Vitamins

Vitamins are organic compounds required in the diet in small amounts to perform specific biologic functions for normal maintenance of optimum growth and health.

Small amounts of vitamins are required in the diet to promote growth, reproduction, and health.

The word Vitamin comes from the Greek word “VITAMINE” which means “Vital for Life”.

Water Soluble Vitamins

- Water-soluble vitamins are **not stored in the body**, it absorbs what it needs and then it usually excretes the excess in your urine.
- Water-soluble vitamins are found in fruit, vegetables and grains.
- Water-soluble vitamins are:
  - ✓ Vitamin C
  - ✓ The B Vitamins
    - Thiamin (Vitamin B1)
    - Riboflavin (Vitamin B2)
    - Niacin (Vitamin B3)
    - Pantothenic Acid
    - Vitamin B6
    - Folic Acid
    - Vitamin B12

Fat Soluble Vitamins

- Soluble in fat
- Bile salts are essential for there absorption
- Generally stored in liver
- Not excreted in urine.
- Fat-soluble vitamins are:
  - Vitamin A
  - Vitamin D
  - Vitamin E
  - Vitamin K

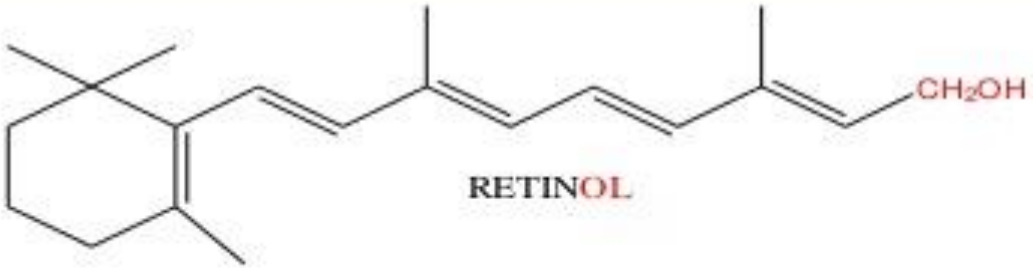
Vitamin-A

- Includes A_1 and A_2.
- A_2 is functionally almost similar to A_1.
- Chemical Structure is slightly different. Vit A_2 has one more double bond
- Emperical formula of Vitamin A_1 is $C_{20}H_{29}OH$ and Vitamin A_2 is $C_{20}H_{27}OH$

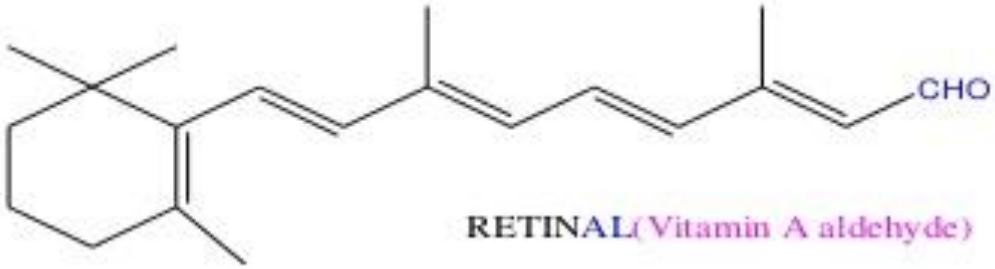
Vitamin A

- 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).**

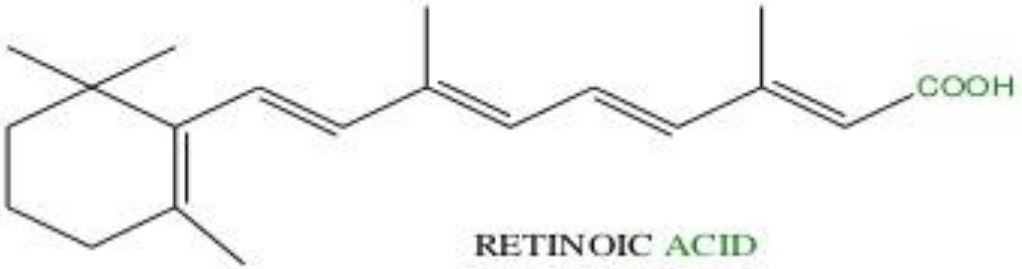
STRUCTURES OF VITAMIN-A



RETINOL



RETINAL(Vitamin A aldehyde)



