

Fat-soluble Vitamins



The logo for 'Learning Outcomes' features the word 'Learning' in a bold, black, sans-serif font with a yellow outline and a drop shadow. A small red apple with a green leaf is positioned above the letter 'i'. Below 'Learning' is the word 'Outcomes' in the same bold, black, sans-serif font with a yellow outline and drop shadow. To the left of 'Outcomes' is a blue graduation cap (mortarboard) with a tassel hanging to the left.

Learning Outcomes

□ At the end of this lecture, students should be able to:

- **Identify provitamins**
- **Identify fat-soluble vitamins**
- **Recognize sources, functions, and deficiency diseases of fat soluble vitamins.**

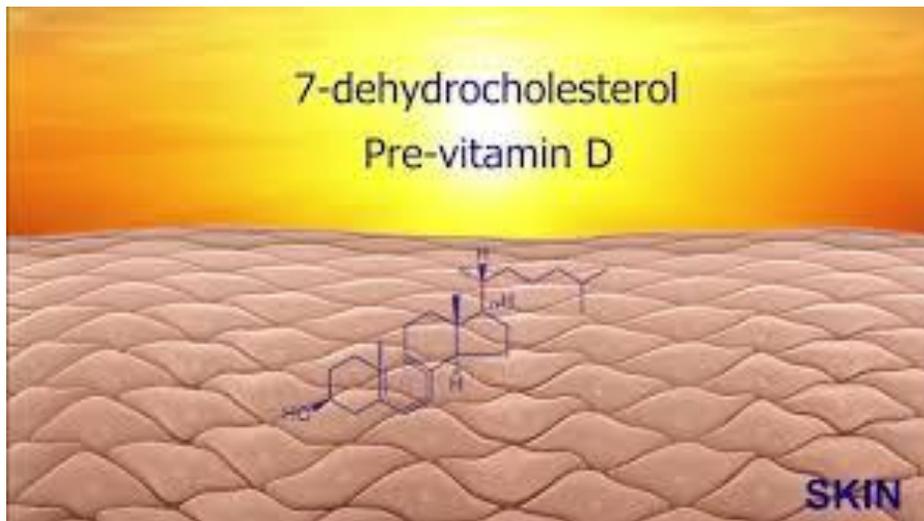
Case Scenario

□ A 3 year old child was brought with **bow legs, a protruding forehead, a pigeon chest, and depressed ribs.** His mother reported that he showed **delayed sitting teething and walking.** Plain film radiographs of his lower legs show **widened epiphyses and bowing of tibiae.**



Provitamins

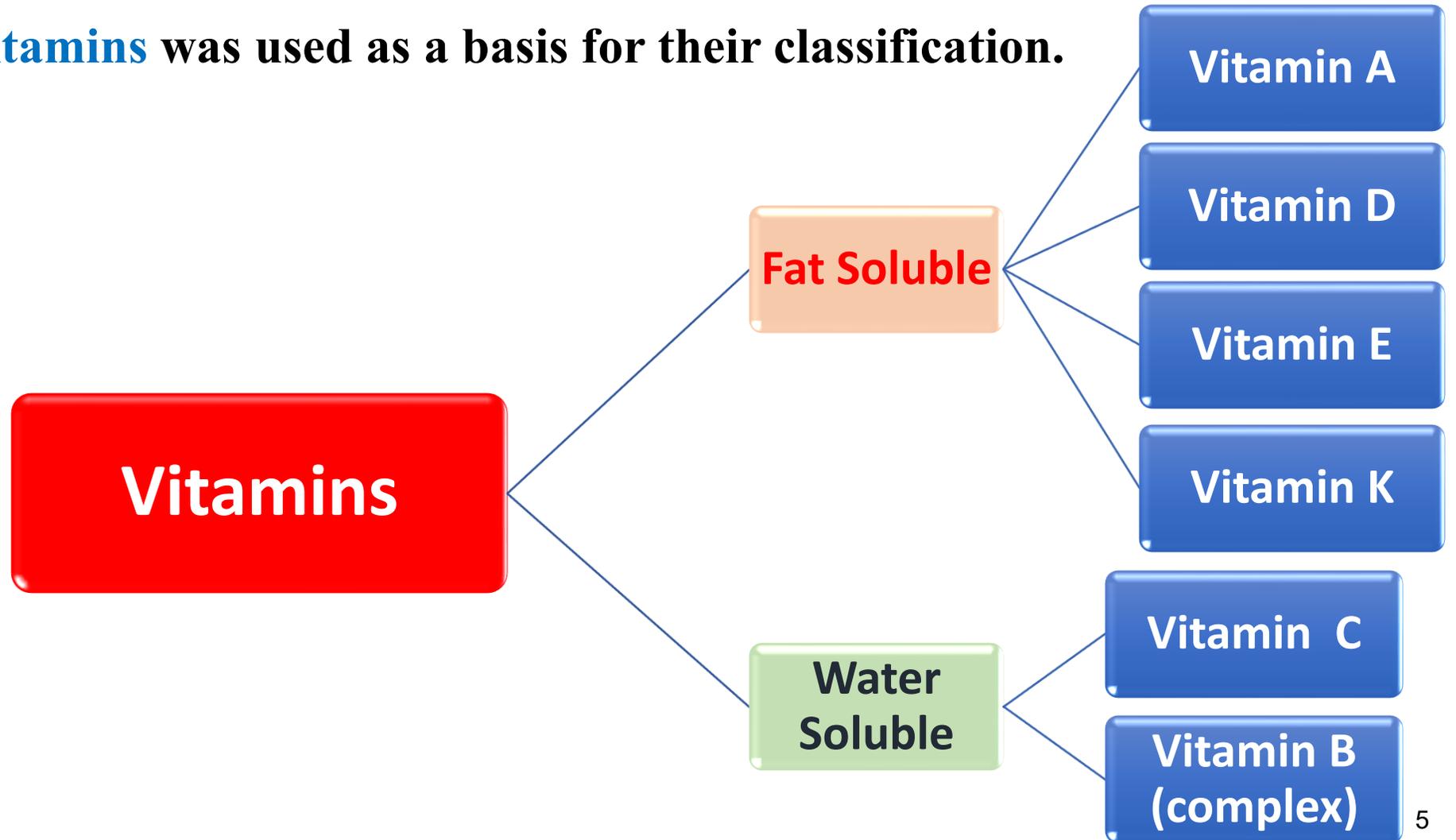
- They are **inactive precursors of vitamins** that are converted to active vitamins inside the body e.g.
 - ❑ **B-Carotenes** are provitamin **A**.
 - ❑ **7-dehydro-cholesterol** is provitamin **D₃**.





