
بسم الله الرحمن الرحيم
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Vitamins
PP
A
B1
K
B2
E
B5
D
B6
C
B12
B9


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Vitamins

- *Definition: A vitamin is an organic compound required as a nutrient in tiny amounts by an organism for normal growth, maintenance, reproduction and health.*

- *Deficiency of any vitamin in the body results in the production of specific disease.*

- *They differ from other organic food stuffs in that:*
- *They do not enter into tissue structures, unlike protein.*
- *Donot undergo degredation for providing energy unlike carbohydrates and lipids.*
- *Many vitamins function as coenzymes.*
- *They differ from hormonesin that it is not being produced within the organism and most of them have to be provided in the diet.*

- ***Provitamine:***

  They are vitamin precursors e.g. carptenes are provitamin A.

- *Vitamer:*
  - *Vitamin which present in more than one chemical formula e.g.*
    - *Vitamin A has 2 vitamers: A1 and A2.*
    - *Vitamin D has 2 vitamers: D2 AND D3.*

- *Vitamins can be broadly classified as two categories: Water Soluble Vitamins and Fat Soluble Vitamins.*
- *Water Soluble Vitamins, are those which easily dissolve in water. They should be taken in small amounts almost everyday, as our human body excretes the excess vitamins instantaneously either through sweat or urine. Vitamin B and C come under this category.*

- *Fat Soluble Vitamins, on the other hand are soluble in fat and fat solvents. Hence they can be stored in the human body for a longer duration. However, excessive of these could be toxic. These fat soluble vitamins are absorbed by the intestines and when needed they are transported to all parts of the body. Vitamin A, D, E and K fall under this category.*

Fat Soluble Vitamins

Vitamin A, D, E and K

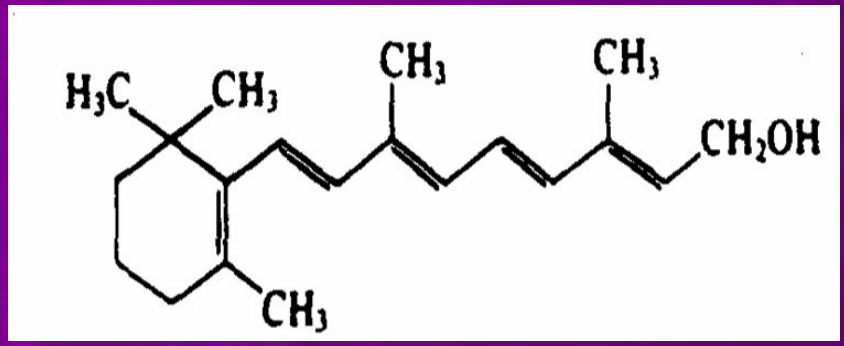
Vitamin A

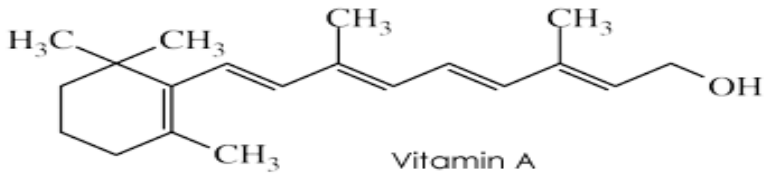
Vitamin A

- *It is also called Anti-night blindness vitamin and Anti-xerophthalmic vitamin.*
- *Chemistry:*

  -It is formed by β-ionone ring and 2 isoprene units.

- *It is found in two forms in nature:*
  - *Vitamin A1 (retinol).*
  - *Vitamine A2 (3-dehydroretinol).*



