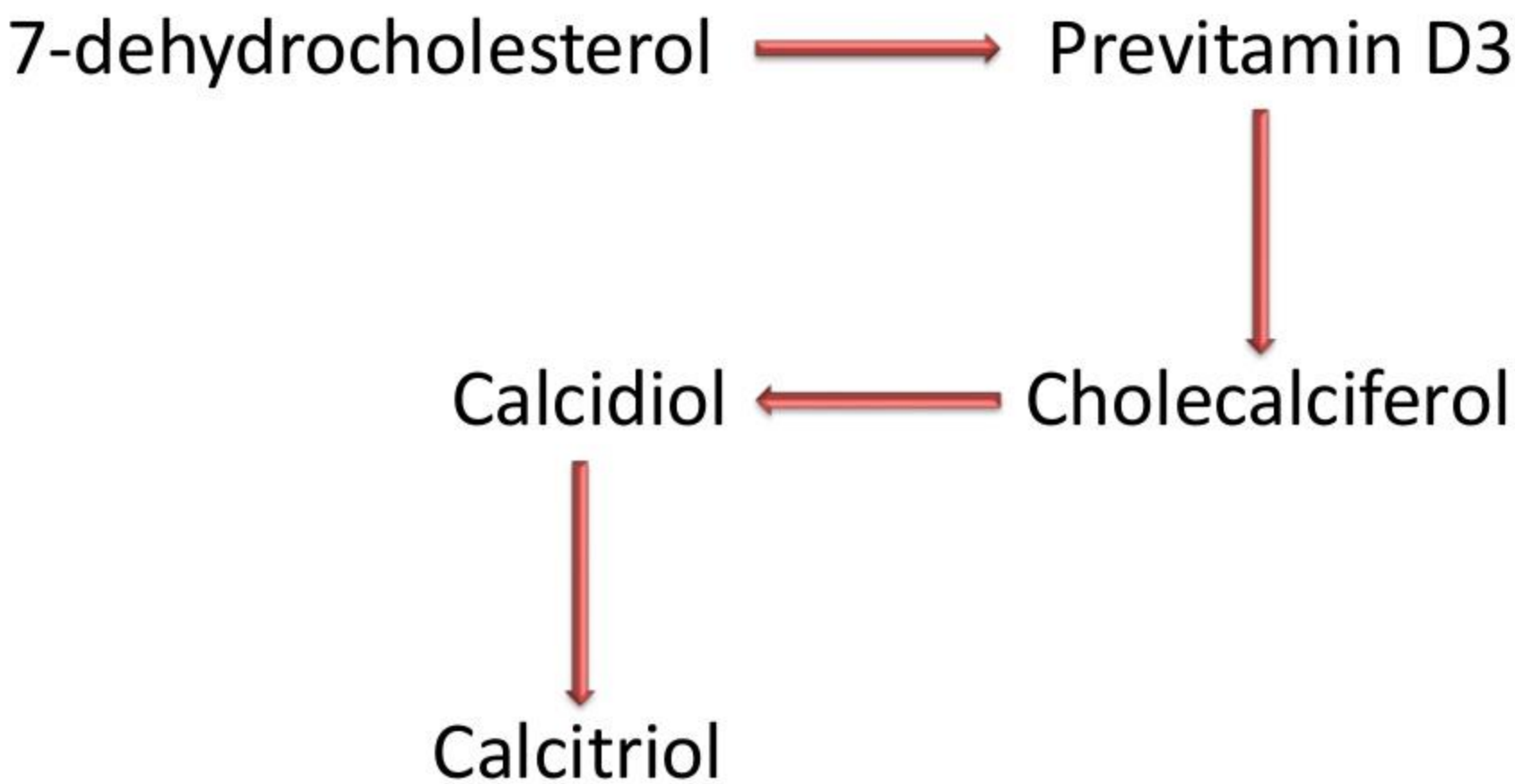
- Vitamin D is found in two forms.
- **Cholecalciferol** or **vitamin D3** is the form produced in the **skin and found in animal foods**.
- **Ergocalciferol** or **vitamin D2** is found in **plants and dietary supplements.**
- Ergocalciferol and Cholecalciferol differ chemically in the structure of their side chains.