Classification of vitamins

The **solubility of vitamins** was used as a basis for their classification.



Vitamin A

Anti-xerophthalmic vitamin

Retinoids (Retinol, Retinal, Retinoic acid)



👉 Sources

- ❖ Vitamin A present **only** in **animal sources** as **liver, kidney, butter, milk and egg yolk.**
- ❖ **Fish liver oil** contains a **high concentration** of vitamin A as **cod liver oil.**



B- Carotenes (provitamin A) are present in **yellow and green vegetables and fruits** as **spinach, lettuce, potato, carrots and tomatoes.**



Functions of vitamin A

1-Antioxidant: (beta carotene role in trapping free radicals in tissues.)

2-Vision (detection of light by the retinal cells.)

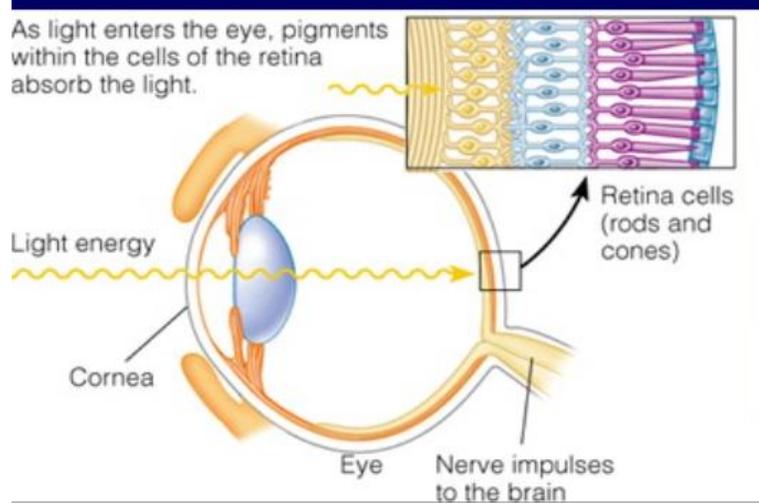
3-Epithelial integrity (Normal differentiation and functions of skin, mucus membranes)

4-Reproduction: spermatogenesis, fetal growth and placental functions.

5-Anticancer: Both vitamin A and carotenes have anticancer activity.

6-Growth : normal growth, cell differentiation and bone growth

Functions of vitamin A



A V E R A G

A=antioxidant

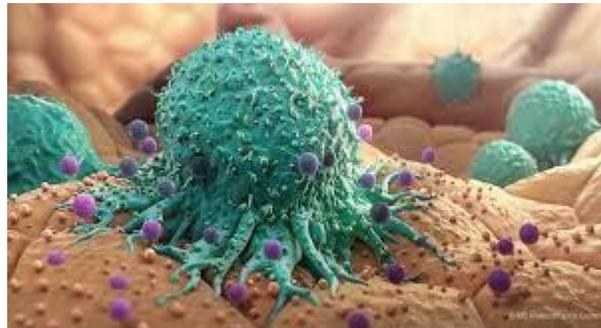
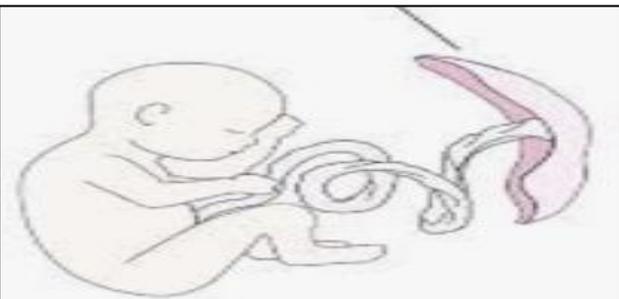
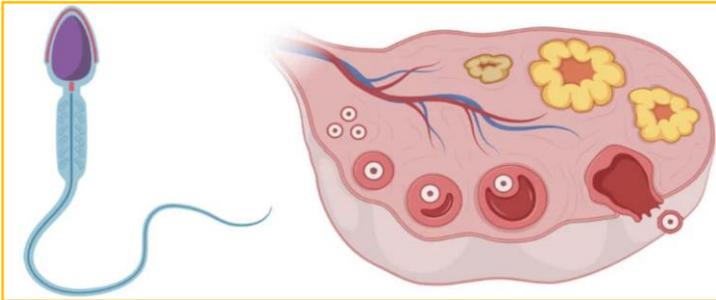
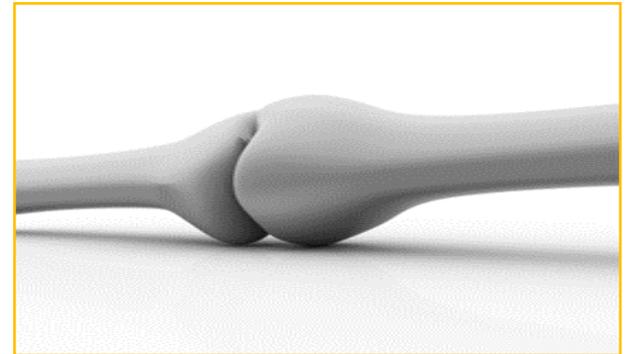
V=vision