RETINOIC ACID

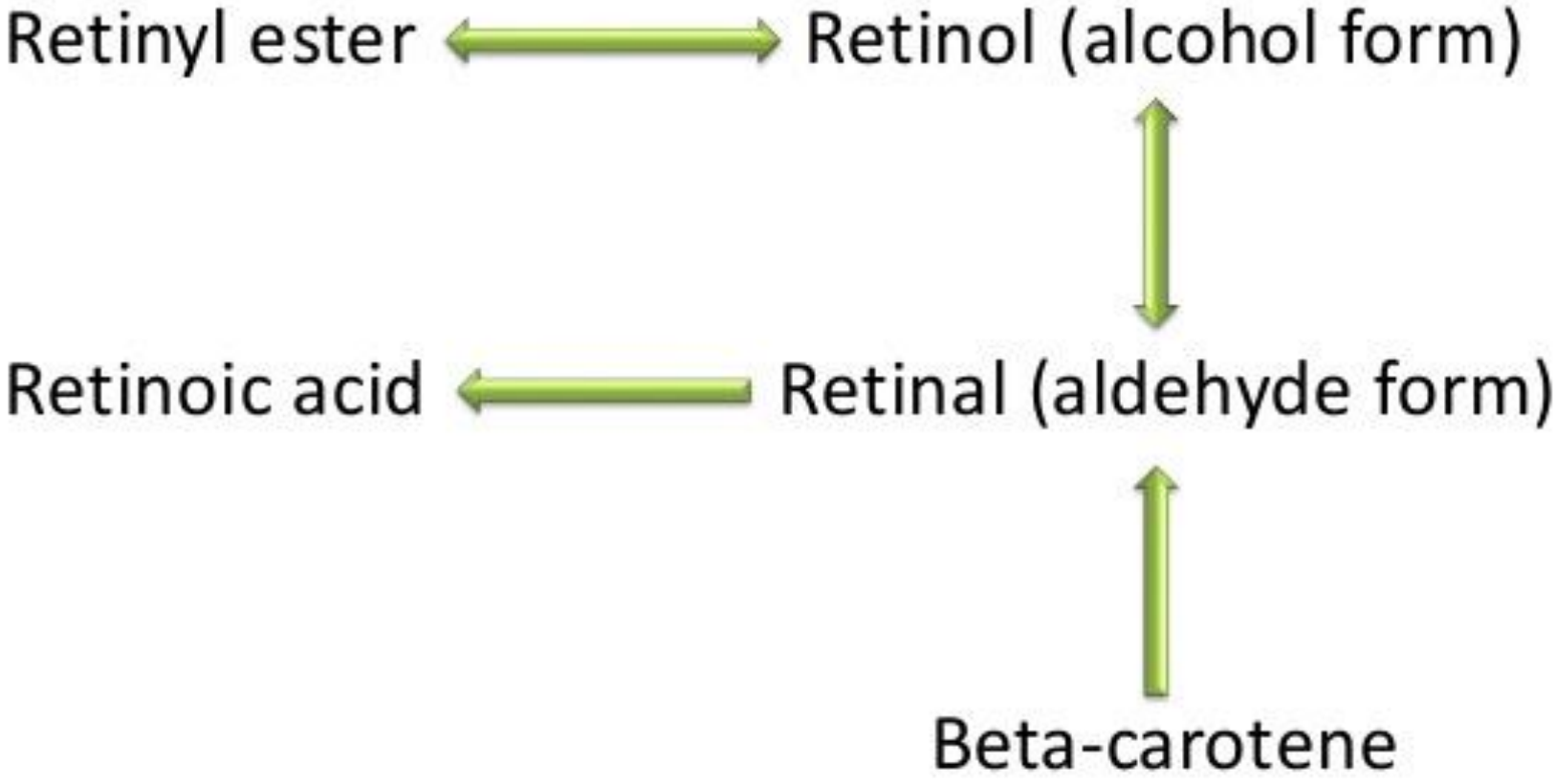
Vitamin A terms

- **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.

Dietary Sources of Vitamin A

Plant sources	Animal sources
Sweet potatoes	Chicken liver
Carrots	Cod liver oil
Pumpkin	Fish oil
Winter squash	Canned beef stew
Cantaloupe	Eggs
Pink Grapefruit	Fish
Mangoes	Shellfish
Apricots	Butter
Oranges	Fortified margarine
Spinach	Cheese
Kale	Whole milk
Beet greens	Fortified skim milk
Broccoli	Fortified low fat dairy products
Dark green leafy vegetables	

Conversion of Vitamin A Compounds



ABSORPTION & STORAGE

- The liver has enoromous capacity to store – in the form of retinol palmitate.

- Free retinol is highly active but toxic & therefore transported in blood stream in combination with retinol binding protein (liver)

DAILY REQUIRMENT

- Men and women – 600 mcg.
- Pregnancy and lactation – 950 mcg.
- Infants – 350mcg.
- Children – 600mcg.

Functions

- Component of rhodopsin, essential for night vision.
- Maintains integrity and activity of epithelial tissues and glands.
- Play some part in protein synthesis.
- Controls the action of the bone cells.
- Helps in keeping normal fertility.
- Participates in reactions which affect the stability of cell membrane.

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**.

Deficiency symptoms

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

TREATMENT

LOCAL OCULAR THERAPHY

- Artificial tears
  (0.7% hydroxypropyl methyl cellulose or 0.3 % hypromellose)
- Should be instilled every 3-4 hours

VITAMIN A

- Oral administration is recommended
- In case of side effects, IM injections of water miscible preparations prefered

HYPERVITAMINOSIS A:

ACUTE TOXICITY

- Headache & dizziness
- Nausea
- Vomiting
- Abdominal pain
- Pseudotumour cerebri{bulging anterior fontanel}

CHRONIC TOXICITY

- Anorexia
- Dry skin
- Pruritis
- Sparse hair
- Bone pain
- Weight loss
- Benign intracranial hypertension
- hepatosplenomegaly

VITAMIN D

it is also called **SUNSHINE VITAMIN**.

it is available in 2 forms

D3 – cholecalciferol

D2 - ergocalciferol

Cholecalciferol (vitamin D3)