Natural sources and bioavailability

- Vitamin D is found in very few products, e.g. as vitamin D3 (Cholecalciferol) in whole milk and liver oils, and as vitamin D2 (Ergocalciferol) in sun-dried green forage.
- **Vitamin D2** is formed under the influence of UV radiation from ergosterol in **plants when they are dried. Vitamin D3 is formed in the epidermis** from 7-dehydrocholesterol by UV radiation (exceptions: dogs, cats).

Metabolism of Vitamin D



Physiological role of vitamin D

- Vitamin D3 has no direct metabolic activity **1,25-dihydroxyvitamin D3 is the form with the largest biological effect.**
- It regulates **calcium and phosphate** absorption and metabolism and controls blood pressure.
- It promotes germ cell production
- It increases the performance of the immune system, and inhibits auto-immunisation.

Interaction with other nutrients

- **Magnesium :** It activate vitamin D into a biologically active form, and required to maintain calcium in the body and is essential for bone health.
- **Vitamin K :** It helps in calcium absorption from foods. And also helps in strengthening of bones.
- **Zinc :** Hepls in absorption of vitamin D into the cells.
- **Boron** : Hepls in absorption of Ca by bones.

- **Vitamin A :** Vitamin A and vitamin D work together for animal health.
- **Calcium :** Low levels of vitamin D causes decreased calcium absorption.
- **Phosphorus :** Ca and P ratio is important for vitamin D.

Deficiency symptoms

- Disorders of calcium and phosphate metabolism.
- Rickets in young animals & Osteomalacia in adults.
- Extraction of mineral substances from the bones.
- Deformed bones and joints (softening of the bones).
- Growth disorders.
- Spontaneous bone fractures.

- Commercial supplement of vitamin D formulations normally have a vitamin D3 content of 500 000 IU/g.

Toxicity

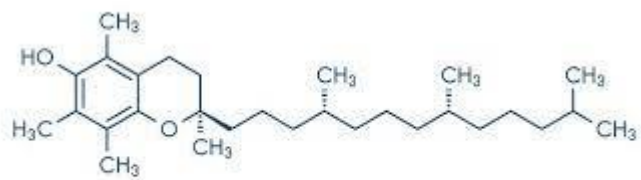
kidney damage, Nausea, Weakness, Disorientation.الارتباك

Excretion

- Bile > feces > urine

Vitamin E

- Vitamin E was discovered 1922 in **wheat germ oil.**
- There are eight different forms of naturally occurring vitamin E, but one form, **alpha-tocopherol (α-tocopherol),** is most active in the body with a side chain of saturated carbons.