E=epithelium

R=reproduction

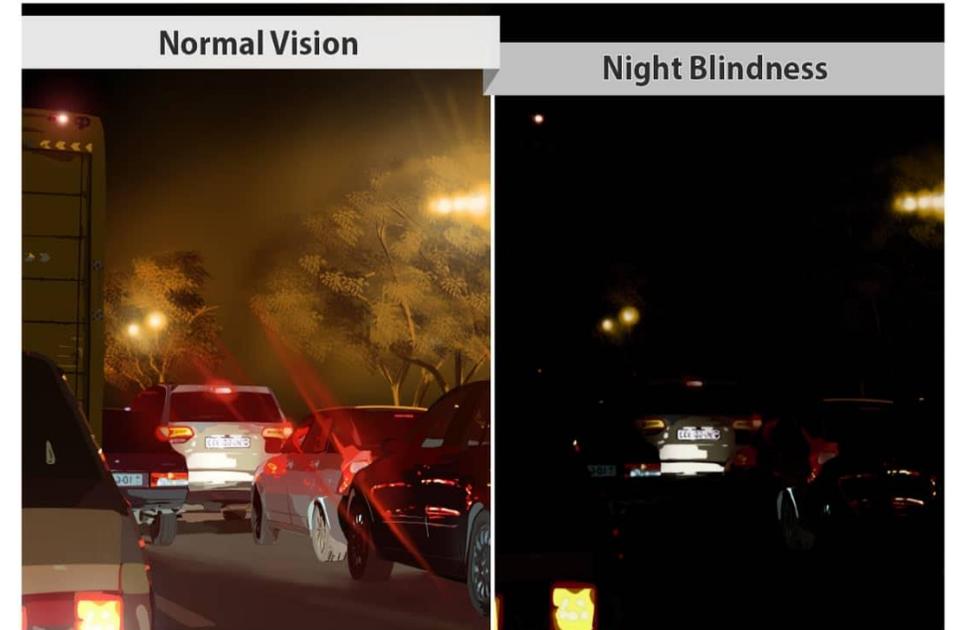
A=anti-cancer

G=growth



Vitamin A Deficiency

1. Night blindness (defective night vision.)
2. Xerosis (dryness) and keratinization of mucus membranes, xerophthalmia (dryness of eye) and susceptibility to infections.
3. Failure of growth as bone growth.
4. Certain forms of skin disease
5. Reproductive disorders.



Vitamin A toxicity (Hypervitaminosis A)

Occurs due to increased supplementation intake

Chronic toxicity symptoms:

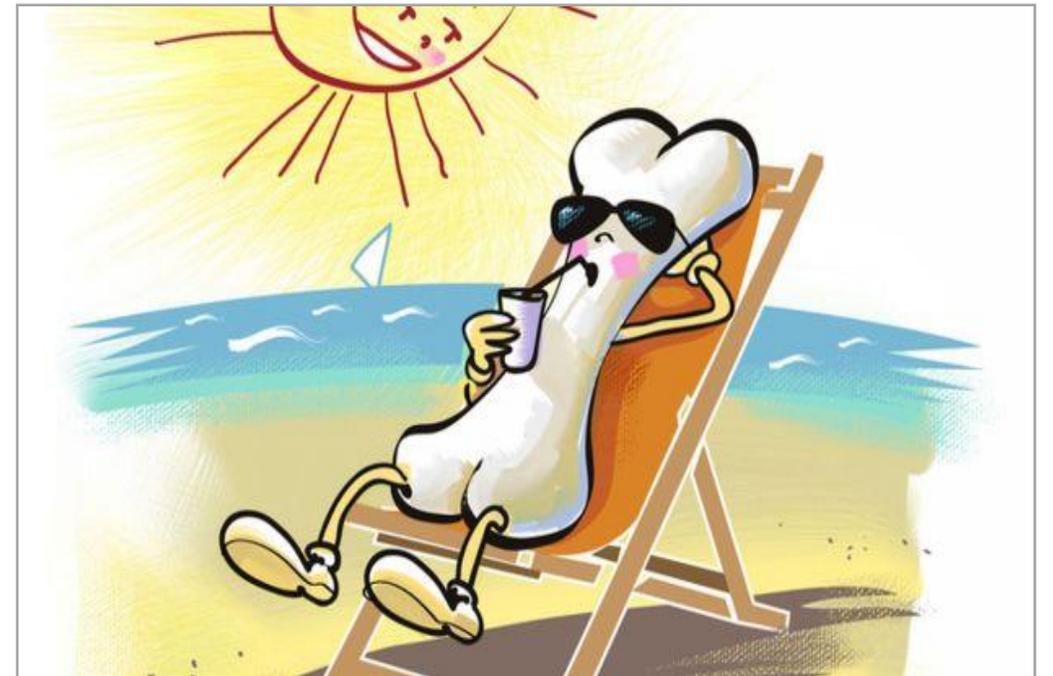
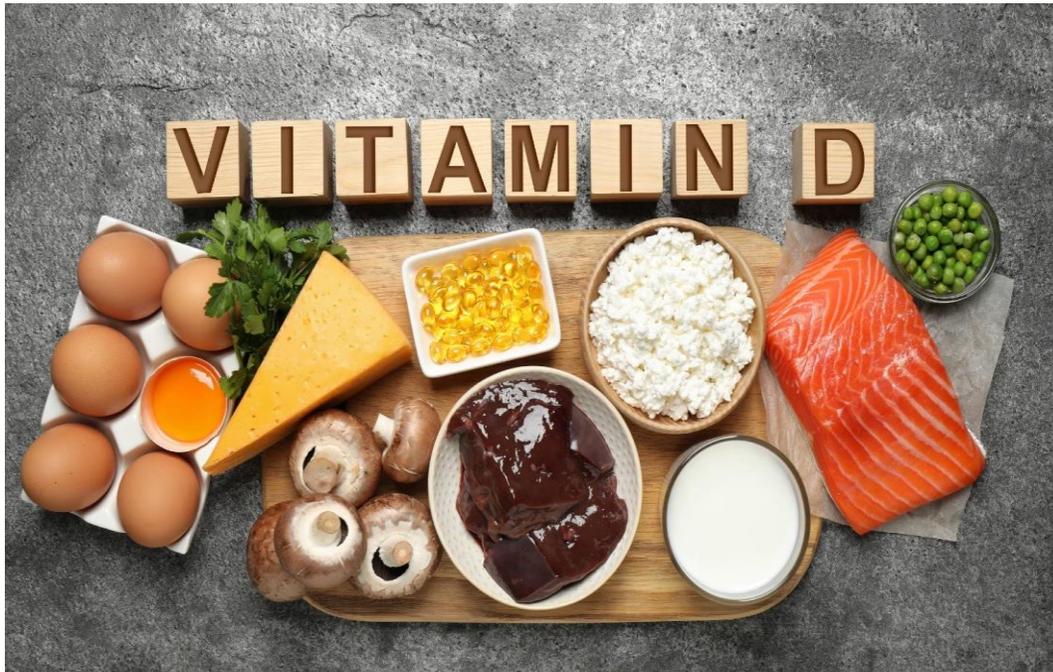
- **Ostroprosis** like symptoms
- **Dry itchy skin** with **loss of hair**.
- **Liver** abnormalities
- **Nausea & Headache**: a rise in intracranial pressure
- **Birth defects** when occurring in a pregnant woman



Vitamin D

Calcitriol

Anti-rachetic vitamin



Chemistry

❑ The D vitamins are a group of sterols that have a hormone-like function (it is a prohormone)

❑ **Forms:**

- ✓ **Ergocalciferol (D2):** Plant sources & supplements.
- ✓ **Cholecalciferol (D3):** Animal foods & made by body.

