



# What are Vitamins ?

Vitamins are a group of substances that are needed for normal cell function, growth, and development.

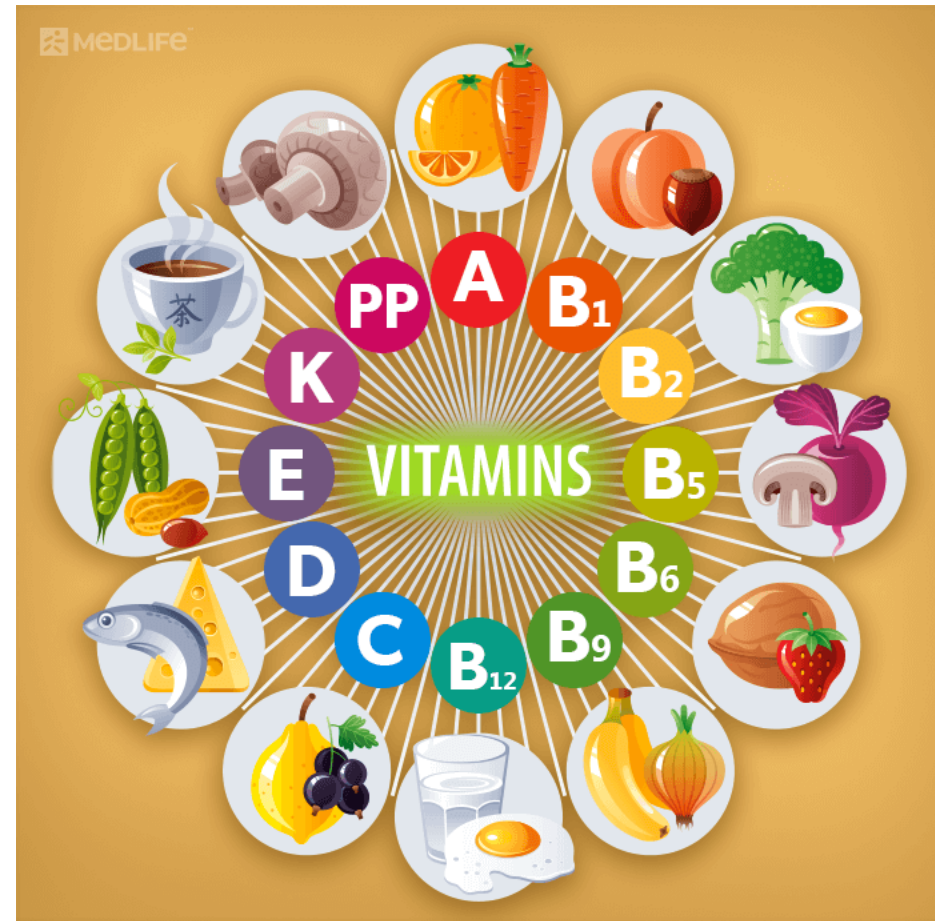
Or

A vitamin is an organic molecule (or related set of molecules) that is an essential micronutrient which an organism needs in small quantities for the proper functioning of its metabolism.



# There are 13 vitamins

- **Vitamin A**
- **Vitamin B1 (Thiamine)**
- **Vitamin B2 (Riboflavin)**
- **Vitamin B3 (Niacin)**
- **Vitamin B5 (Pantothenic acid)**
- **Vitamin B6 (Pyridoxine)**
- **Vitamin B7 (Biotin)**
- **Vitamin B9 (Folic acid)**
- **Vitamin B12 (Cyanocobalamin)**
- **Vitamin C**
- **Vitamin D**
- **Vitamin E**
- **Vitamin K**



# Types of Vitamins

- **Fat-Soluble Vitamins**
- **Water-Soluble Vitamins**



# Fat-Soluble Vitamins



- ❖ **Fat-soluble vitamins are happy to remain in your body for a while, some stay for some days, some for up to six months.**
- ❖ **Stored in liver and fatty tissues until needed.**
- ❖ **Then, once it is time for them to be used, special carriers in your body take them to wherever they are required.**

# Water Soluble Vitamins (B & C)

Water-soluble vitamins are carried to the body's tissues but are not stored in the body. Since they are eliminated in urine, we require a continuous daily supply in our diet.

Water Soluble Vitamins	
Vitamin:	Name:
B1	Thiamine
B2	Riboflavin
B3	Niacin
B5	Pantothenic Acid
B6	Pyridoxine
B7	Biotin
B9	Folate
B12	Cobalamin
C	Ascorbic Acid



# Fat soluble vs. Water soluble

## FAT-SOLUBLE VITAMINS: VITAMINS A, D, E, AND K

## WATER-SOLUBLE VITAMINS: B VITAMINS AND VITAMIN C

**Absorption**

Absorbed like fats, first into the lymph, then the blood.

Absorbed directly into the blood.

**Transport and Storage**

Must travel with protein carriers in watery body fluids; stored in the liver or fatty tissues.

Travel freely in watery fluids; most are not stored in the body.

**Excretion**

Not readily excreted; tend to build up in the tissues.

Readily excreted in the urine.

**Toxicity**

Toxicities are likely from supplements, but occur rarely from food.

Toxicities are unlikely but possible with high doses from supplements.

**Requirements**

Needed in periodic doses (perhaps weeks or even months) because the body can draw on its stores.

Needed in frequent doses (perhaps 1 to 3 days) because the body does not store most of them to any extent.