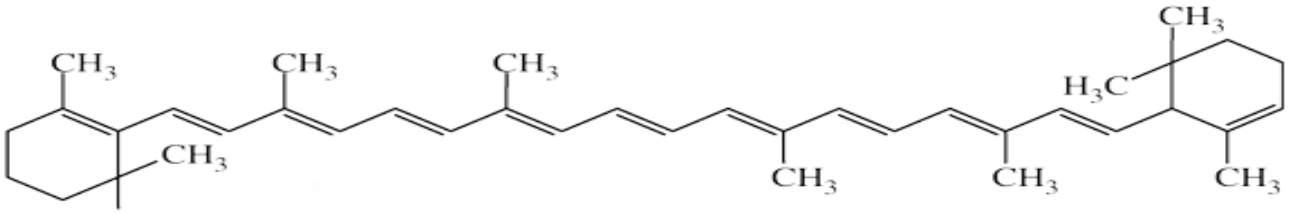


Vitamin A

$C_{20} H_{30} O$

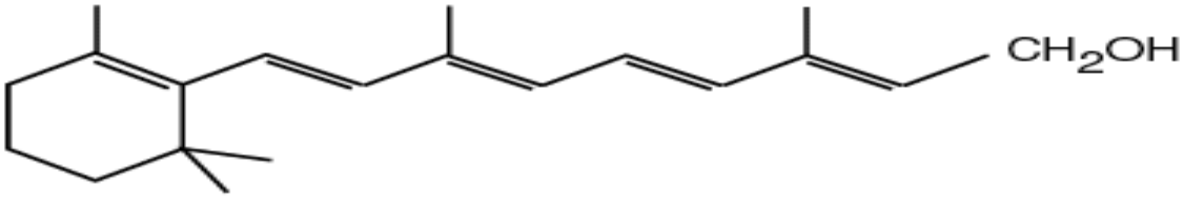
VITAMIN

A



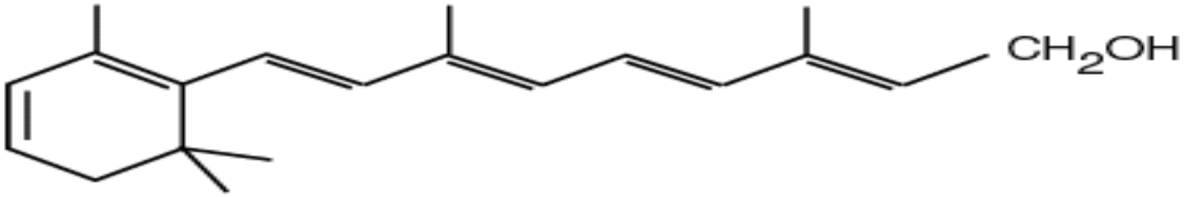
Beta-karoten

Vitamin A_1



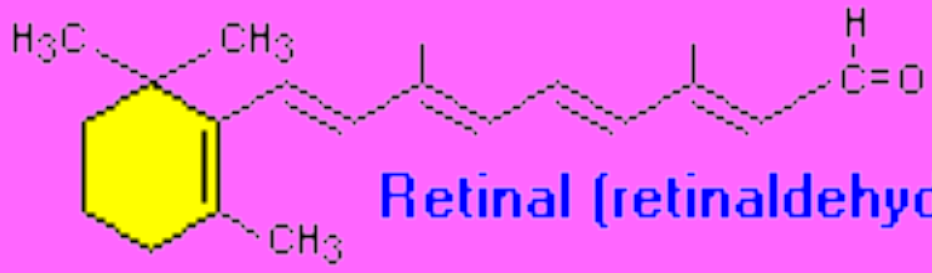
Retinol

Vitamin A_2



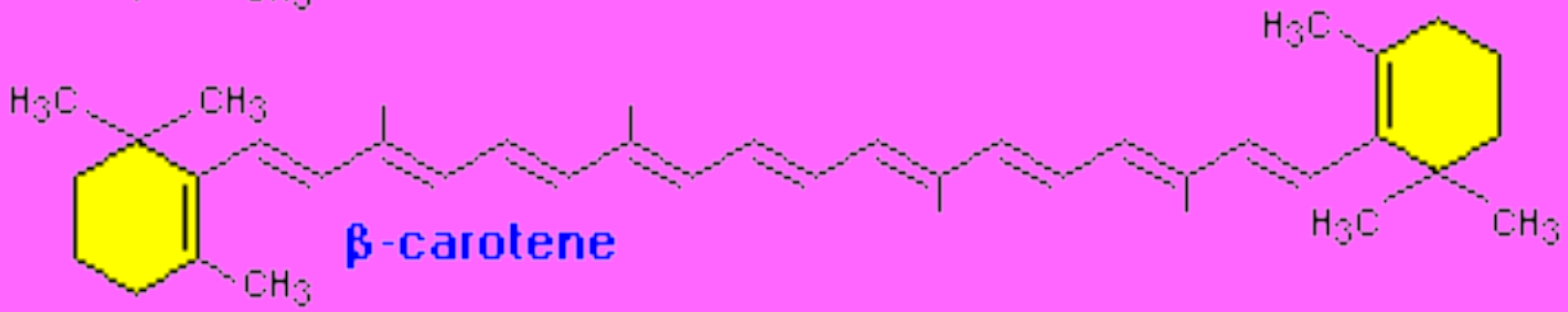
3,4-dehydro-retinol

Retinol

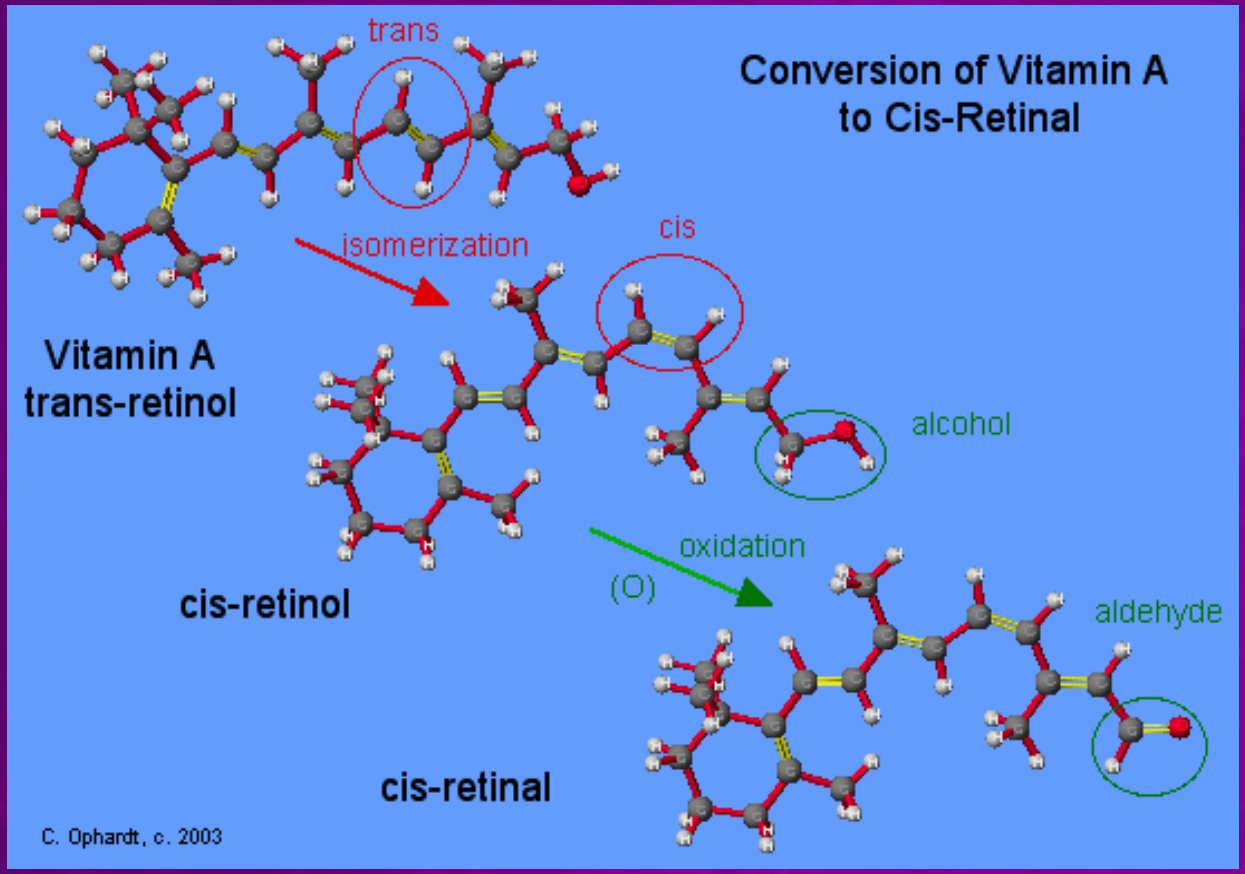


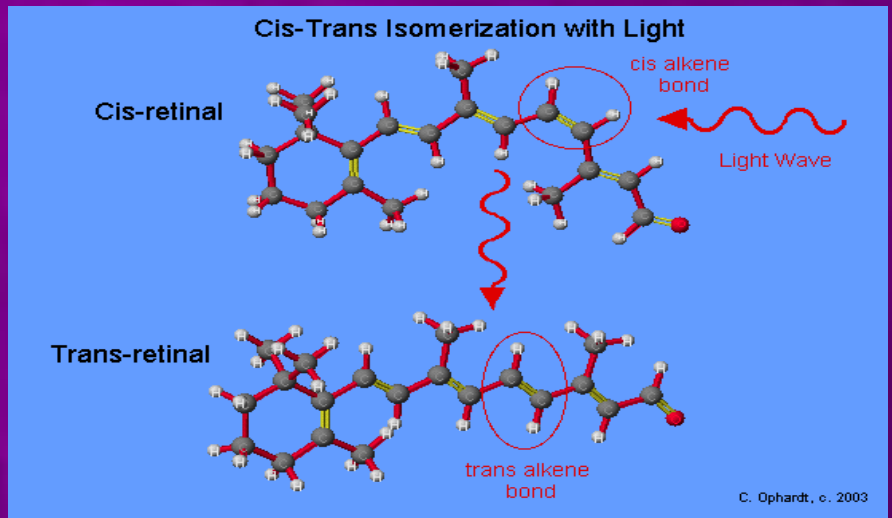
Retinal (retinaldehyde)

Retinoic Acid



β-carotene


Conversion of Vitamin A
to Cis-Retinal
trans
isomerization
cis
Vitamin A
trans-retinol
alcohol
oxidation
(O)
cis-retinol
aldehyde
cis-retinal
C. Ophardt, c. 2003