Vitamin D₂
(Ergocalciferol)

Vitamin D₃
(Cholecalciferol)

plant sterol
(supplement)

Animal sterol

❑ Vitamin D2 and D3 are not biologically active. They are converted in vivo to the active form of the D vitamin by two hydroxylation reactions.

Sources

❑ **Vitamin D3 is derived (by exposure to sun UV):**

7-dehydrocholesterol in animal and man is derived from cholesterol by intestinal mucosa and passes to skin whereby the effect of UV rays converted to vitamin D₃ (Cholecalciferol)

Cholesterol (intestinal-mucosa) → 7-dehydrocholesterol → skin ^{U.V} → vit D3

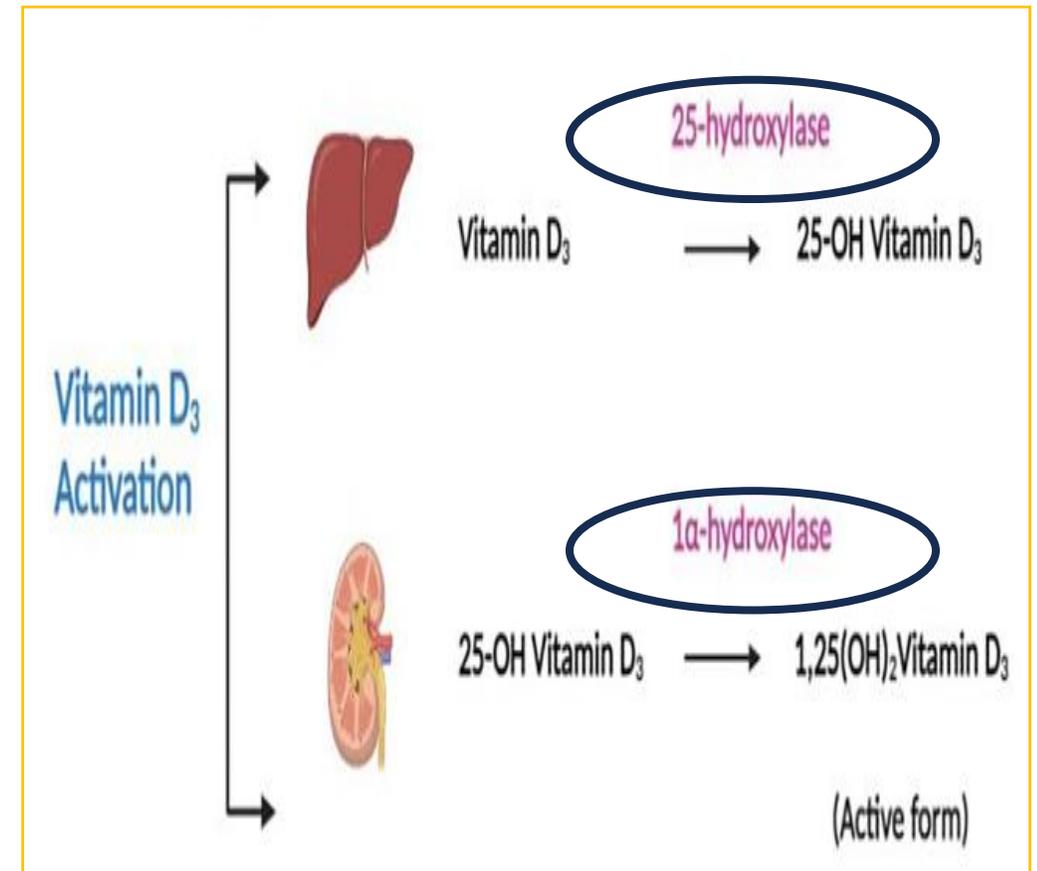
❑ **Diet** (Minor source) Animal sources:

- Fishes liver oils, cod liver oil, liver and egg yolk are good sources of vit D3
- but milk is a poor source of vitamin D