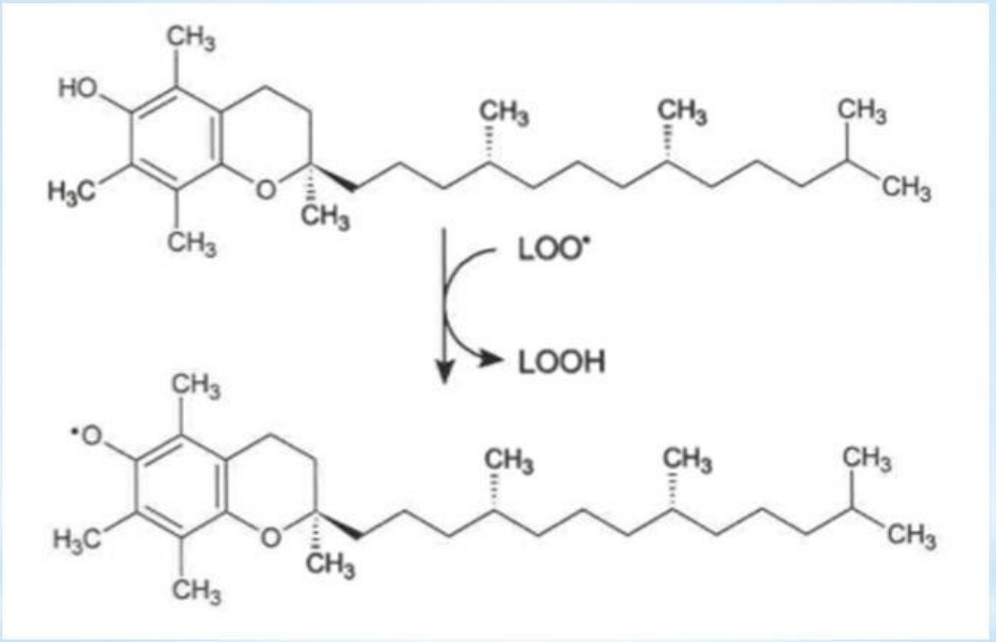


alpha-tocopherol

Physiological Role

- Reduces the production of lipid peroxyl radicals from highly unsaturated fatty acids.
- Antitoxic effect in cell metabolism.
- Reduces the incidence of liver necrosis and muscular degeneration. الضمور العضلي
- Antioxidant effect and .
- Stabilization of fat (protection against oxidation) in animal products (meat, milk, eggs).

Vitamin E metabolism

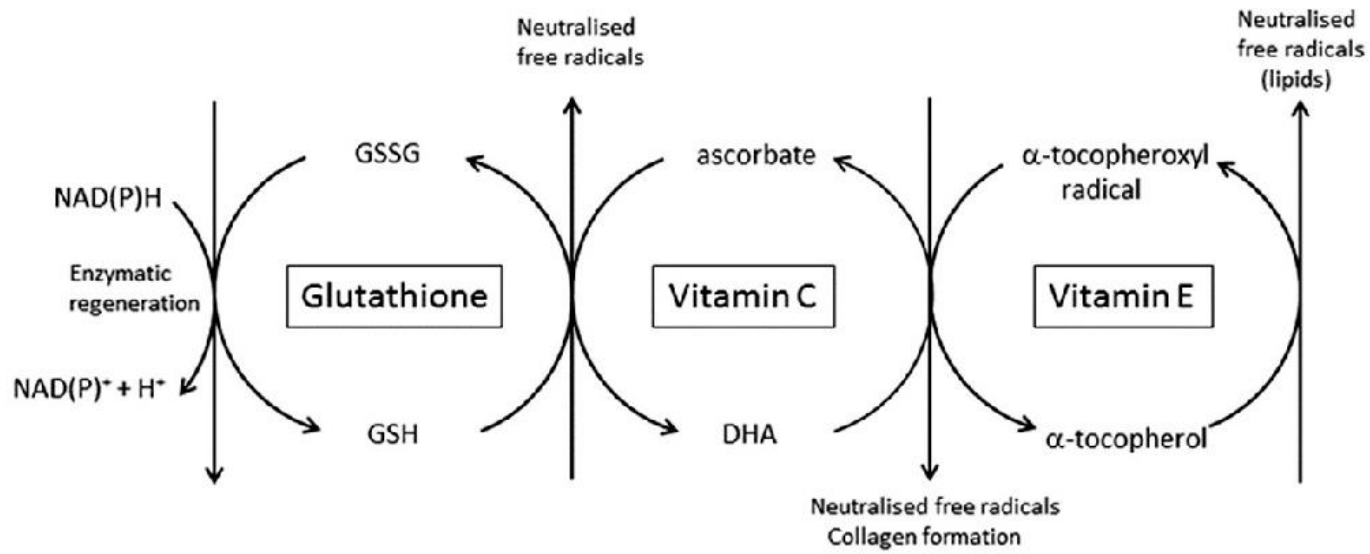


The aim of vitamin E: termination of lipid peroxidation
Vitamin E changes peroxyl radicals in lipid peroxides and changes in tocopheryl radical itself

Interaction with other nutrients

Nutrients Synergistic to Vitamin E

- **Selenium :** Function closely linked to vitamin E (needed for GSH peroxidase).
- **Vitamin C :** Helps in anti oxidant property.
- Sulfur containing amino acids.