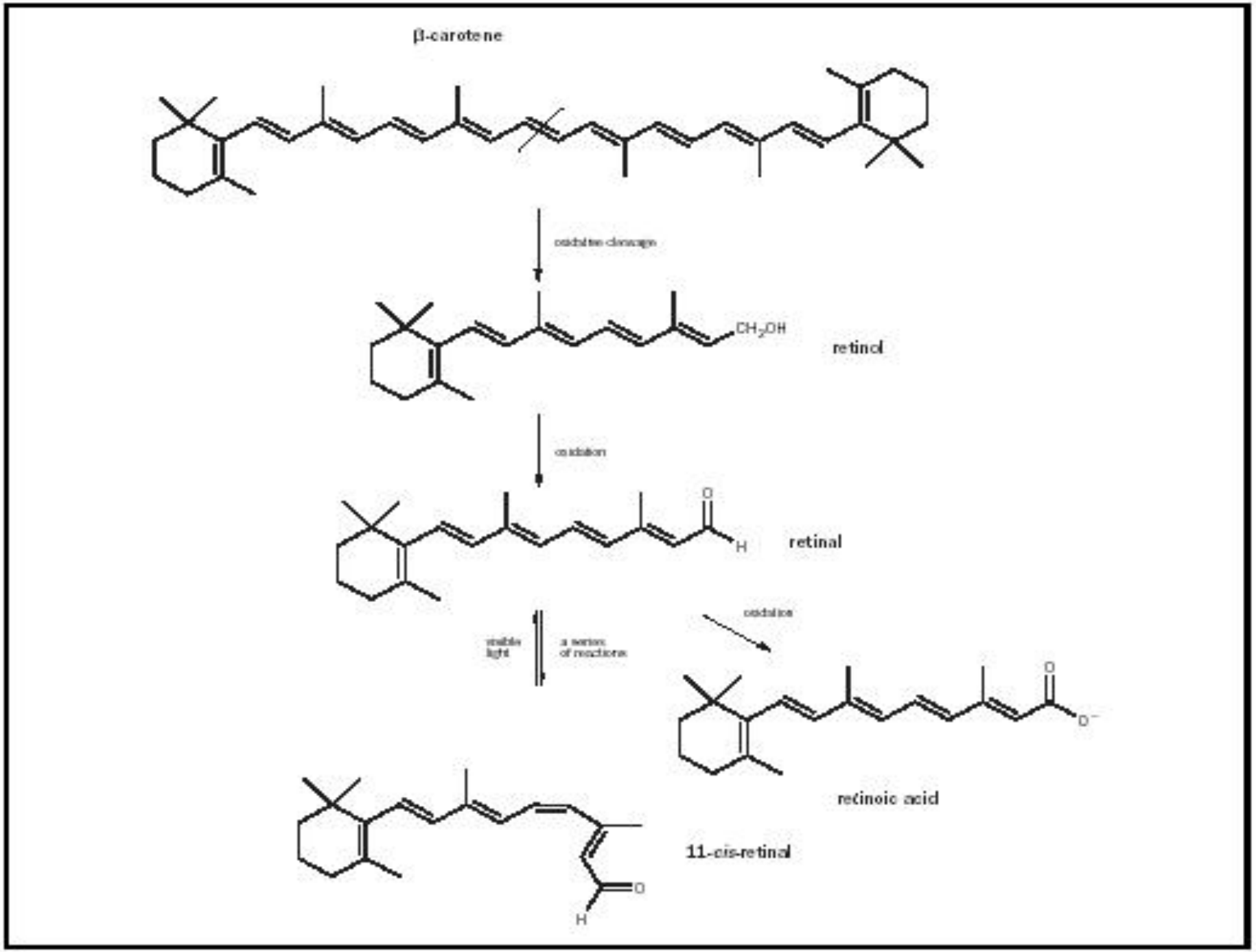

Cis-Trans Isomerization with Light
cis alkene
bond
Cis-retinal
Light Wave
Trans-retinal
trans alkene
bond
C. Ophardt, c. 2003

- *Provitamines:*

  The provitamins or precursors of vitamine A are carotenoids containing β-ionone ring e.g.α, β and γ carotene and cryptoxan.

- *Carotenes:*
  - *These are hydrocarbons e.g. lycopene present in tomato, water melons, and α, β and γ carotenes are yellow pigments found in carrots, milk, butter and green vegetables.*

- *There is a β—ionone ring at the end in all 3 carotenes.*
- *At the other end there is an α—ionone ring in α—carotene, a β-ionone ring in β-carotene and pseudoionone ring in γ—carotenes.*
- *Carotenes by carotenase enzyme in the liver are converted to vitamin A aldehyde (retinal) by oxidation of central double bond. Reduction of retinal produces vitamin A1 alcohol (retinole).*
- *β-carotene is the most useful type as it can give 2 molecules of vitamin A1because it is asymmetrical molecule while the others can only give one molecule of vitamin A1.*

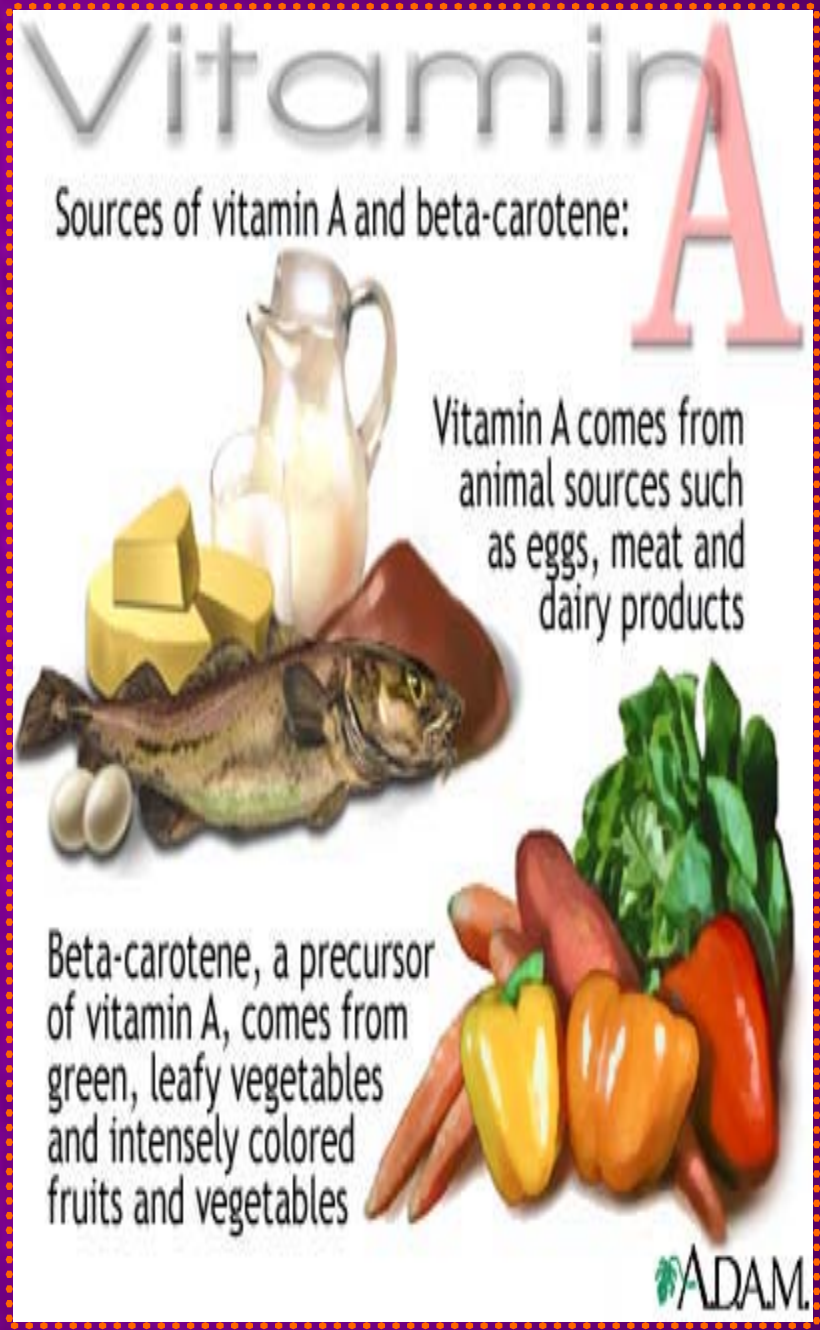

β-carotene
oxidative cleavage
CH_2OH
retinol
oxidation
O
H
retinal
visible light
a series of reactions
oxidation
O
O⁻
retinoic acid
O
H
11-cis-retinal