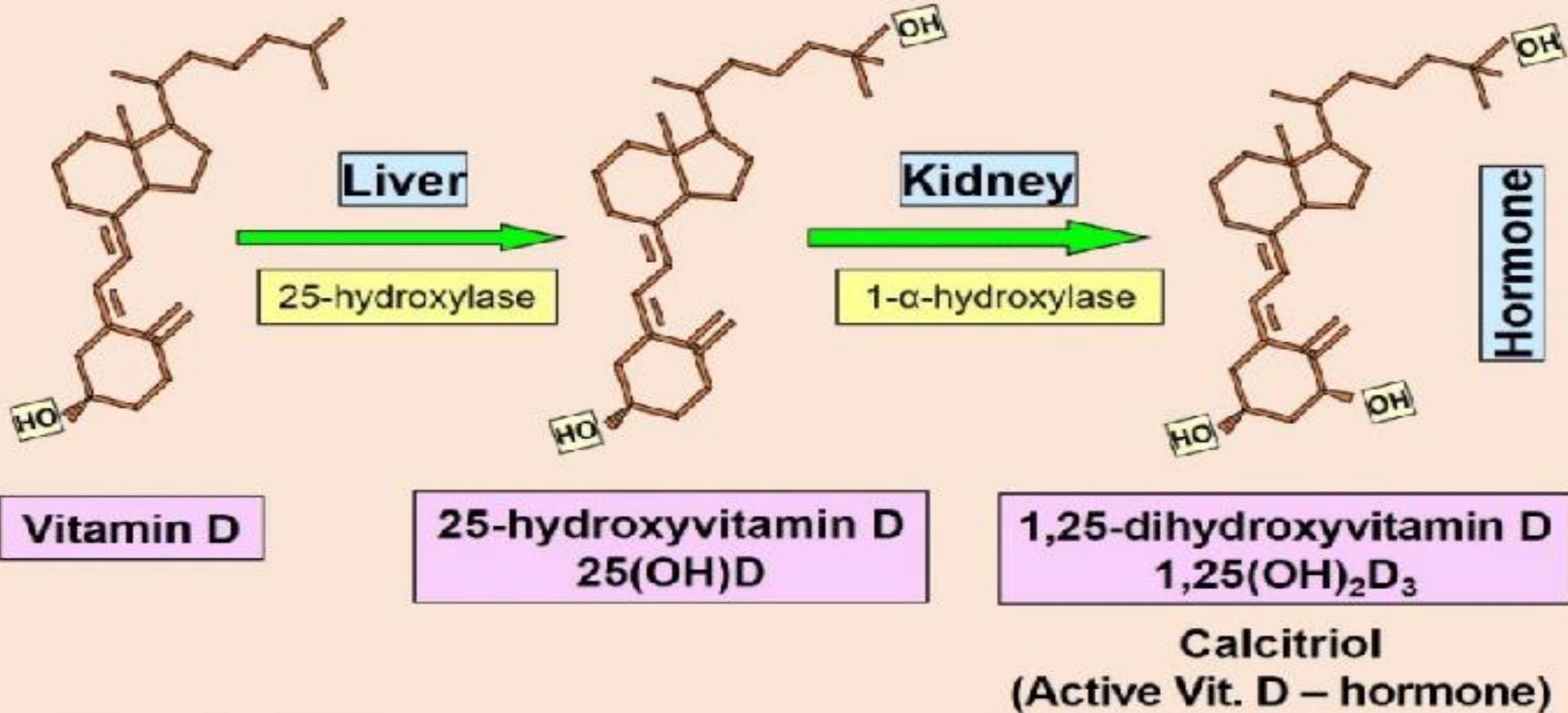
Vitamin D activation

Ingested vitamins D2 and D3 are converted to the active form of the vitamin D by two sequential hydroxylation reactions:

- ❑ The first hydroxylation occurs by **25 hydroxylase** in **the liver** producing 25-hydroxy cholecalciferol (25-OH-D3)
- ❑ 25-OH-D3 is further hydroxylated by **1 α -hydroxylase** in **the kidney**, forming 1,25-diOH-cholecalciferol (calcitriol) (the active form of vit D).