Nutrients antagonistic to Vitamin E

- **Vitamin A :** Vitamin E Inhibits carotene absorption and conversion to retinol.
- **Vitamin K :** May impair absorption.
- May cause **vitamin -D** dependent bone mineralization problems.

Vitamin E deficiency

- **Severe vitamin E deficiency causes:**
  - Neurological symptoms (impaired coordination) & muscle weakness.
  - Increased risk of cardiovascular diseases
  - Hemolytic anemia in children

تنسيق

Toxicity

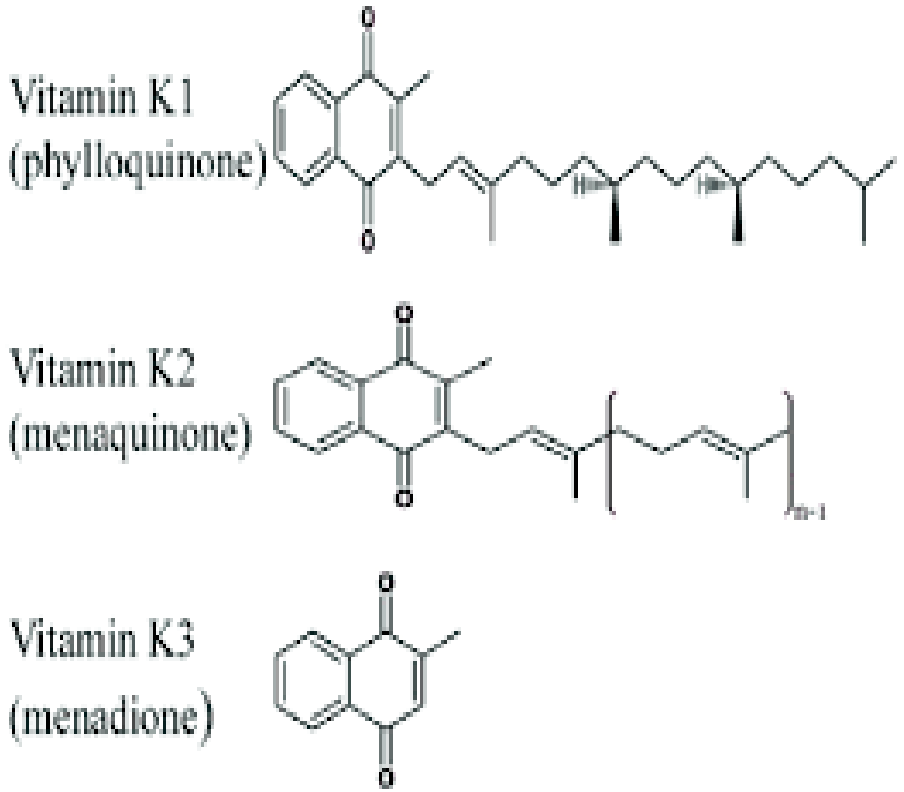
- There isn’t any known risk of consuming too much vitamin E from natural food sources.
- Because vitamin E can act as an anticoagulant and interfere with blood clotting, excess amounts in the body increase the risk of **hemorrhage.**