- *Vitamin A1:*
  - *Present in all animals except fresh water fishes.*
  - *It is more potent than A2.*
  - *One double bond in the ring.*

- *Vitamin A2:*
  - *Present in fresh water fishes only.*
  - *It is 40% of activity or potency of A1.*
  - *More than double bond in the ring.*

- *Properties:*
  - *It is a fatsoluble vitamin which is light yellow in color.*
  - *It is soluble in fat solvents but no soluble in water.*
  - *It is stable for heat (thermostable).*
  - *the biological activity of vitamin A is lost by exposure to ultraviolet light, ordinary light and by oxidation.*
  - *Vitamin A is labile to be present in the form of isomers:*
  - *All trance vitamin A1.*
  - *II-cis vitamin A1.*

- *Sources:*
- *Sources of carotenes (provitamin A):*
  - *In plants:*
    - *carrots, sweet potato, tomatoes ,green leafy vegetables and intensely colored fruits and vegetables.*
  - *In animals:*
    - *Adrenals, placenta and corpus luteum.*
- *Sources of vitamin A:*
  - *It is present only in animals e.g. milk, butter, egg yolk and liver.*
  - *The liver of certain fish contains higher concentration of vitamin A e.g. cod liver oil, halibut liver oil and tuna liver oil.*
  - *The liver of marine fishes contain vitamin A1, while fishes of fresh water contain vitamin A2 in their livers.*
  - *Liver of polar bears is very rich in vitamin A.*



- *Absorption:*
- *Site of absorption: small intestine.*

- *Mechanism of absorption:*
- *Dietary vitamin A is chiefly in the form of esters which is hydrolyzed in the intestinal lumen to free vitamine A and fatty acid.*
- *In mucosa, re-estrification occurs and also in the liver.*
- *So vitamin A appears in blood in ester form.*
- *Vitamin A is more rapidly absorbed than carotenes.*

- *Factors affecting absorption:*
- *Being fat-soluble, it is affected by factors affecting fat absorption e.g. bile salts.*
- *Presence of mineral oils in diet e.g. paraffin oil decreases absorption of vitamin A and carotenes as they are soluble in such oils and pass to stools with these oils.*

- *Storage and intermediary metabolism:*
- *Carotenes which contain β–ionone ring can give vitamin A by hydrolysis.*
- *In certain species e.g. rats and rabbits this occurs in intestinal mucosa.*
- *In man, this occurs only in liver.*
- *Carotene* —(*Carotenase enzyme*)→ *vitamin A*
- *Thyroxine helps such transformation. It hlp mobilization of vitamin A from liver.*
- *95% of vitaminAis stored in liver as ester from where as 5% is present in adrenala, lactating breast, lung and intestine.*
- *High doses of vitamin A antagonize thyroxine and causes toxic symptoms to take place because vitamine A is not easily excreted.*

- *Excretion:*
- *Vitamin A is excreted by:*
  - *Urine: only after administration of larg doses of vitamin A.*
  - *Stools: very small amounts which are increased if mineral oils are taken in diet.*
  - *Colostrum: great amounts of vitamin A are excreted by colustrum (fluid excreted by mammary gland in the first weak after labour) vitamin A decreses gradually over the period of lactation.*
  - *Sebacious glands of skin.*

- ***Function:***

1-It is essential for normal growth and essential for protein and mucopolysaccarides synthesis.

2-Maintenance of healthy epithelium:

- *Epithelium most commonly affected are those which perform mucous secretion functions.*
- *This observation suggested that vitamin A regulates the formation of mucopolysaccarides.*

3-Responsible for reproduction espicially in animals:

- *It isnecessary for normal synthesis or releas of androgen from the testis.*
- *It is necessary for normal fertilization and implantation.*
- *It is necessary for maintenance of normal placenta and protects it from injury.*

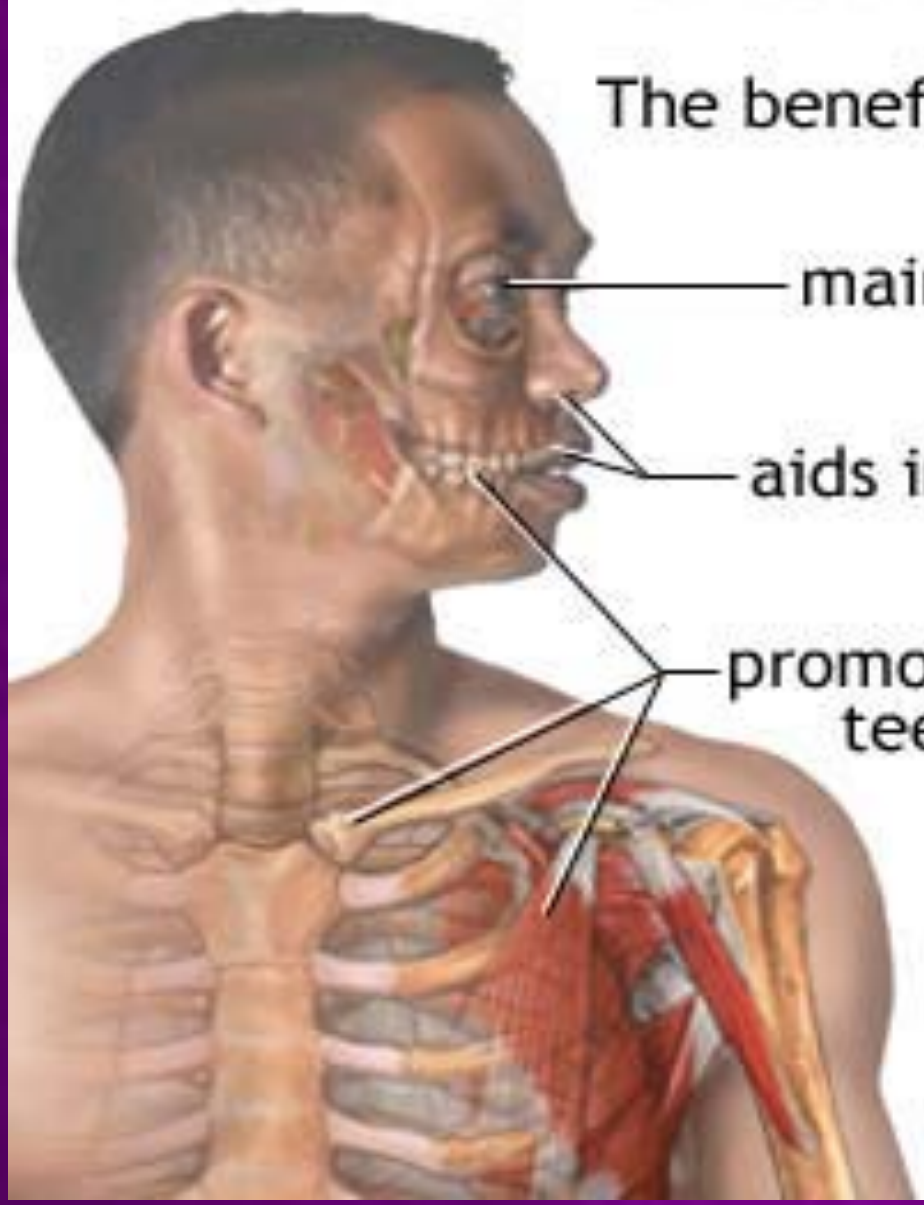
4-Responsible for normal construction of bone and teeth:

- *Vitamin A accelerates the normal growth of bones as it controls the activity of osteoblasts (bone forming cells) and osteoclasts (bone eating).*

5-It has a rol in stability of cell membranes and mitochondria.