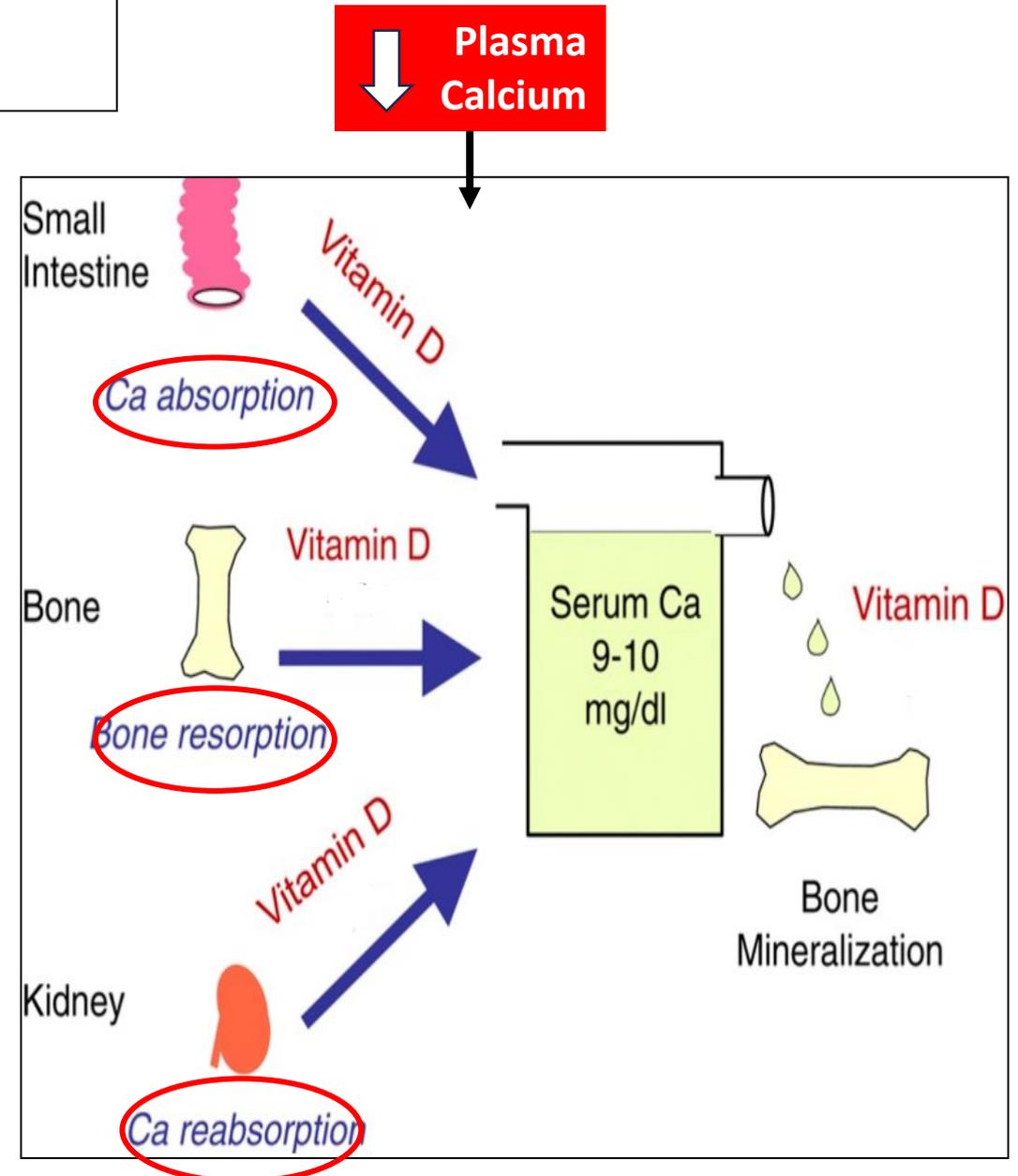
Vitamin D activation



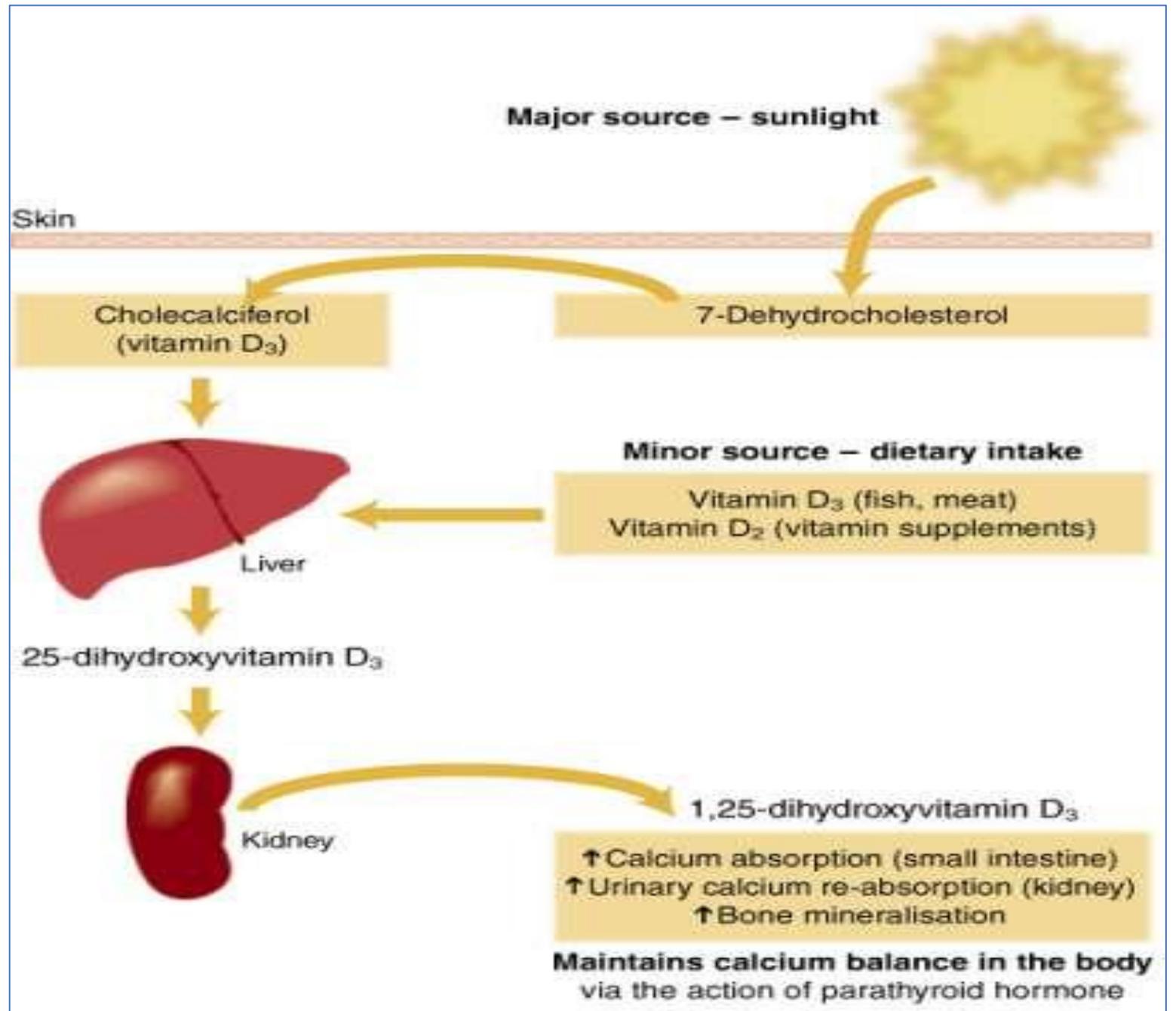
Functions of vitamin D

□ **vitamin D** maintains an adequate serum level of **calcium**. This function is performed by:

1. **Increasing uptake (absorption) of calcium by intestine.**
2. **Increasing reabsorption of calcium by the kidney.**
3. **Increasing bone resorption (mobilization of calcium) when needed.**



Vitamin D



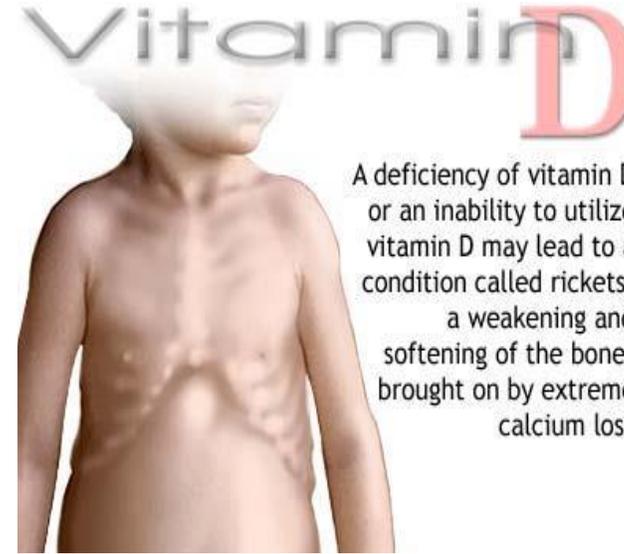
Vitamin D deficiency

■ In Children → Rickets.

- * Delayed setting, walking and teething.
 - * Deformed bones (skull, chest and legs)
(squared head, pigeon chest and bow legs)
-

■ In Adult → Osteomalacia.

- * Bone deformation
- * Bone fracture



A deficiency of vitamin D or an inability to utilize vitamin D may lead to a condition called rickets, a weakening and softening of the bones brought on by extreme calcium loss



Vitamin D toxicity (Hypervitaminosis D)

Vitamin D Toxicity symptoms:

- **Elevated blood calcium**
- **Calcification of soft tissues**
(especially blood vessels and kidneys causing stones)
- **Thirst and frequent urination**



Vitamin E
Tocopherol
Anti-sterility vitamin



Sources

❑ Wheat germ oil, Sunflower oil, nut oils, such as almonds and hazelnuts.

❑ Green leafy vegetables: such as spinach.

Sources of Vitamin E



Olive Oil



Coconut Oil



Sunflower Oil



Broccoli



Kale



Spinach



Avocado



Almonds



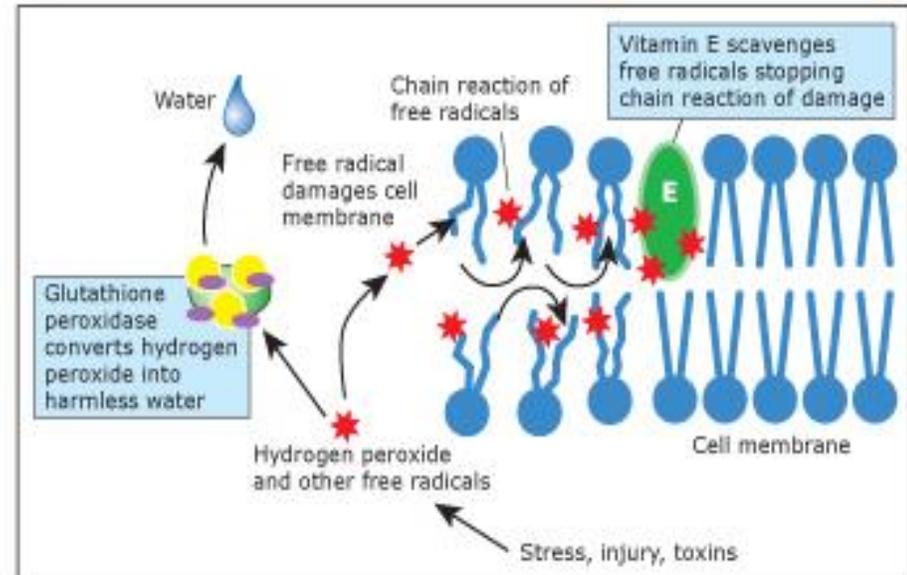
Peanuts

Functions of vitamin E

Antioxidant function

The most potent natural antioxidant.