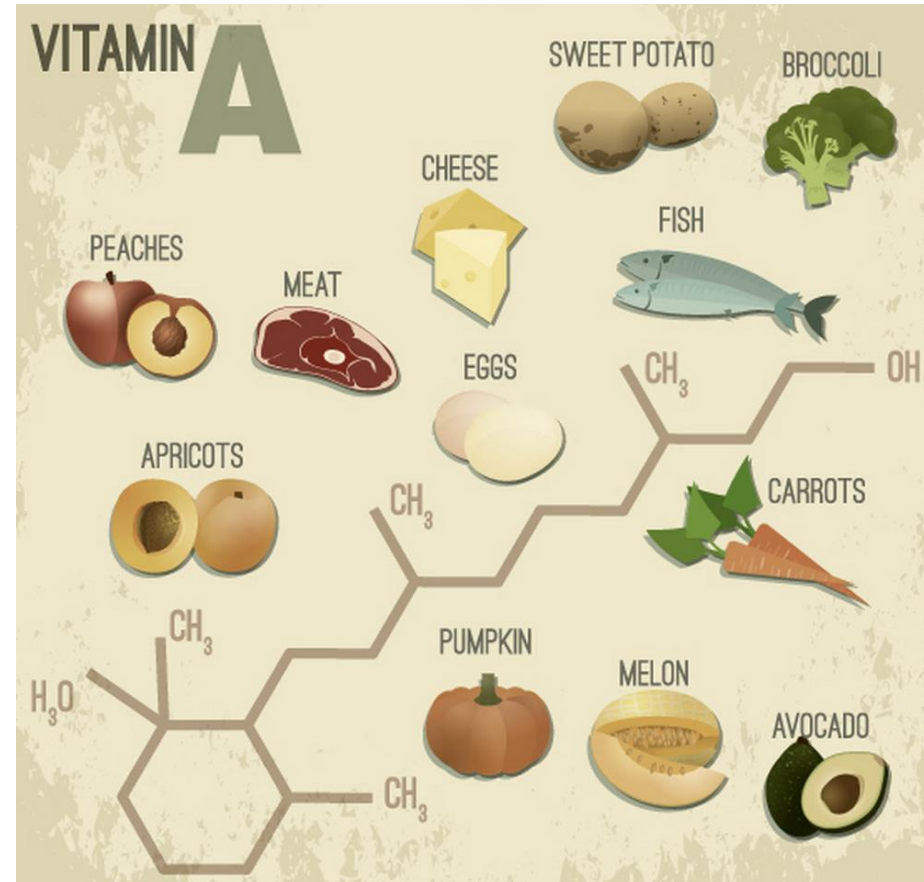




# What is Vitamin A?

Vitamin A or Retinol is the immediate precursor to two important active metabolites: **retinal**, which plays a critical role in vision, and **retinoic acid**, which serves as an intracellular messenger that affects transcription of a number of genes.

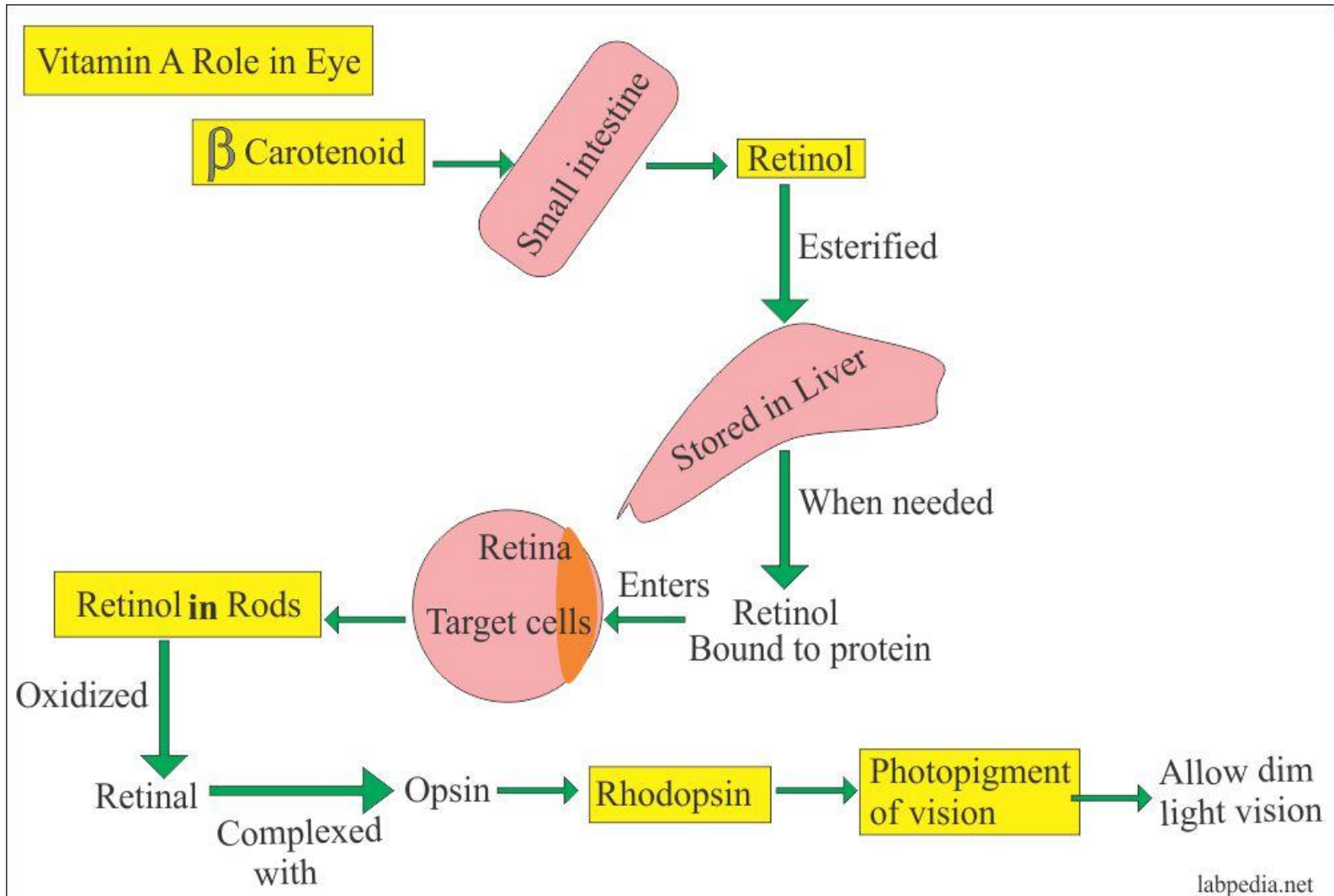
Health depends on maintaining vitamin A levels within range