- *It is responsible for visual process in the dim light.*

Vitamin A



The benefits of vitamin A:

- maintains health of specialized tissues such as the retina
- aids in growth and health of skin and mucous membranes
- promotes normal development of teeth, soft and skeletal tissue

Adult RDA: 1000 µg RE

Fat-soluble

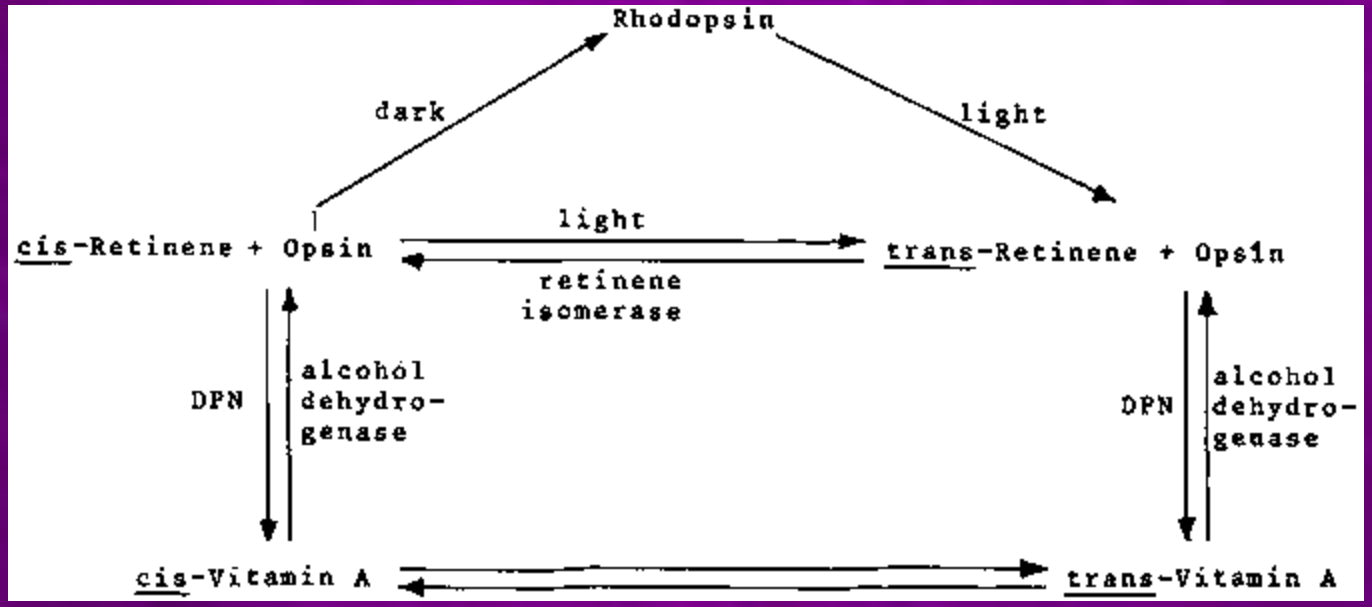
A.D.A.M.

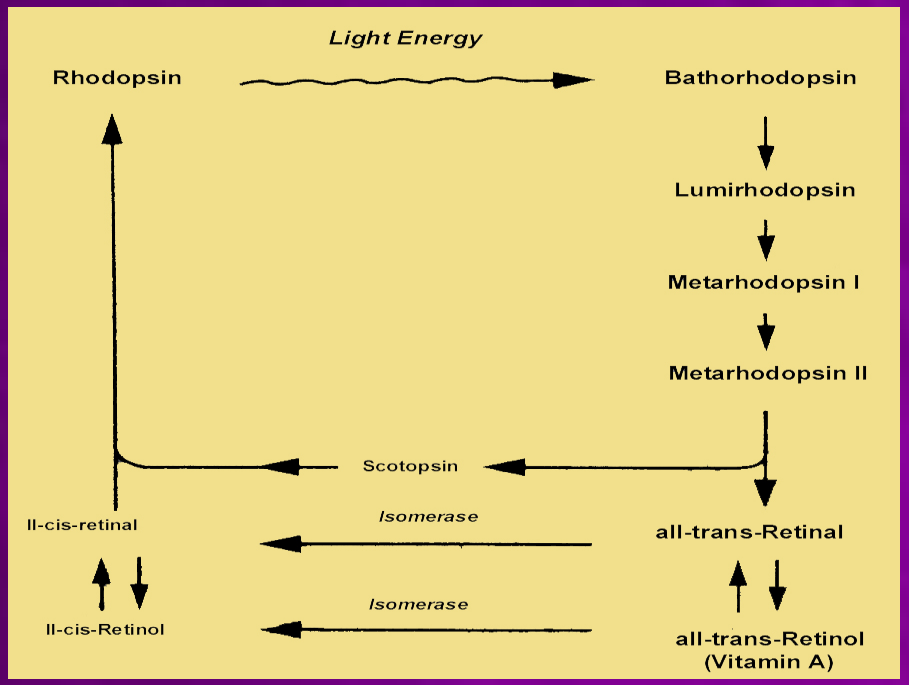
- *The retina contains 2 types of receptors:*
- *Rods: Which are responsible for vision in dim light.*
- *Cones: Which are responsible for vision in bright light.*
- *Light striking these receptors produces chemical changes which stimulate the production of nerve impulses that reach the optic nerve to brain.*
- *Vitamin A plays a big role in the photochemical phase of the process as follows:*

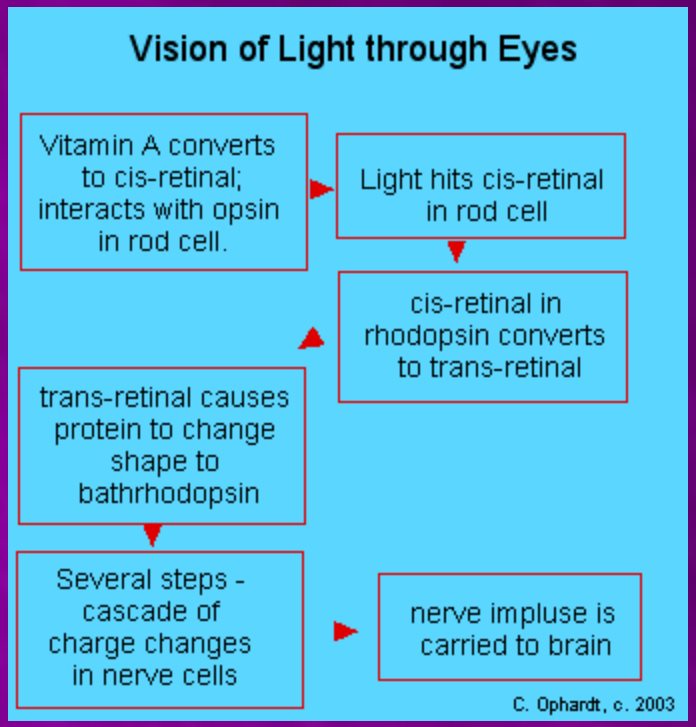
A-Rods:

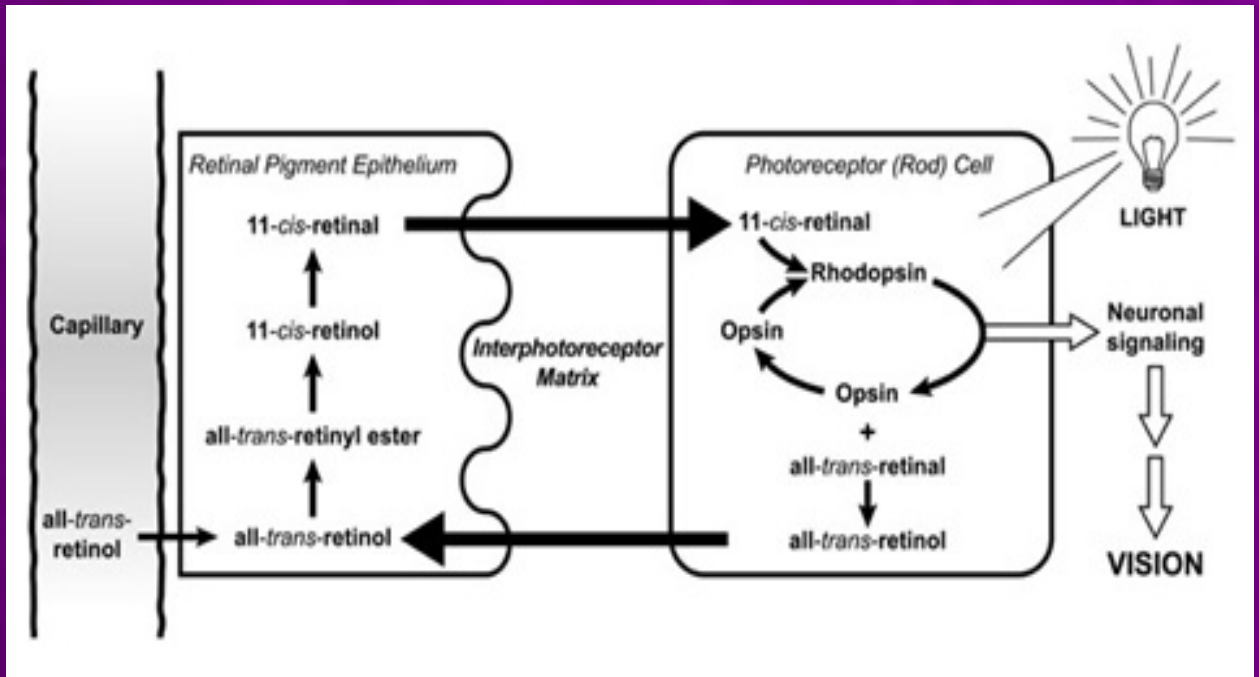
- *Rhodopsin cycle:*
- *Rods contain a photosensitive pigment called rhodopsin or visual purple which is formed from vitamin A aldehyde (retinal) and opsin which is a simple protein.*
- *When light strikes rhodopsin, it is changed to lumirhodopsin (red or orang red compound) then to metarhodopsin (also orange red colour) then it splits to vitamin A aldehyde retinal (all trans) and opsin.*
- *Retinal (all trans)is then reduced to retinol (all trans) by retinine reductase and reduced NAD as coenzyme which diffuses out to pigment epithelium and some to blood stream where by isomerase enzyme the all trans vitamin A is changed to II-cis vitamin A*

- *The II-cis vitamin A enters the retina again to be oxidized to II-cis retinal and remains in this form till the time of darkness.*
- *In this darkII-cis retinal will combine rapidly with opsin to form rhodopsin by which vision in dim light is possible i.e. regeneration of rhodopsin takes place in dark and needs adequate amount of vitamin A.*
- *These are the chemical changes that occur by the effect of light (photochemical which produce the nerve impulses that pass to optic nerve to brain).*




Light Energy
Rhodopsin
Bathorhodopsin
Lumirhodopsin
Metarhodopsin I
Metarhodopsin II
Scotopsin
Isomerase
Isomerase
ll-cis-retinal
all-trans-Retinal
ll-cis-Retinol
all-trans-Retinol
(Vitamin A)


Vision of Light through Eyes
Vitamin A converts to cis-retinal; interacts with opsin in rod cell.
Light hits cis-retinal in rod cell
cis-retinal in rhodopsin converts to trans-retinal
trans-retinal causes protein to change shape to bathrhodopsin
Several steps - cascade of charge changes in nerve cells
nerve impluse is carried to brain
C. Ophardt, c. 2003


Retinal Pigment Epithelium
Photoreceptor (Rod) Cell
LIGHT
11-cis-retinal
11-cis-retinal
Rhodopsin
Capillary
11-cis-retinol
Interphotoreceptor Matrix
Opsin
Neuronal signaling
Opsin
all-trans-retinyl ester
+
all-trans-retinal
all-trans-retinol
all-trans-retinol
all-trans-retinol
VISION

- *B-Cones:*
- *Contains a photosensitive pigment called iodopsin.*
- *It is formed from vitamin A aldehyde and a protein called photopsine.*
- *Iodopsin is necessary for vision in bright light.*

- *Deficiency:*

1. *In eyes: night blindness.*
2. *Dry cornea (xerophthalmia).*
3. *Fissuring of cornea (Keratomalacia).*
4. *Inflamation of conjunctiva.*
5. *Bitot's spots (white areas in the conjunctiva).*
6. *In skin: the skin becomes rough, scaly and follicular.*
7. *Respiratory tract: repeated cough from lowered resistance of its mucosa.*
8. *Urinary tract: infection and stone formation.*
9. *Bone and teeth: only in rabbits and rats the bones lose their fine structural details.*
10. *Reproduction: mainly in rats.*
    - *Release or synthesis of androgens from testis is interfered with. Also impairment of fertilization or implantation.*
11. *Adrenal cortex: Glycogen neogenesis is decreased.*

Requirements:

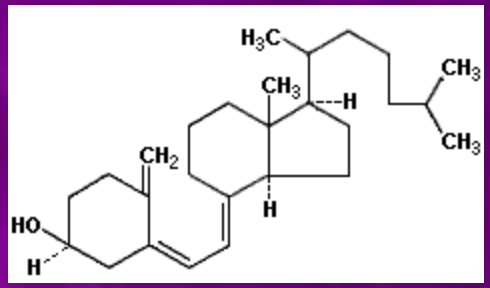
- Adults: 5000 IU/day.
- During Pregnancy: 6000 IU/day.
- During lactation: 8000IU/day.
- Under 1 year: 1500 IU/day.

Excess of vitamin A:

- Acute symptoms include: headache, vomiting , dizziness,drowsiness and white areas around the mouth.
- High doses of vitamin A inhibits thyroxine.
- Haemorrhagic manifestation: due to hypoprothrombinimia as a result of deficiency of vitamin K.
- Carotenimia: it is a harmless condition characterized by yellow colouration of skin.
- Conjunctiva and urine are normal.
- It is a result of high intake of carotenes in diet and so they are increased in blood.