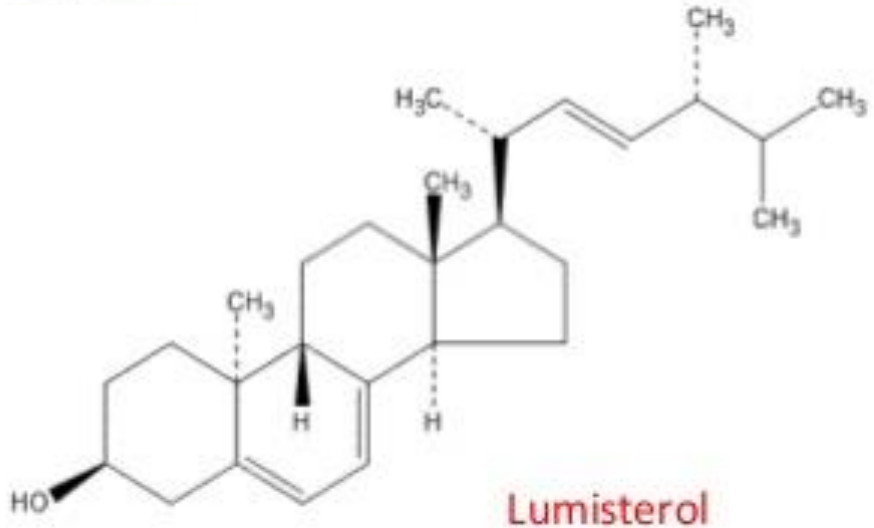
is made from 7-dehydrocholesterol in the skin of animals and humans.

Ergocalciferol - D2

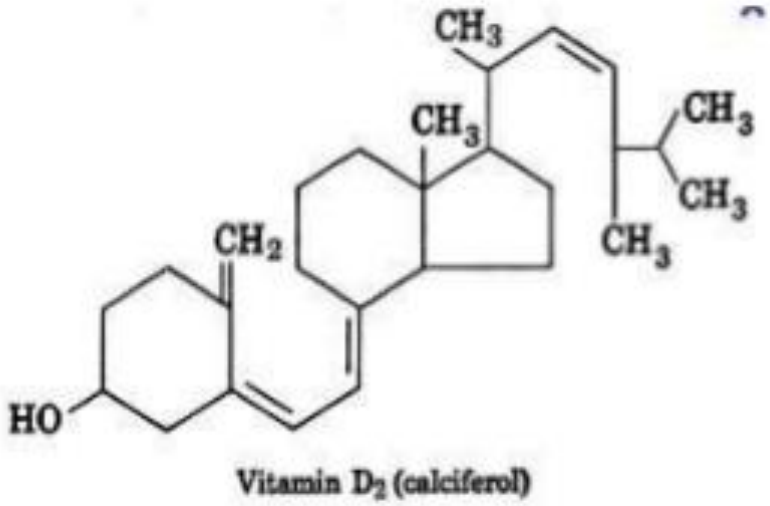
obtained artificially by irradiation of ergo- sterol

VITAMIN-D_1

- Infact Vitamin-D_1 is containing molecular compound of lumisterol and D_2 in 1:1 ratio.



Lumisterol

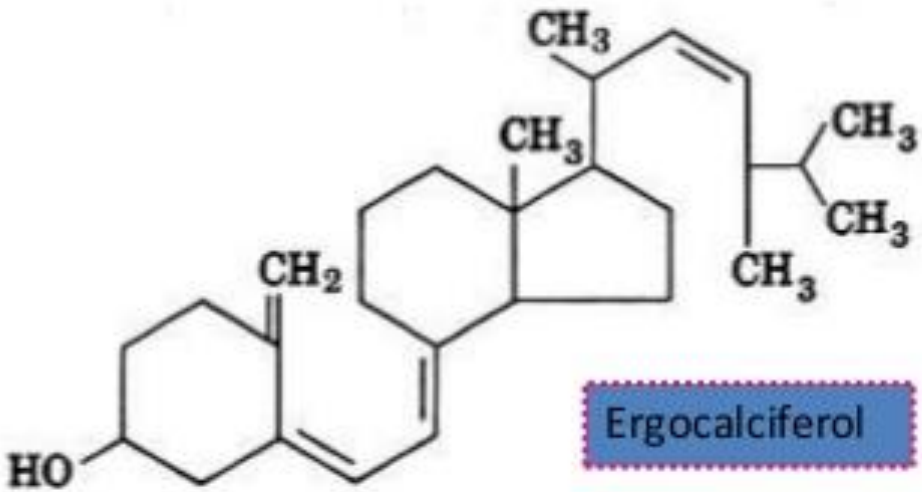


Vitamin D_2 (calciferol)

Vitamin-D_1= Lumisterol + Vitamin D_2 (calciferol)

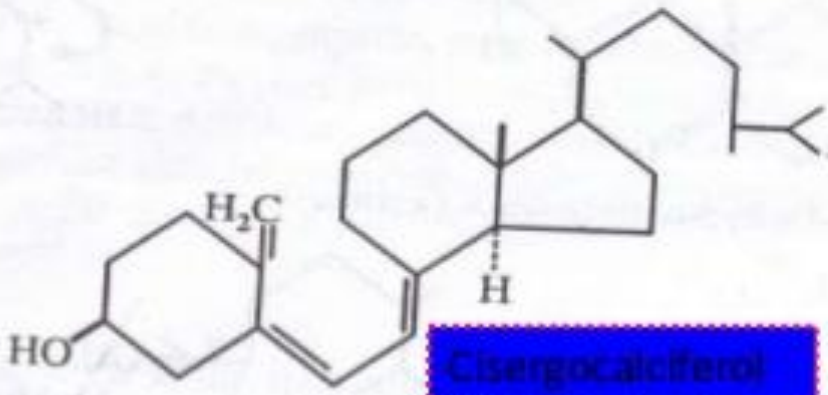
(1 : 1) Ratio.