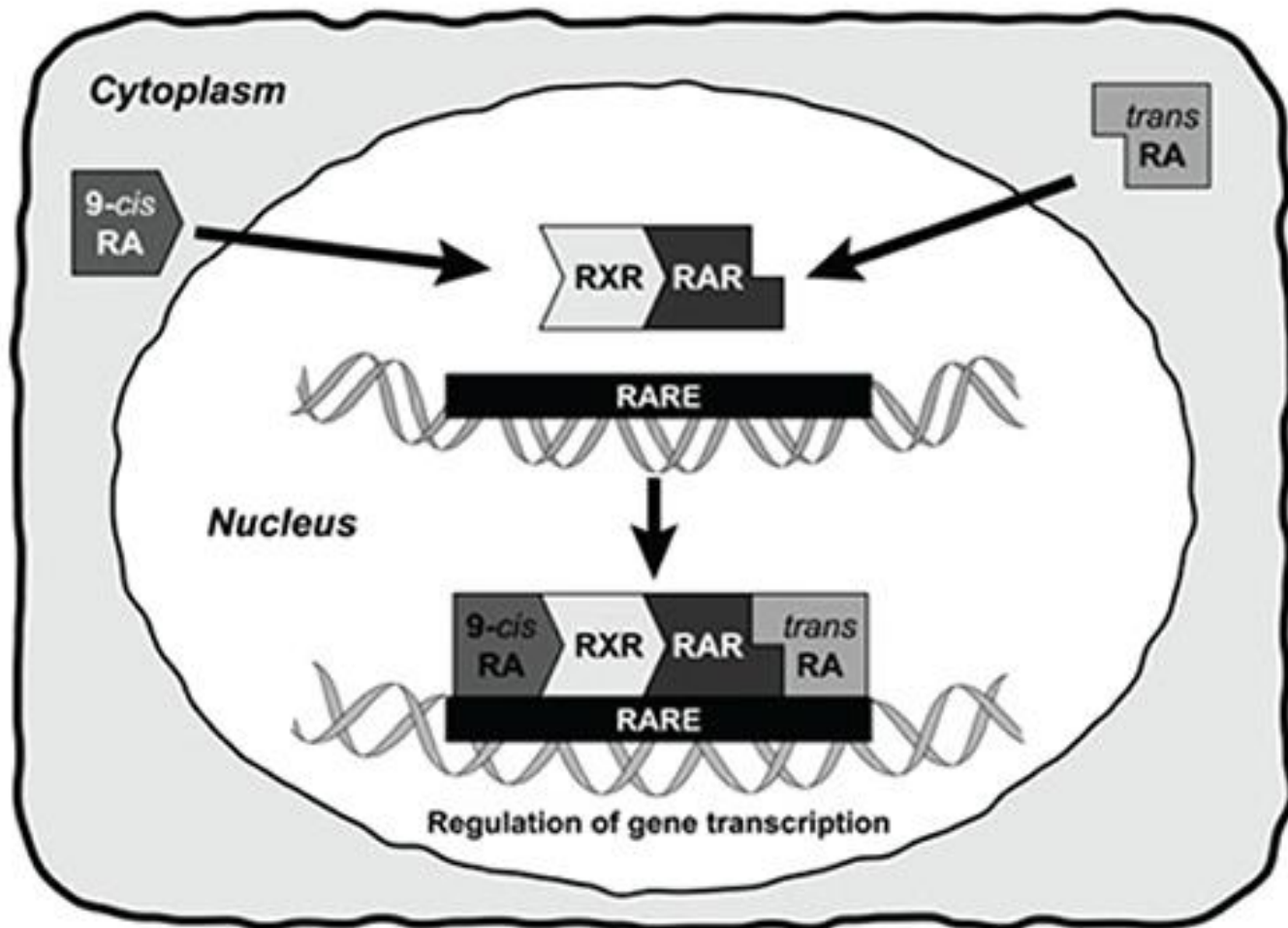
# Physiologic Effects of Vitamin A

- **Vision:** Retinal is a necessary structural component of **rhodopsin** or *visual purple*, the light sensitive pigment within rod and cone cells of the retina. If inadequate quantities of vitamin A are present, vision is impaired.



# Role of Vit A in Gene transcription

Vitamin A, in the retinoic acid form, plays an important role in gene transcription. Production of retinoic acid is tightly regulated, due to its activity as a ligand for nuclear receptors.



# Physiologic Effects of Vitamin A

- **Immune /function:** Vitamin A was initially coined “the anti-infective [vitamin](#)” because of its importance in the normal functioning of the immune system. It plays a role in many areas of the immune system, particularly in T cell differentiation and proliferation. Vitamin A has also been shown to be important for T cell homing to the intestine, effects dendritic cells, and can play a role in increased IgA secretion, which is important for the immune response in mucosal tissues
- **Epithelial cell "integrity":** Many epithelial cells appear to require vitamin A for proper differentiation and maintenance. Vitamin A, and more specifically, retinoic acid, appears to maintain normal skin health by switching on genes and differentiating keratinocytes (immature skin cells) into mature epidermal cells. Lack of vitamin A leads to dysfunction of many epithelia - the skin becomes keratinized and scaly, and mucus secretion is suppressed.
- **Bone remodeling:** Normal functioning of osteoblasts and osteoclasts is dependent upon vitamin A.
- **Reproduction:** Normal levels of vitamin A are required for sperm production, reflecting a requirement for vitamin A by spermatogenic epithelial (Sertoli) cells. Similarly, normal reproductive cycles in females require adequate availability of vitamin A.

# Vitamin A Deficiency

- **Vitamin A deficiency** usually results from malnutrition, but can also be due to abnormalities in intestinal absorption of retinol or carotenoids.
- **Blindness** due to inability to synthesize adequate quantities of rhodopsin. Moderate deficiency leads to deficits in vision under conditions of low light ("**night blindness**"), while severe deficiency can result in severe dryness and opacity of the cornea (xerophthalmia).
- **Increased risk of mortality from infectious disease** has been best studied in malnourished children, but also is seen in animals. In such cases, supplementation with vitamin A has been shown to substantially reduce mortality from diseases such as measles and gastrointestinal infections.
- **Abnormal function of many epithelial cells**, manifest by such diverse conditions as dry, scaly skin, inadequate secretion from mucosal surfaces, infertility, decreased synthesis of [thyroid hormones](#) and elevated cerebrospinal fluid pressure due to inadequate absorption in meninges.
- **Abnormal bone growth** in vitamin A-deficient animals can result in malformations and, when the skull is affected, disorders of the central nervous system and optic nerve.