Vitamin K

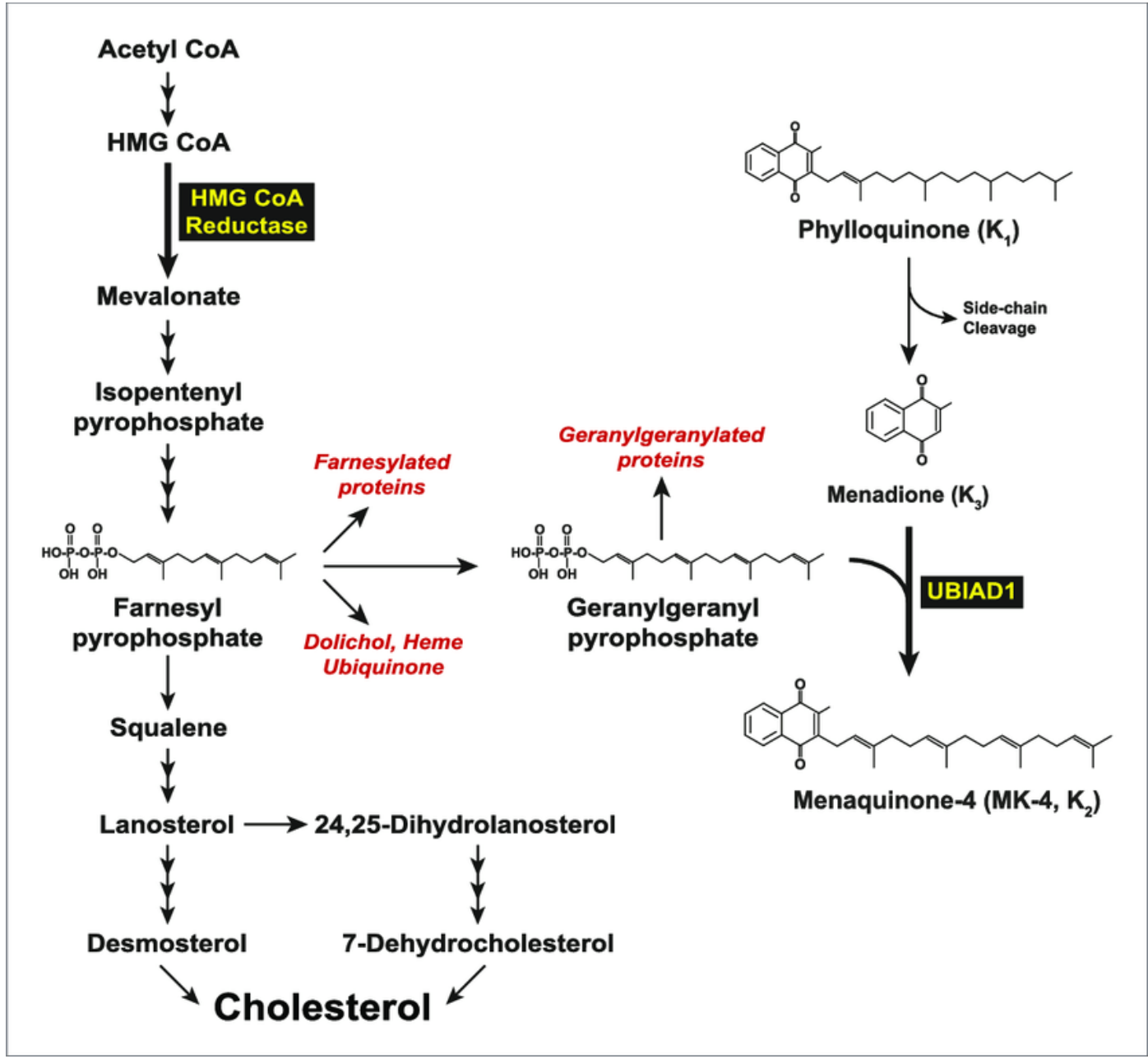
- Vitamin K was discovered in 1929 in alfalfa البرسيم

Natural sources and bioavailability

- Vitamin K is a generic term for vitamin K1 (phylloquinone), K2 (menaquinone) and K3 (menadione).
- Green plants are rich in vitamin K1, Vitamin K2 is produced by bacteria in the rumen and in the large intestine.