Important structures of vitamin D



Ergocalciferol

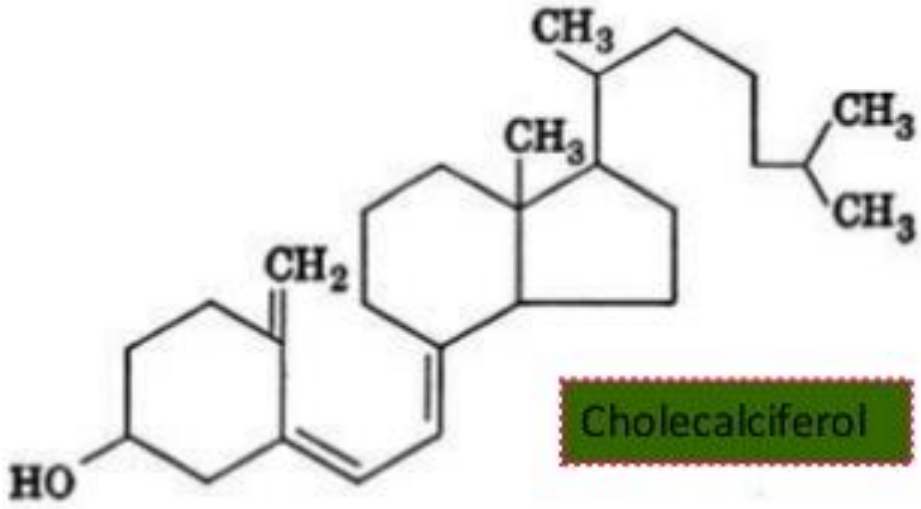
Vitamin D_2 (calciferol)