# Sources of Vitamin A

The sources of Vitamin A are eggs, milk, butter, papaya, mango, liver fish, liver oil, sweet potatoes, green and yellow vegetables etc.

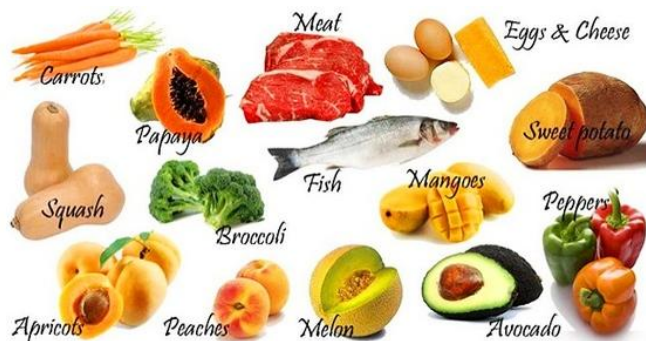
## Vitamin A

Sources of vitamin A and beta-carotene:

Vitamin A comes from animal sources such as eggs, meat and dairy products



Beta-carotene, a precursor of vitamin A, comes from green, leafy vegetables and intensely colored fruits and vegetables





VITAMIN  
D



## ➔ Other names of Vitamin D

Cholecalciferol

Calciferol

Antirachitic factor

Sun-shine Vitamin



**VITAMIN D**  
**HORMONE OR VITAMIN**

## VITAMIN D - HORMONE OR VITAMIN



As it can be synthesized in the body

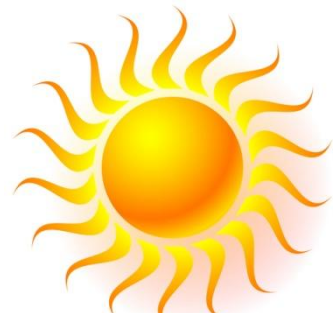
It is released in the circulation

Has distinct target organs.

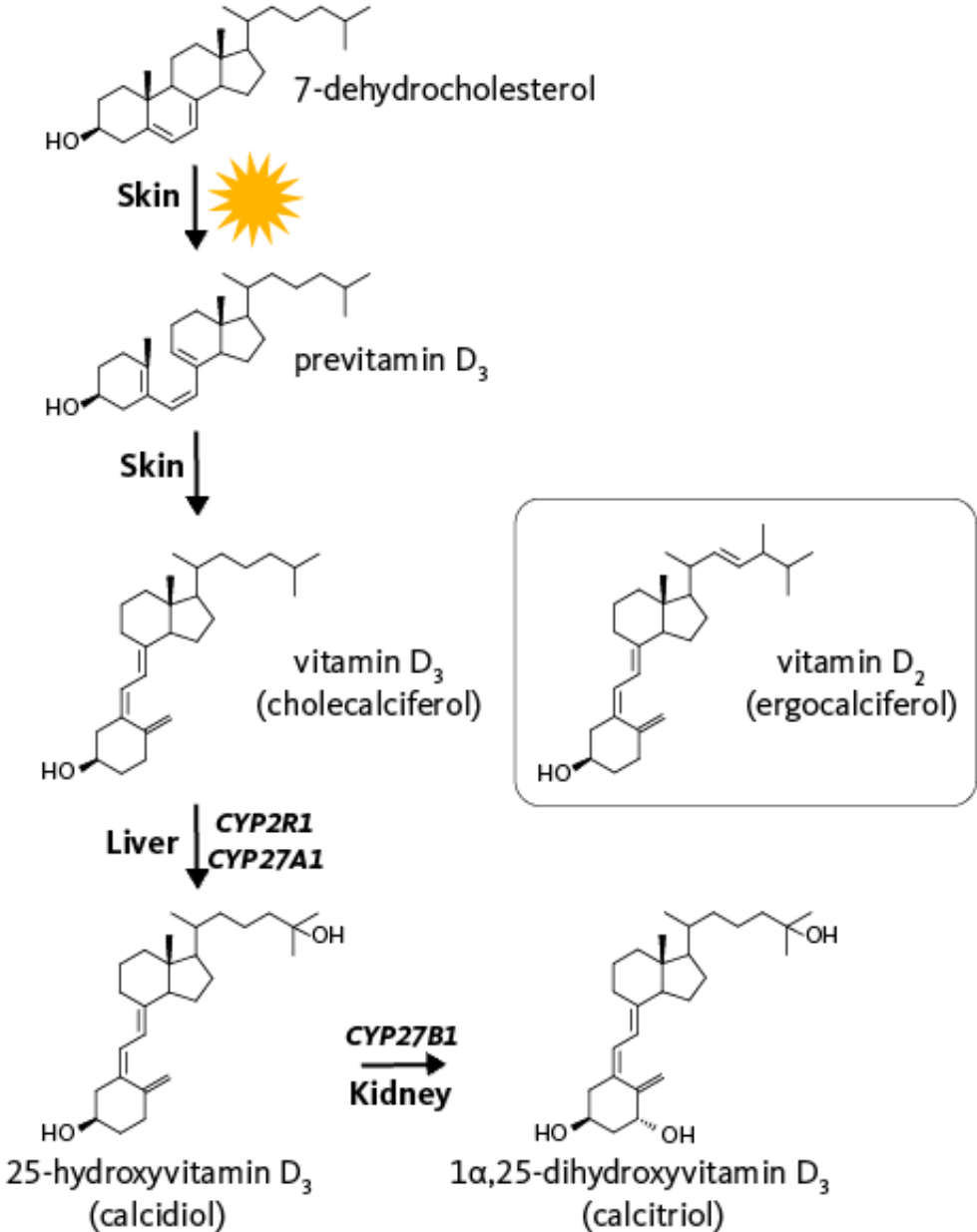
Action is similar to steroid hormones.