Vitamin D

Vitamin D

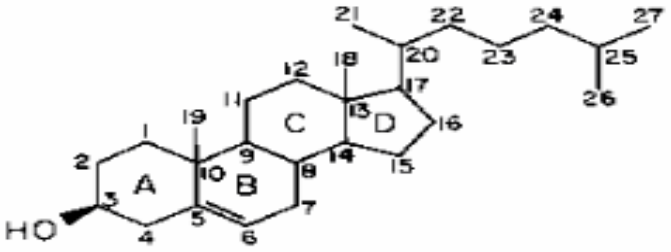


- *Vitamins D are a group of compounds all of them are steroid in nature (sterols) and occur mainly in animals.*
- *Vitamins D are derived from certain precursors, only 2 of them are of most importaance:*
- *Ergosterol is a plant sterol and acts as a precursor of vitamin D2 (ergocalciferol).*
- *7-dehydrocholesterol is an animal sterol and acts as a precursor of vitamin D3 (cholecalciferol).*

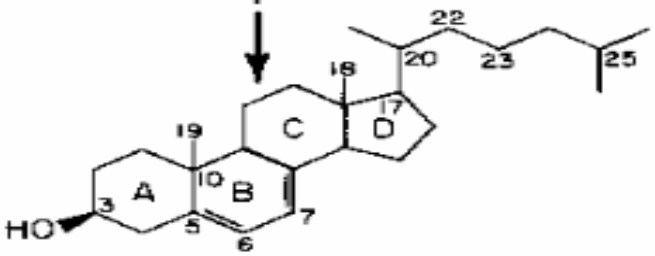
- *Properties:*
- *It is a white crystalline substance.*
- *Vitamins D are fat soluble vitamins thus are soluble in fat solvents.*
- *It is stable towards oxidizing and reducing substances.*
- *They can form ester with fatty acids since they are alcohols.*

- *Mode of action of vitamin D:*

- *Cholecalciferol is not the active form of vitaminD in the tissues. 1,25-dihydroxycholecalciferol is the metabolically active for of the vitamin which induces transport of calcium ions across the intestinal membrane. This derivative also promotes mobilization of calcium from bone.*
- *Cholecalciferol is hydroxylated in 2 steps:*
- *First hydroxylation in the liver to give 25-hydroxycholecalciferol.*
- *Followed by dyhydroxylation in the kidney in position 1 to give 1,25-dihydroxycholecalciferol.*
- *It was suggested that active form of vitamin D induces formation of the mRNA needed for synthesis of proteins in intestinal mucosa that can bind calcium (calcium-binding protein).*
- *This protein is a part of the calcium transport system through the intestinal mucosal cells.So vitamin D functions as a hormone more than a vitamin.*
- *In chronic renal failure, hydroxylation in position 1 does not occur with the rewsult of decrease of absorption of calcium from intestine followed by hypocalcaemia with increased production of parathyroidhormone.*

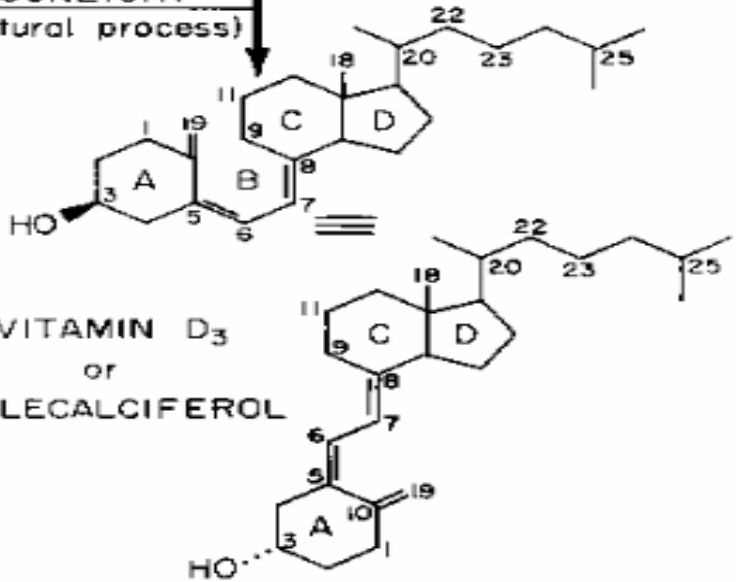


CHOLESTEROL

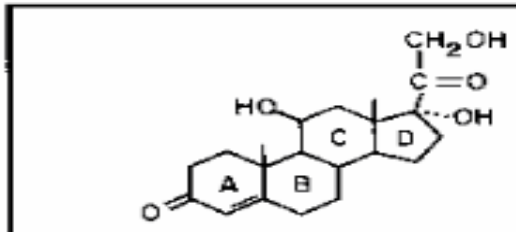


7-DEHYDROCHOLESTEROL
(Pro-Vitamin D_3)

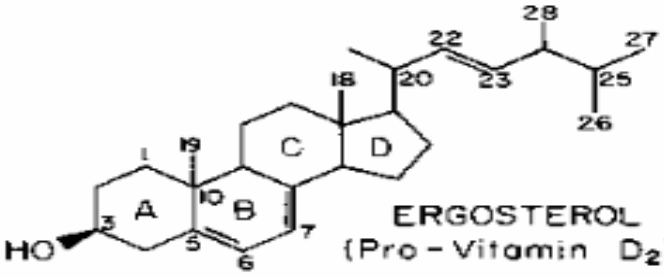
SUNLIGHT
(Natural process)



VITAMIN D_3
or
CHOLECALCIFEROL

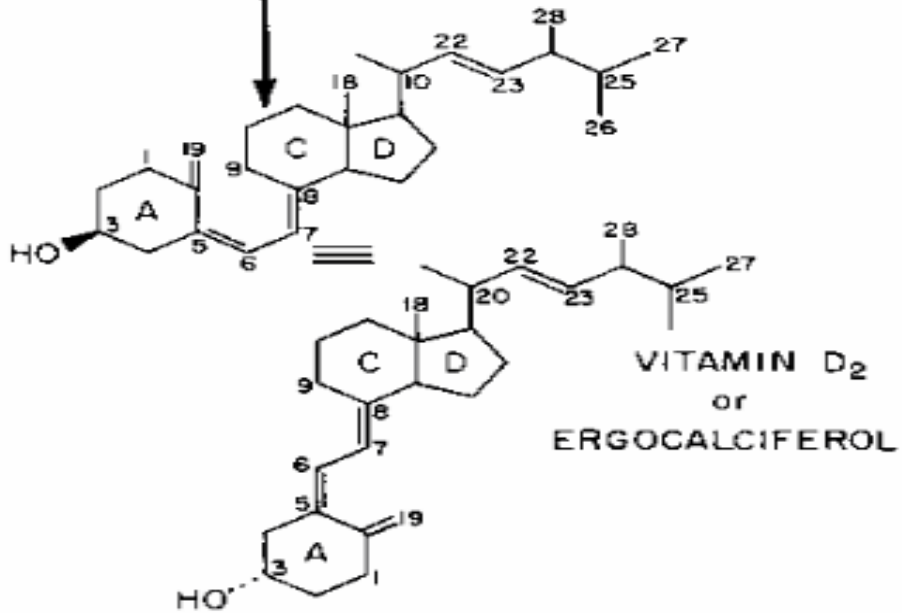


CORTISOL
(A CLASSIC STEROID HORMONE)