Cisergocalciferol

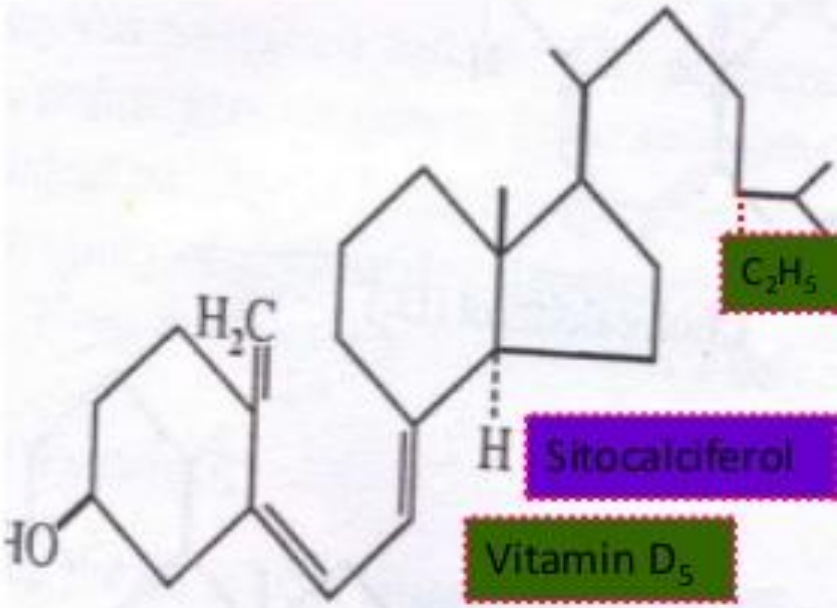
Vitamin D_4

22, 23-Dihydro-5, 6-*cis*-ergocalciferol m.p. 107°C, $[\alpha]_D$ + 89°



Cholecalciferol

Vitamin D_3



Sitocalciferol

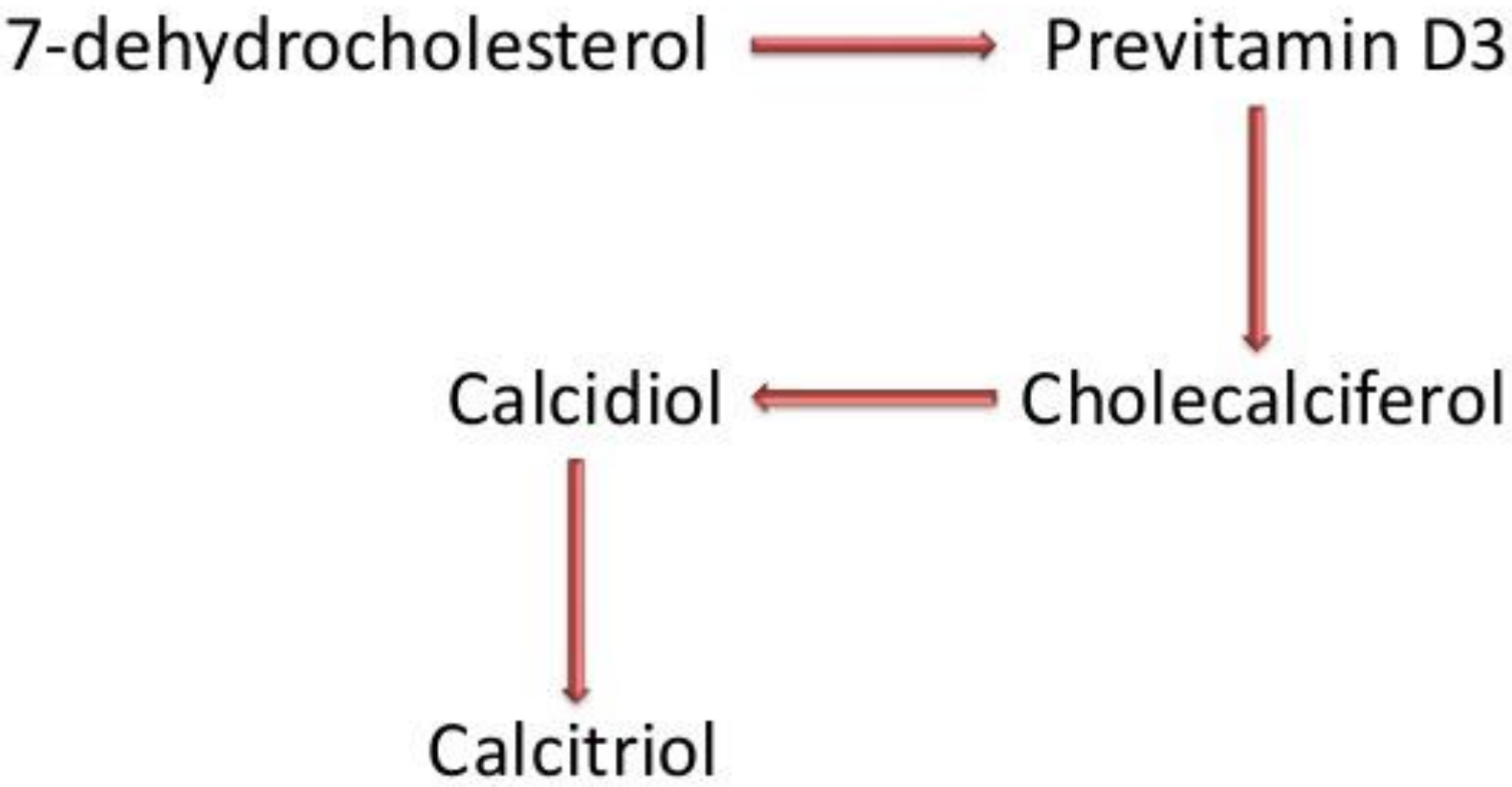
Vitamin D_5

VITAMIN-D SOURCES

- Fortified
  - Milk
  - Margarine
  - Butter
  - Cereal
- Veal, Beef
- Egg yolk
- Fatty fish (salmon, sardines, herring)

Table 2: Recommended Dietary Allowances (RDAs) for Vitamin D [1]				
Age	Male	Female	Pregnancy	Lactation
0–12 months*	400 IU (10 mcg)	400 IU (10 mcg)		
1–13 years	600 IU (15 mcg)	600 IU (15 mcg)		
14–18 years	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)
19–50 years	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)
51–70 years	600 IU (15 mcg)	600 IU (15 mcg)		
>70 years	800 IU (20 mcg)	800 IU (20 mcg)		

Metabolism of Vitamin D



FUNCTIONS

- Calcium Balance
- Cell Differentiation
- Immunity
- Blood Pressure Regulation
-
- Development of Bones & Teeth

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.
- Poor eggshell stability.

vitamin D - deficiency

- RICKETS → Children's
- OSTEOMALACIA → Adults
- Increase the risk of Osteoporosis

MANAGEMENT

- Dietary enrichment of vitamin D in the form of milk
- Curative treatment includes **2000 to 4000 IU** of calcium daily for **6 to 12 weeks.**
- osteomalacia due to **intestinal malabsorption** require larger dose of vitamin D & calcium i.e.

40,000 to 1,00,000 IU of vitamin D
15 to 20 gms of calcium lactate.

HYPERVITAMINOSIS D

- Anorexia, nausea & vomiting
- Constipation
- Hypertension
- Drowsiness, irritability & hypotonia
- Polyuria & polydipsia
- Renal damage
- Hyperkalaemia

CLOUDING OF CORNEA

Vitamin E (Tocopherols)

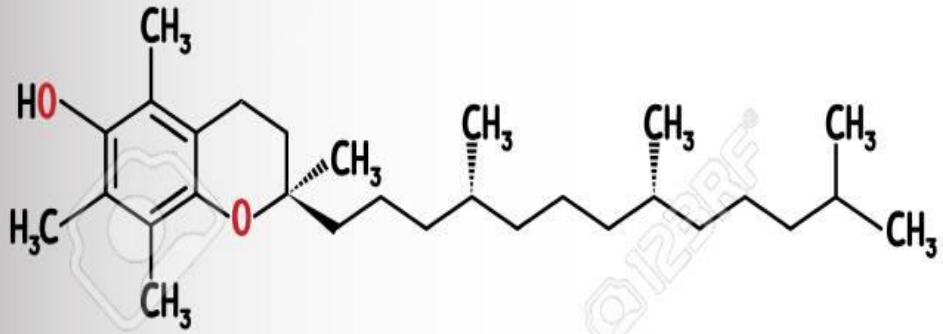
- They are soluble in fat and fat solvents, heat-stable and exists naturally as an yellow oil.
- These tocol types of viatmin can stand cooking and they are extraordinarily stable in heat in the absence of oxygen.
- The Vitamin activity is destroyed by ultraviolet light as well as by oxidation.
- They are excellent antioxidants.
- They prevent other vitamins present in food from oxidative destruction.