# Vitamin D

- **Vitamin D** is a group of fat soluble steroids responsible for increasing intestinal absorption of calcium, magnesium, and phosphate, and multiple other biological effects.
- In humans, the most important compounds in this group are vitamin D<sub>3</sub> (also known as [cholecalciferol](#)) and vitamin D<sub>2</sub> ([ergocalciferol](#)).
- The major natural source of the vitamin is synthesis of cholecalciferol in the lower layers of skin epidermis through a chemical reaction that is dependent on sun exposure (specifically [UVB radiation](#)).
- Cholecalciferol and ergocalciferol can be ingested from the diet and from supplements



**Figure 1. Chemical Structures of Vitamin D**



# FUNCTIONS OF VITAMIN D

➔ It maintains the normal plasma level of **calcium** and **phosphorus** by acting on...



Intestine



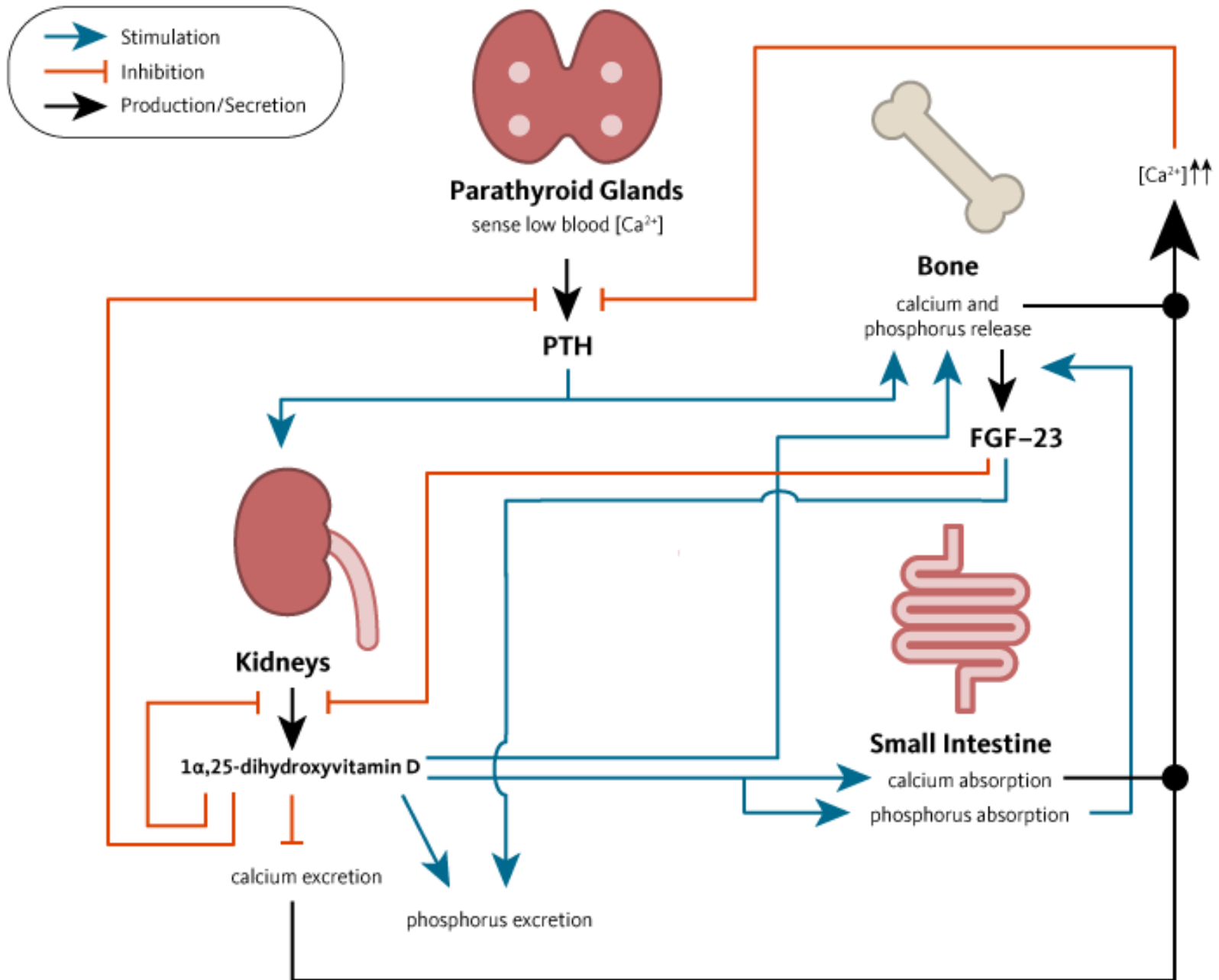
bone



Kidneys



**Figure 3. Regulation of Calcium and Phosphorus Homeostasis**



# FUNCTIONS OF VITAMIN D

CONT...

➔ Action of calcitriol on intestine



Intestine

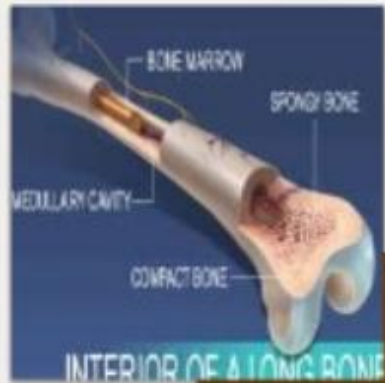
- ↑ plasma calcium & phosphorus conc.
- ↑ Synthesis of calcium binding proteins **calbindins**.
- ↑ absorption of calcium & phosphorus from the intestine



# *FUNCTIONS OF VITAMIN D*

*CONT...*

## ➔ Action of calcitriol on bone



## Bone

- It is believed that calcitriol has both anabolic & catabolic role on bone.
- It promotes the mineralization of bones (anabolic)
- $D_3$  along with PTH stimulates the mobilization of calcium & phosphorus from bone (catabolic)

# *FUNCTIONS OF VITAMIN D*

*CONT...*

➔ Action of calcitriol on kidneys



**Kidneys**

- ↑ The reabsorption of calcium & phosphorus from the kidney
- ↓ Excretion of calcium & phosphorus.