- Protect against fatty acids peroxidation in membranes of cells: prevents free radicals from oxidizing compounds such as polyunsaturated fatty acids in phospholipid bilayer of cell membrane → Maintains integrity of membranes
- Protect RBCs from hemolysis.



Vitamin E deficiency

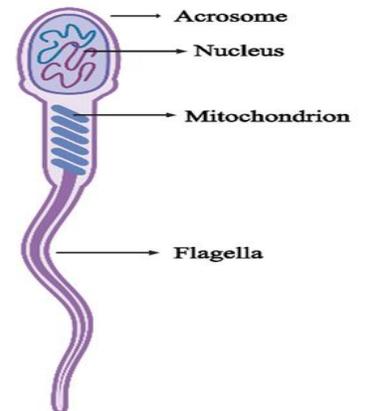
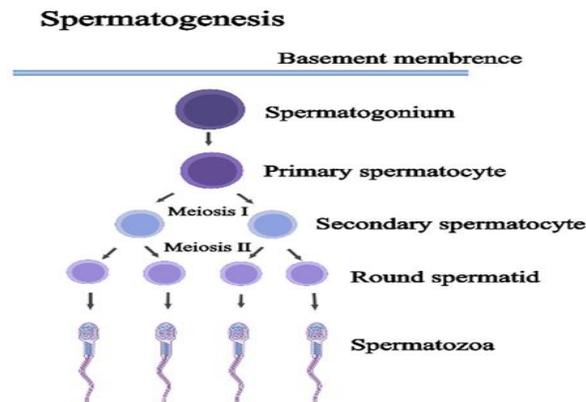
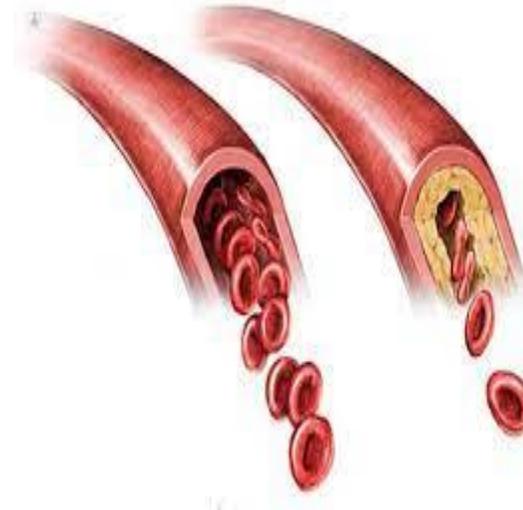
❑ Hemolytic anemia

Due to RBCs destruction by peroxides

❑ **Atherosclerosis** and cardiovascular disease.

❑ Sterility

Due to abnormal spermatogenesis in males, failure to retain zygotes, and fetal resorption in females.



Vitamin K
phylloquinone
Anti-hemorrhagic vitamin



Vitamin K

Sources:

□ **K1:** Green leafy vegetables as:
Cabbage, Cauliflower, Spinach

□ **K2:**

-in egg yolk, liver.

-It is synthesized by intestinal
bacteria

□ **K3:** synthetic

Vitamin **K**
Food sources of vitamin K include cabbage,
cauliflower, spinach and other green,
leafy vegetables, as well as cereals

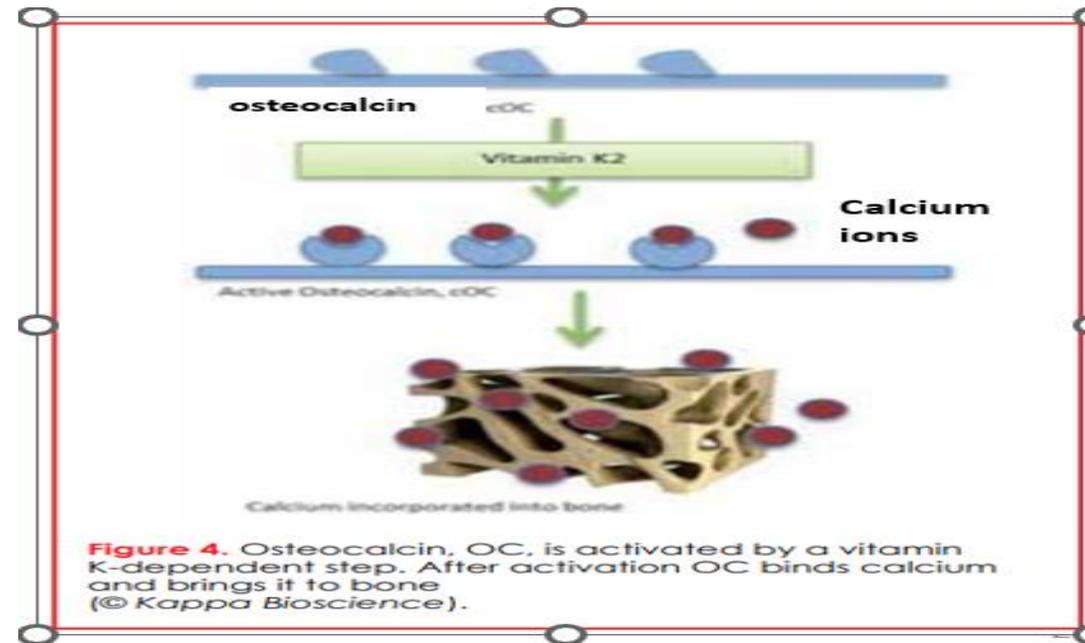
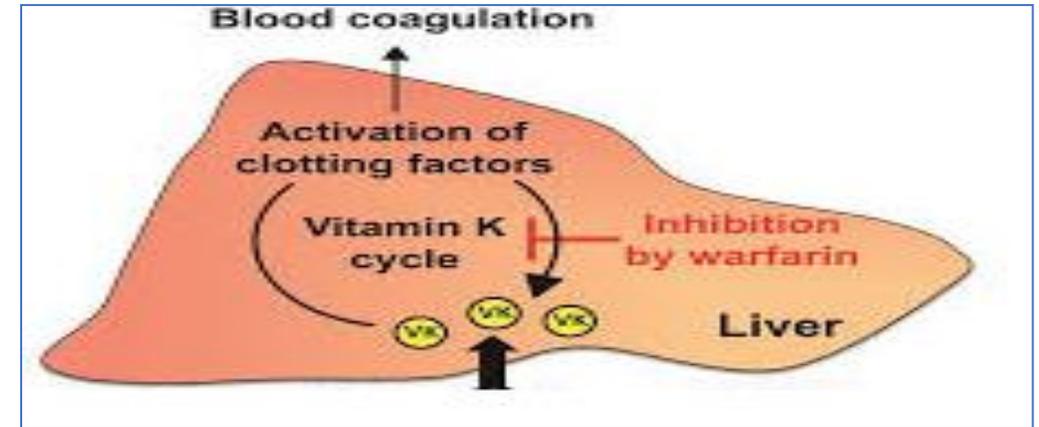