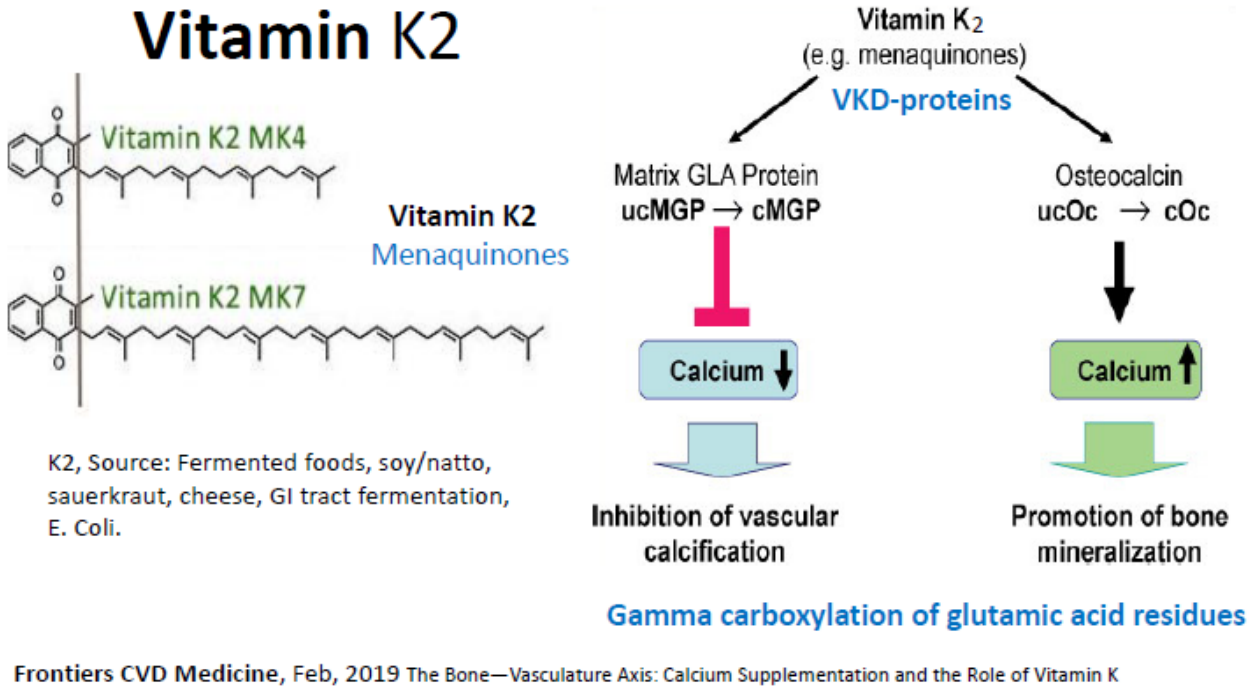


- Vitamin K3 (menadione) is an industrial form.
- The fat-soluble forms K1 and K2 can only be absorbed when pancreas lipase and bile acid are secreted.
- This is not necessary for the water-soluble vitamin K3.
- All three forms serve as a basis for the production of **menaquinone-4,** which is highly active in the metabolism.



Physiological role

- Synthesis of blood coagulation factors II (pre-thrombin), VII, IX and X.
- Production of the calcium transport protein **osteocalcin** for bone mineralization Participation in carboxylation of other proteins.



Frontiers CVD Medicine, Feb, 2019 The Bone—Vasculature Axis: Calcium Supplementation and the Role of Vitamin K

Vitamin K - deficiency

- Deficiency is caused by fat malabsorption or by the liver failure.
- Blood clotting disorders – dangerous in newborns, life -threatening bleeding (*hemorrhagic disease of the newborn)*.

- Osteoporosis due to failed carboxylation of osteokalcin and decreased activity of osteoblasts.

- Under normal circumstances there is not a shortage, vit. K is abundant in the diet.

Interaction with other nutrients

- **Vitamin A & Vitamin E :** May reduce the absorption of Vitamin K.
- **Vitamin E :** interfere with blood clotting mechanism of Vitamin K.

Toxicity

- Occurs rarely.
- Vitamin K, excessive amounts can cause the breakdown of red blood cells and liver damage.

THANK YOU