# DEFICIENCY OF VITAMIN D



Rickets  
(in children)



Osteomalacia  
(in adults)



# RICKETS

Decreased serum calcium



Soft & pliable bones



Bone deformities



Delayed dentition



Delayed closure of anterior fontanelle



# CLINICAL MANIFESTATIONS - RICKETS

bow legs →



← Knock knee

# CLINICAL MANIFESTATIONS - RICKETS

rickety rosary →



← pigeon chest

# OSTEOMALACIA (ADULT RICKETS)

Decreased serum calcium



Insufficient mineralization



Soft & pliable bones



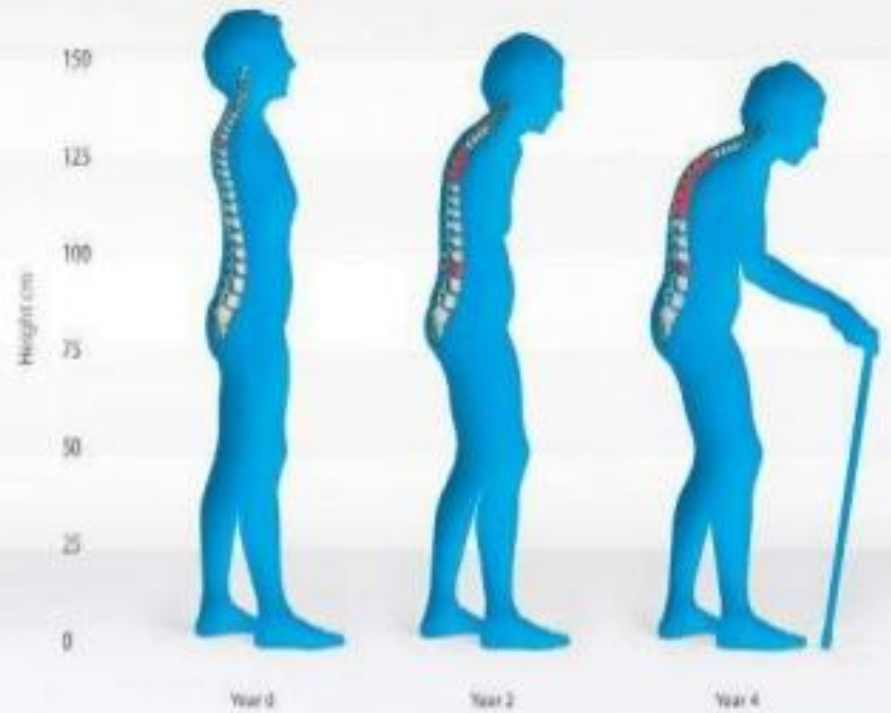
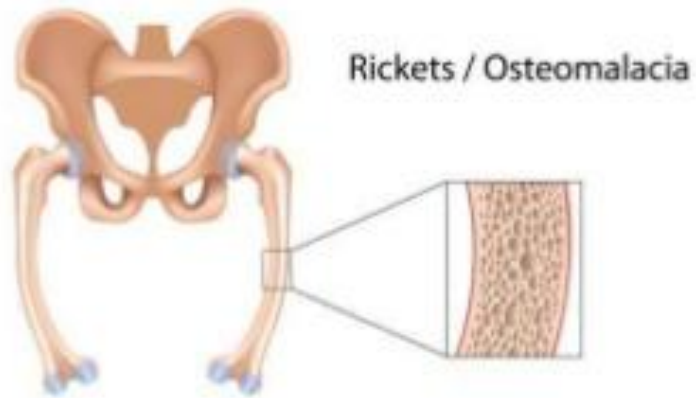
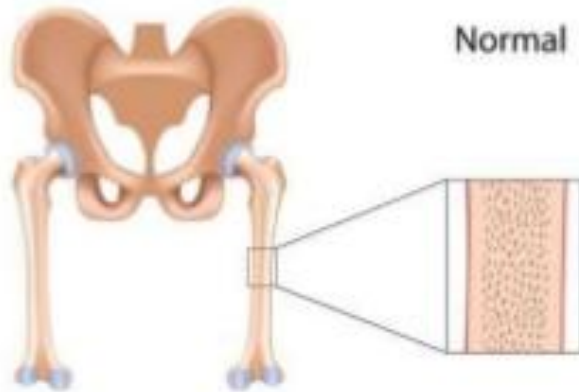
Increased osteoporosis



Bone deformities



# OSTEOMALACIA





# Source of Vitamin D

- The flesh of fatty fish (such as salmon, tuna, and mackerel) and fish liver oils are among the best sources . Small amounts of vitamin D are found in beef liver, cheese, and egg yolks.

**SUNLIGHT**  
The body itself makes  
vitamin D when it is  
exposed to the sun

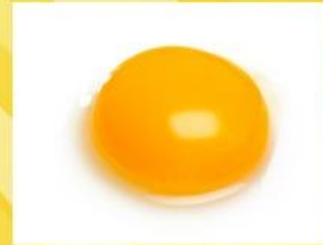
## 10 Best Vitamin D Rich Foods



**Fortified Cereals**



**Orange Juice**



**Egg Yolk**



**Mushroom**



**Ricotta Cheese**



**Fatty Fish**



**COD Liver Oil**



**Cavier (Fish eggs)**



E

# Vitamin E

- Fat soluble
- Antioxidant
  - Reduce the energy of the free radical
  - Stop the free radical from forming in the first place
  - Interrupt an oxidizing chain reaction to minimize the damage of free radicals