Chemical Structure

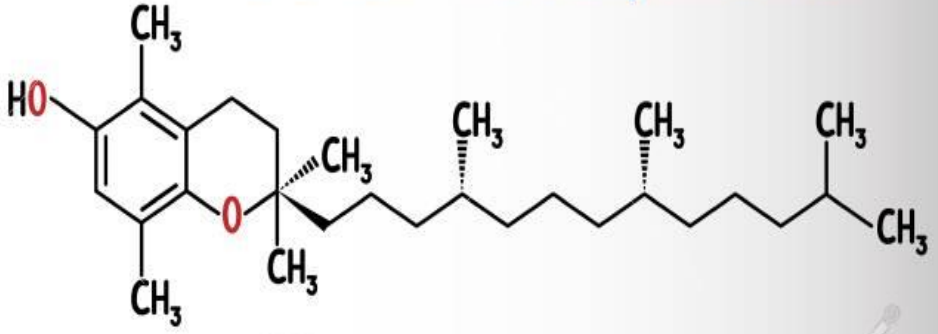
- Vitamin E is the name given to group of tocopherols and tocotrienols.
- About 8 tocopherols have been identified .
- Alpha tocopherol is most active.
- The tocopherols are 6 derivatives of 6-hydroxy chromane (tocol) ring with isoprenoid side chain.
- The antioxidant property is due to the chromane ring.
- There are four main forms of tocopherols.