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Functions of vitamin K

1- Vitamin K is essential for activation of **Blood clotting factors: II, VII, IX and X.**

2- Vitamin K is essential for synthesis of some proteins as **osteocalcin** (important in bone ossification).



Vitamin K deficiency

Deficiency is rare but may occur in:

- 1- Liver disease
- 2- New born: there is no intestinal bacteria
- 3- Prolonged use of antibiotics (kills intestinal bacteria)

Manifestations of vitamin K deficiency:

- Hemorrhage: in the new born.
- increased risk of bleeding tendency (hemorrhage and bruises).



Case 1

A 3 year old child was brought with **bow legs, a protruding forehead, a pigeon chest, and depressed ribs**. His mother reported that he showed **delayed sitting teething and walking**. Plain film radiographs of his lower legs show widened epiphyses and bowing of tibiae.

1. Which vitamin is expected to be deficient in this child?
2. What are the chemical forms of this vitamin?
3. What is the active form of this vitamin? which organs are involved in its activation? Illustrate the pathway of activation
4. What is the underlying etiology of bowing leg in this child?
5. Which minerals do you expect to be deficient in the blood of this patient?
6. What is the treatment of this case?



Case 1 Answer

1. Which vitamin is expected to be deficient in this child?

✓ **Diagnosis: vitamin D deficiency. (rickets)**

2. What are the chemical forms of this vitamin?

✓ **D2 = ergocalciferol—plants source.**

✓ **D3 = cholecalciferol**

• **Vitamin D3 from the diet**

• **Vitamin D3 Synthesised in the body from cholesterol in intestine then sun exposed skin**

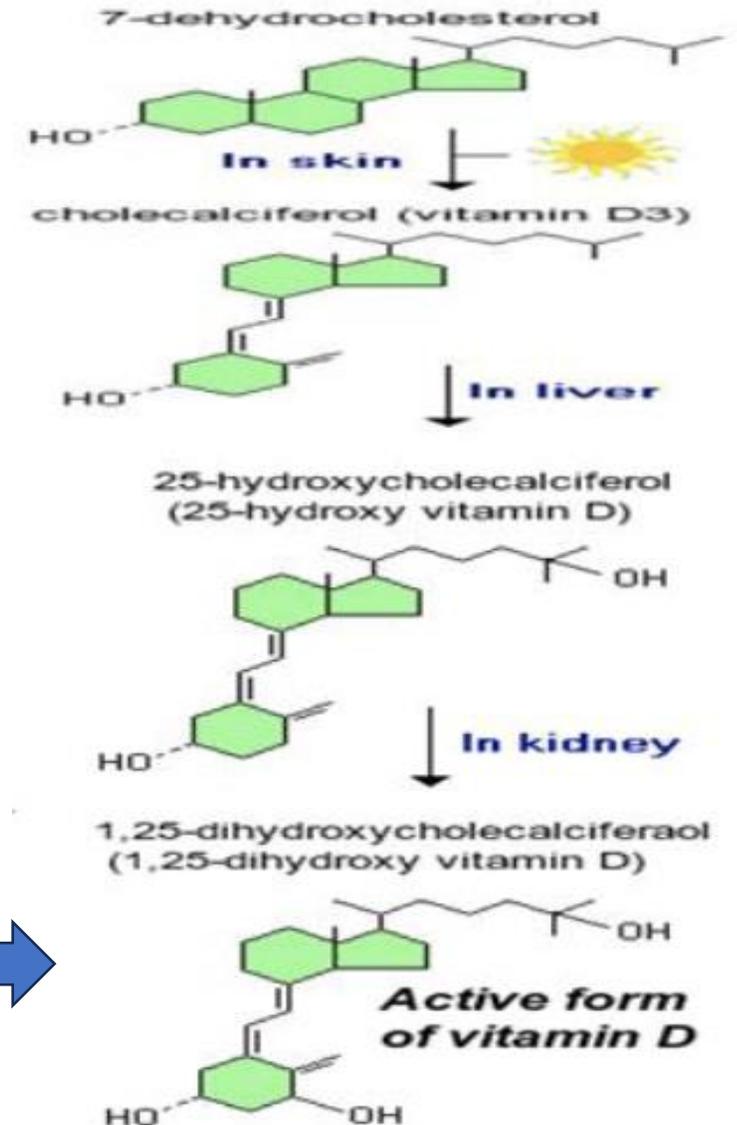
Case 1 Answer

3. What is the active form of this vitamin? which organs are involved in its activation? Illustrate the pathway of activation

✓ The active form of vitamin D3 is 1,25-(OH)₂ vit D3 (calcitriol)

✓ Two organs are involved in activation of vitamin D3: liver and kidney

✓ The pathway of vit D3 activation 



Case 1 Answer

4- What is the underlying etiology of bowing leg in this child?

Vitamin D deficiency

5- Which mineral do you expect to be deficient in the blood of this patient?

Low serum Ca

6- Treatment of this case

Administration of Vitamin D and Ca as supplement

Increase sun exposure

Eating diet rich in Ca and vitamin D

Quick quiz

Anti-anemic vitamins???

Anti-oxidant vitamins??

Vitamins essential for bones???

Thank
you