# Vitamin E ( Tocopherol )

□ Vitamin E = Tocopherol

Tocos = child birth

Pheros = to bear

Ol = OH (Alcohol)



anti-infertility Vitamin

Infertile animal + vitamin E → conception of animal

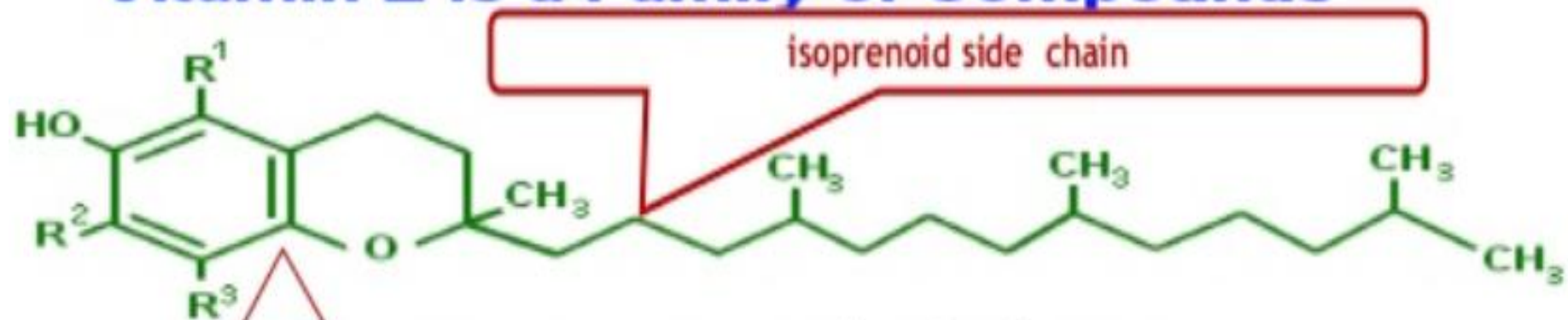
Vitamin E = anti-infertility Vitamin (because of Antioxidant Property)

Structure of Vitamin E was elucidated by Paul Karr ( Noble prize-1937)

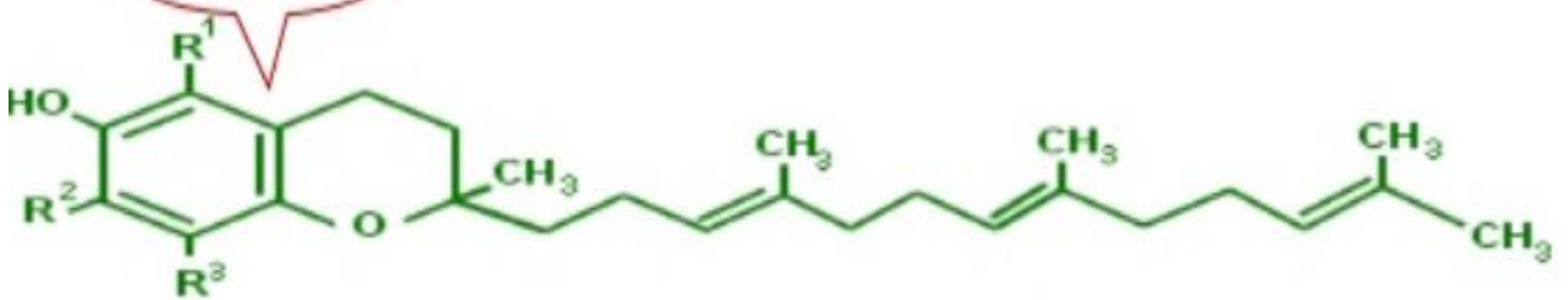


# Structure of of Vitamin E Tocopherols and Tocotrienols

## Vitamin E is a Family of Compounds



(A)  $\alpha$ -tocopherol ( $R^1 = R^2 = R^3 = CH_3$ )



(B)  $\alpha$ -tocotrienol ( $R^1 = R^2 = R^3 = CH_3$ )

# Role of Vitamin E

- Anti infertility Vitamin (maintain germinal epithelium of gonads)
- Anti Protects cell membranes and other fat-soluble parts of the body (LDL cholesterol) from oxidation
  - May reduce the risk of heart disease
  - May also discourage development of some types of cancer
- Promotes normal growth and development
- Promotes normal red blood cell formation
- Acts as anti-blood clotting agent
- Plays some role in the body's ability to process glucose
- Also been known to aid the process of wound healing

## Symptoms of Vitamin E Deficiency

❑ Symptoms of Vitamin E Deficiency are

➤ increased fragility of RBC

➤ neurological changes

• **Retrolental fibroplasia (RLF)**: a neuropathy observed in premature infants with low birth weight due to poor placental transfer of Vitamin E .

❑ Symptoms of Vitamin E Deficiency in human beings are very mild. .

# Source of Vitamin E

Vegetable oils (such as wheat germ, sunflower, safflower, corn, and soybean oils) Nuts (such as almonds, peanuts, and hazelnuts/filberts) Seeds (such as sunflower seeds)





Vitamin K

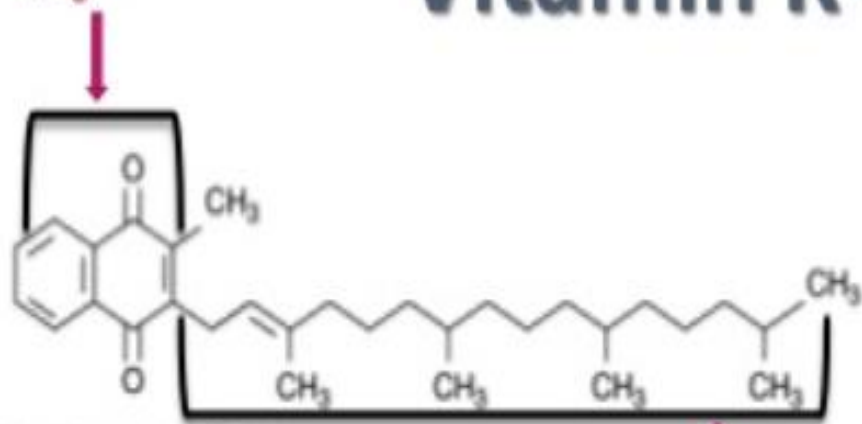


# Vitamin K

- Vitamin K represents a group of **lipophilic and hydrophobic** vitamins.
- Originally identified for its role in the process of blood clot formation
- ("K" is derived from the German word "koagulation")
  
- Three compounds have the biological activity of vitamin K
- **Phylloquinone (Vitamin K<sub>1</sub>)**, the normal dietary source, found in **green vegetables**
- **Menaquinones (vitamin K<sub>2</sub>)**, synthesized by **intestinal bacteria**, with differing lengths of side chain;
- and **Menadione** and **menadiol diacetate**, **synthetic compounds** that can be metabolized to phylloquinone.