Vitamin E Tocopherol

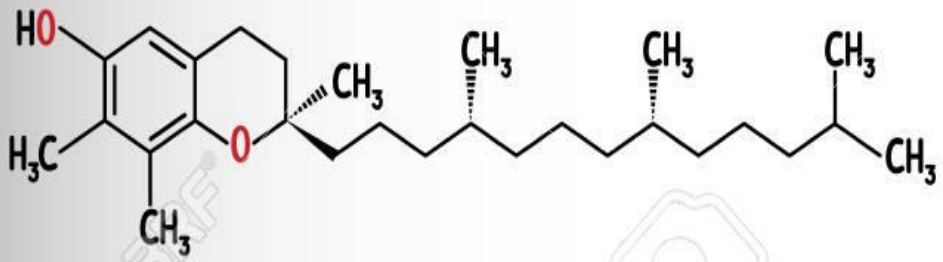
alpha-Tocopherol



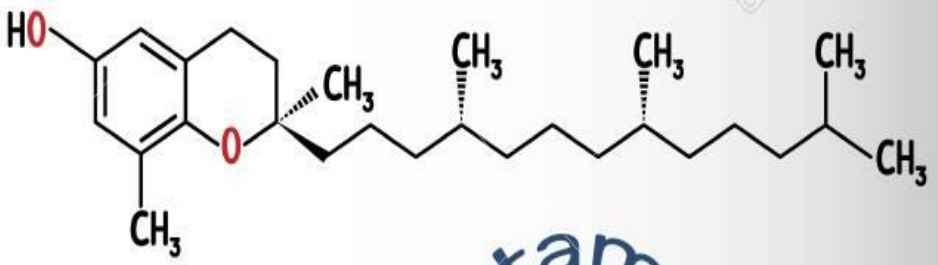
beta-Tocopherol



gamma-Tocopherol



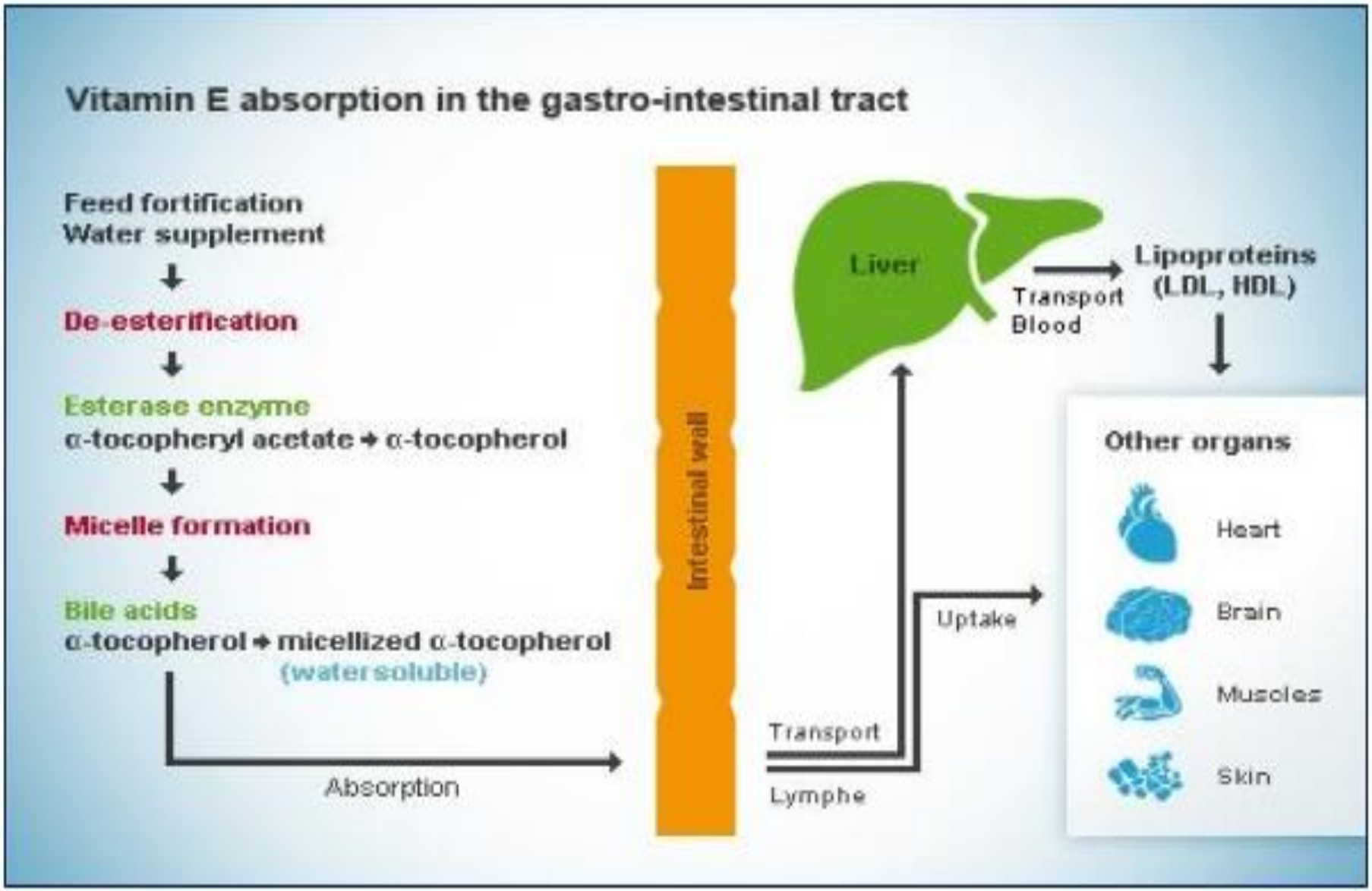
delta-Tocopherol



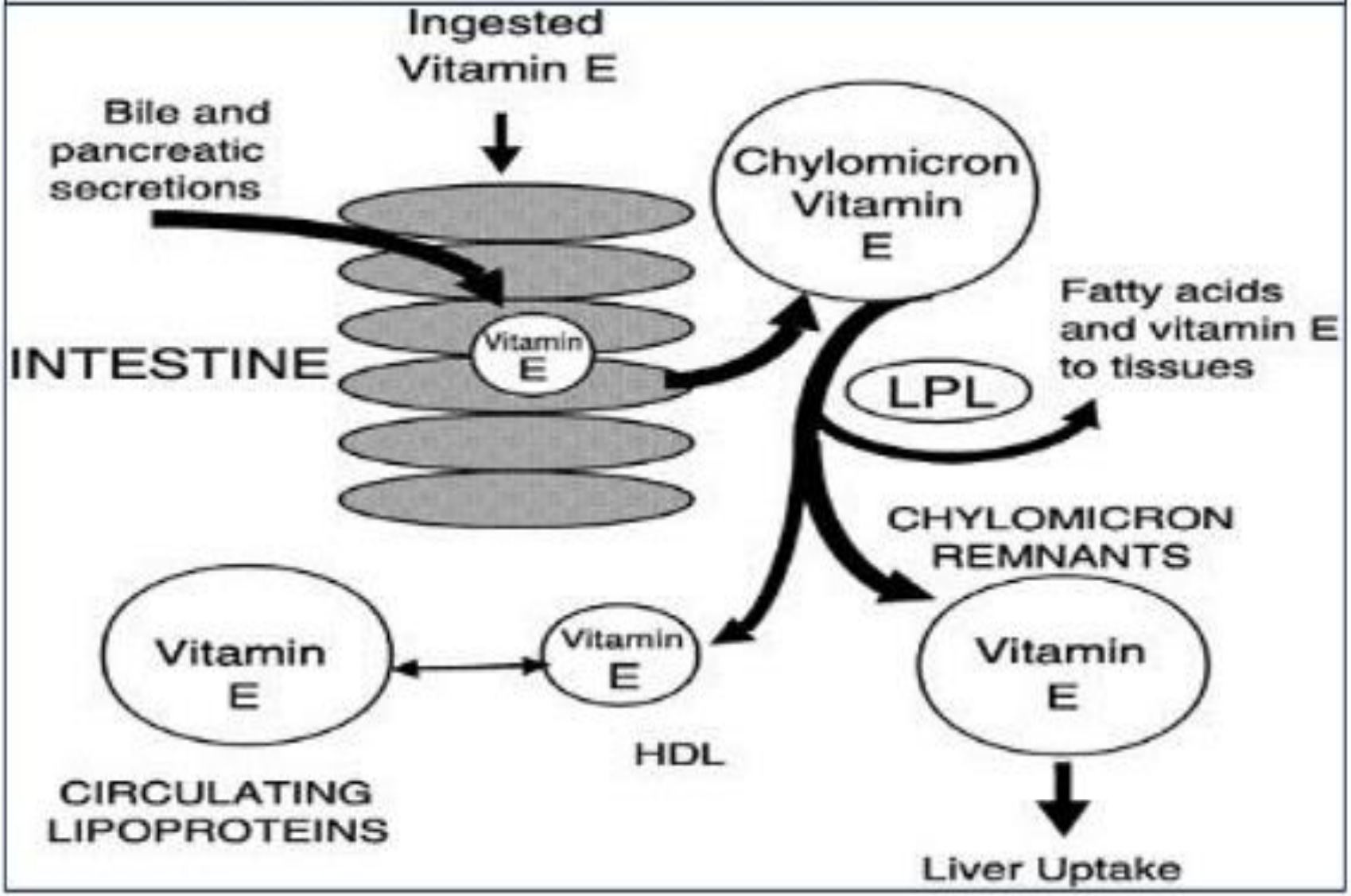
ABSORPTION

- Vitamin E is absorbed along with fat in the upper small intestine
- *Mechanism:* Vitamin E combines with Bile salts (micelles) to form mixed micelle and taken up by the mucosal cell
- In the mucosal cell, it is incorporated into chylomicrons

Metabolism Of Vitamin E



Metabolism Of Vitamin E



Daily Requirement

- Males -10 mg/day
- Females - 8 mg/day
- Pregnancy - 10 mg/day
- Lactation - 12 mg/day
- 15 mg of vitamin E is equivalent to 33 IU
- Pharmacological dose is 200-400 IU/day
- ***Sources:***
- Rich sources are vegetable oils
- Includes germ oil, sunflower oil, corn oil and margarine

Transport

- Dietary vitamin E is incorporated to chylomicrons
- In the circulation, chylomicrons transport vitamin E to the peripheral tissue or to the liver
- Hepatic vitamin E is incorporated to VLDL
- In the circulation, VLDL is converted LDL
- Vitamin E is transported with LDL to reach the peripheral tissues including adipose tissue
- ***Storage:*** Mainly stored in liver and adipose tissue
- Present in biological membranes, because of its affinity to phospholipids

Biochemical functions

- Most of the functions of the vitamin E are related to its antioxidant property
- It prevents the non-enzymatic oxidations of various cell components by molecular oxygen and free radicals such as superoxide and hydrogen peroxide (H_2O_2)
- Selenium helps in these functions
- Vitamin E is lipophilic in character and is found in association with lipoproteins, fat deposits and cellular membranes

- It protects the PUFA from peroxidation reactions

1. Vitamin E is essential for membrane structure and integrity of the cell, hence it is membrane antioxident
2. It prevents the peroxidation of PUFA
3. It protects the RBC from hemolysis by oxidizing agents (H_2O_2)
4. It is associated with reproductive function and prevents sterility

5. Vitamin E preserves and maintains germinal epithelium of gonads for proper reproductive function
6. It increases the synthesis of heme by enhancing the activity of enzyme – δ aminolevulinic acid (ALA) synthase and ALA dehydratase
7. It is required for cellular respiration –through ETC (Stabilize coenzyme Q)
8. Vitamin E prevents the oxidation of Vitamin A and carotenes

9. It is required for proper storage of creatine in skeletal muscle
10. It is required for absorption of amino acids from intestine
11. It is involved in synthesis of nucleic acids
12. It protects the liver from toxic compounds such as carbontetrachloride
13. It works in association with vitamin A,C and beta-carotene, to delay the onset of cataract

14. Vitamin E is recommended for the prevention of chronic diseases such as **cancer and heart disease**

- *Vitamin E prevents oxidation of LDL*
- *Oxidized LDL promotes heart diseases*
- **Selinium:** It is a component of glutathione peroxidase and function as antioxidant
- It reduces the requirement of vitamin E in diet
- It is required for normal pancreatic function and enhancing the absorption of vitamin E

DEFICIENCY

- In humans, deficiency of vitamin E is seen in
- Premature infants:
- Transfer of vitamin E from meternal blood occurs during last few weeks of pregnancy
- Premature infants will have vitamin E deficiency
- Impaired absorption: Seen in conditions such as
- abetalipoproteinemia (fat malabsorption)
- Obstructive jaundice
- Intestinal diseases such as celiac spure

- **Genetic vitamin E deficiency:** It is caused by lack of a protein that normally transports α-tocopherol from hepatocytes to VLDL
- **Clinical features:**
- **Hemolytic anemia or macrocytic anemia** seen in premature infants
- In adults, increased susceptibility of erythrocytes for hemolysis under oxidative stress
- Muscle weakness and **proteinuria** is seen

Muscular dystrophy

- Vitamin E deficiency leads to increased oxidation of PUFA, with consumption of oxygen and production of peroxides
- Peroxides increase the intracellular hydrolase activity
- The hydrolases catalyze breakdowns in muscle and produce muscular dystrophy
- The muscle creatine is low and creatinuria occurs

Hepatic necrosis

- Vitamin E and selenium prevents hepatic necrosis
- *Spinocerebellar ataxia and impaired vision:*
- Chronic deficiency in children is associated with ataxia, weakness, loss of touch and position senses, impaired vision and retinopathy
- Increased lipid peroxidation in nervous tissue causes neurological lesions

- Oxidation of PUFA in rods leads to oxidative damage in retina
- Deficiency in animals:
- Muscular dystrophy and reproductive failure
- Vitamin E is least toxic

Hypervitaminosis E

- Hypervitaminosis E : toxicity at doses above 1000 IU

- Administration of Vitamin E 300mg per day for 23 years →no toxic effects observed = LEAST TOXIC fat soluble vitamin

Hypervitaminosis

1. Intestinal cramps
2. Diarrhea
3. Fatigue
4. Double vision
5. Muscle weakness