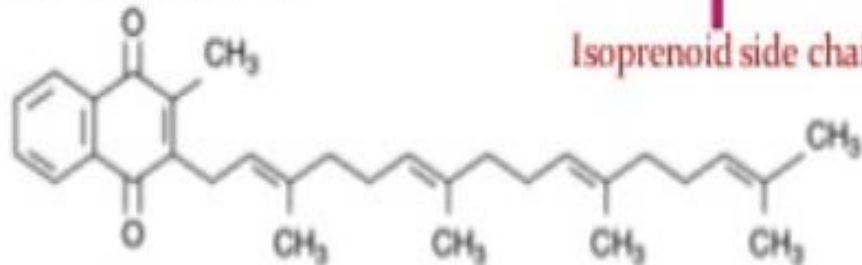
# Vitamin K-Chemistry

Naphthoquinone ring

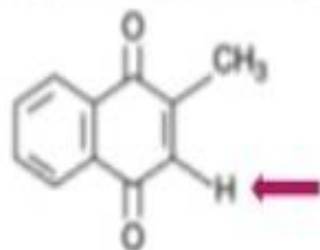


Phylloquinone (vitamin K<sub>1</sub>)

Isoprenoid side chain



Menaquinone-4 (vitamin K<sub>2</sub>)

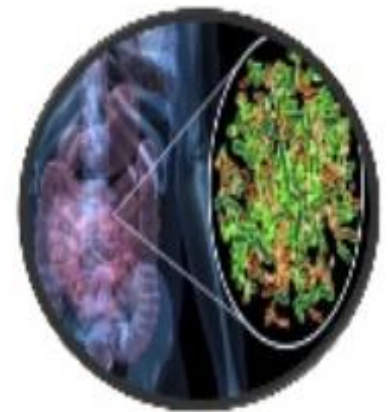


Menadione (vitamin K<sub>3</sub>)

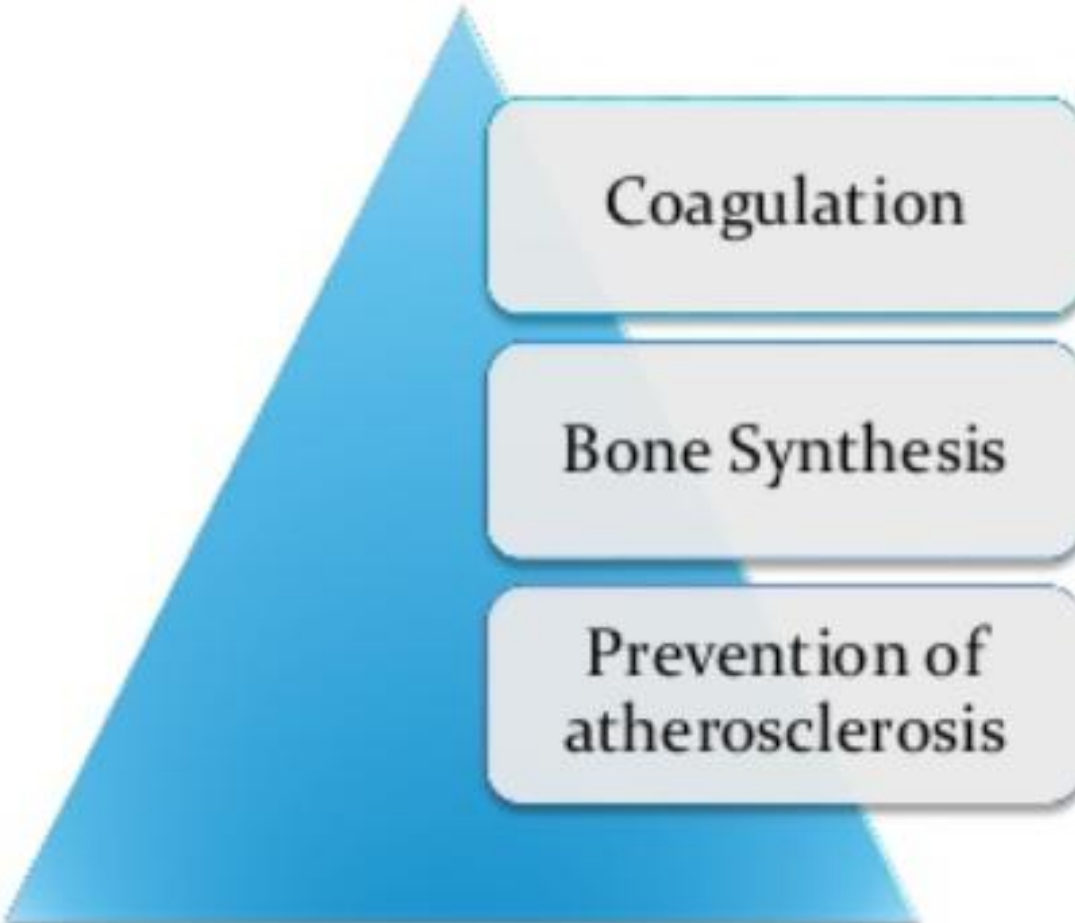
- ❑ Phylloquinone have a 20 C side chain ,
- ❑ Menaquinones have a 30 C side chain.
- ❑ The synthetic vitamin K (menadione, menadiol diacetate) have only hydrogen in place of isoprenoid side chain that makes these vitamin water-soluble.

# Dietary Sources

- Green leafy vegetables such as kale and spinach,
- Margarine and liver.
- Vegetable oils and particularly olive, canola, and soybean oils.
- Some amount is contributed by intestinal bacteria



# Functions of Vitamin K



Coagulation

Bone Synthesis

Prevention of  
atherosclerosis

# Vitamin K Deficiency

## Clinical Manifestations

- The main symptom is **bleeding (hemorrhage)**—into the skin (causing bruises), from the nose, from a wound, in the stomach, or in the intestine.
- Blood may be seen in the urine or stool.
- In newborns, life-threatening **bleeding within or around the brain** may occur.