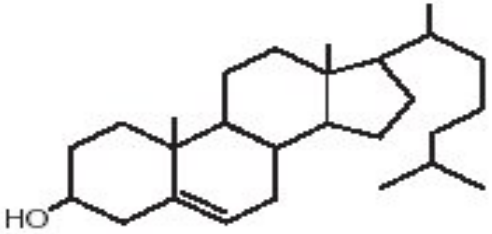


ERGOSTEROL
(Pro-Vitamin D_2)

UV LIGHT
(Commercial preparation)

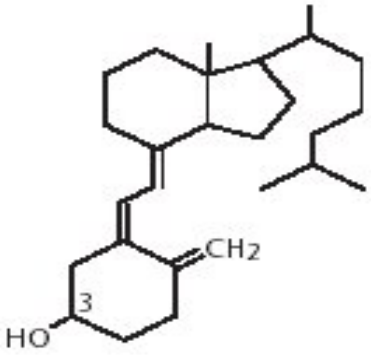


VITAMIN D_2
or
ERGOCALCIFEROL



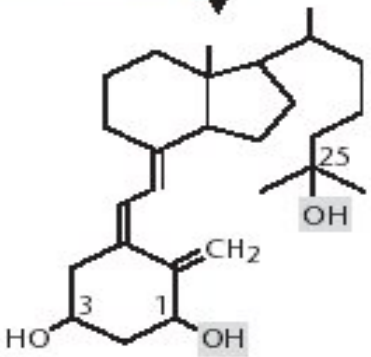
7-Dehydrocholesterol

UV-Licht



Cholecalciferol (Calciol)
= Provitamin D

in der Leber: 25-Hydroxylase
in der Niere: 1-Hydroxylase



1,25-Dihydroxycholecalciferol (Calcitriol)
= „D-Hormon"

- *Sources:*
- *Provitamines:*
- *Can give vitamin D2 and D3 by ultraviolet rays:*
- *Ergosterol is widely distributed in plants espicially yeast. Also present in animal e.g. snail, eggsand milk.*
- *7-dehydrocholesterol in animals and man only.*
- *It is formed by intestinal mucosa from cholesterol and passes to become subcutaneous. So exposure to sun light is essential for formation of vitamin D3.*
- *Vitamin D it self:*
- *It is widely distributed in animals e.g.*
- *Fishes: in liver oil as cod liver oil, halibut liver oil and tuna liver oil and in flesh in some fishes.*
- *Egg yolk: very rich in vitamin D.*
- *liver andbutter.*
- *Milk: is very poor source of vitamin D.*

- *Absorption:*
  - *Ergosterol is poorly absorbed from small intestine and irradiation increases its absorption.*
  - *Bile salts help its absorption.*
- *Storage:*
  - *The liver is main site of storage especially in fishes.*
  - *Skin and brain (significant amounts).*
  - *Lung, spleen and bone (small amounts).*
- *Excretion:*
  - *By bill to be absorbed by small intestine.*
  - *By milk.*
  - *No excretion in urine.*

- *Function:*

1-It increases the absdorption of calcium and phosphorious from the intestine as follow:

- *1,25-dihydroxycholecalciferol(active formof vitamin D) induces formation of a specific mRNA responsible for synthesis of proteins in intestinal mucosa that can bind calcium (calcium-binding protein).*
- *This calcium-binding protein helps transport of calcium from the intestinal lumen into the intestin cells.*
- *The calcium-binding protein is located at the brush border of the intestinal mucosa.*
- *The absorption of the phosphate occurs secondary to absorption of calcium.*

2-Vitamin D helps renal tubular absorption of calcium.

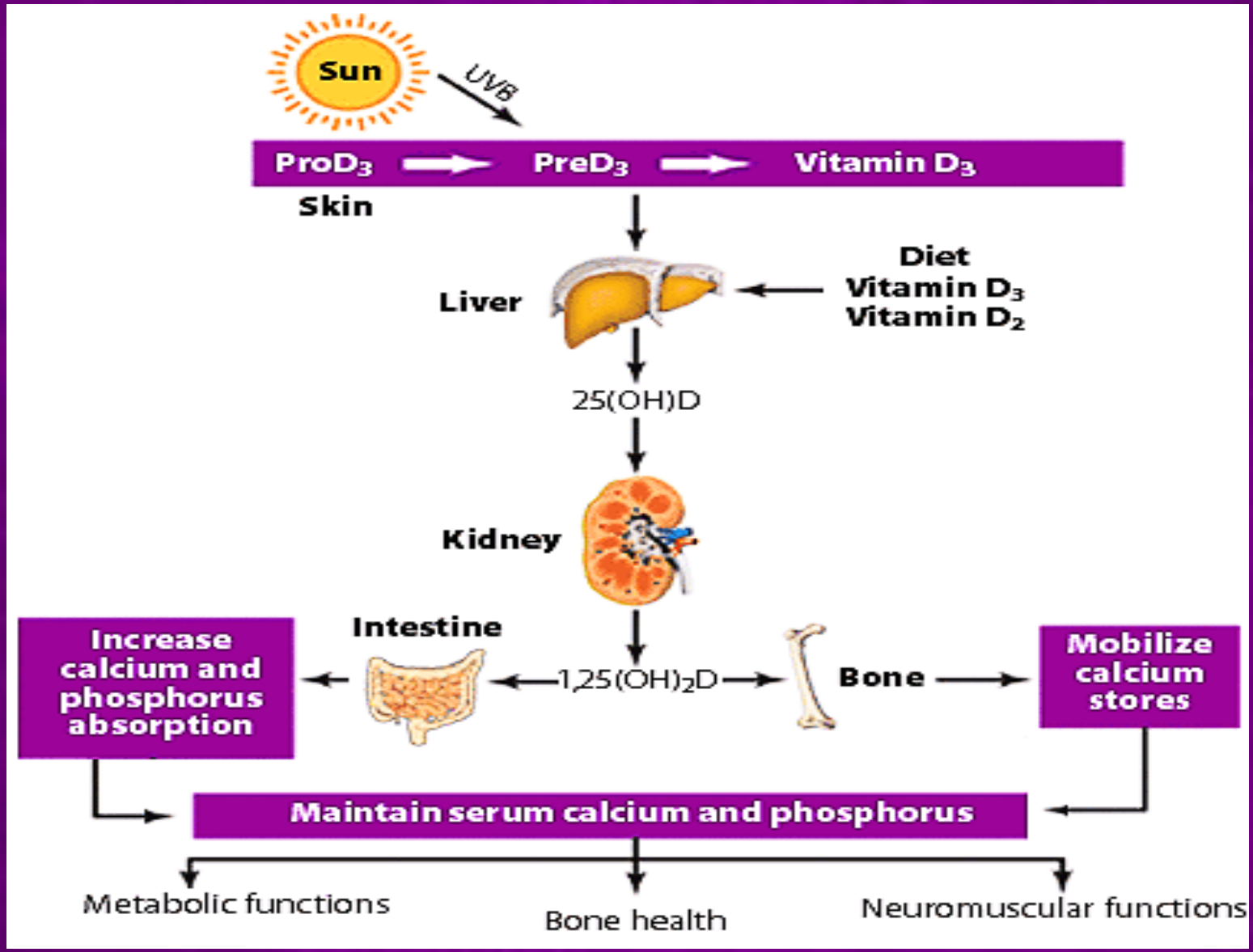
- *In addition to 1,25-(OH)2-D3 another metabolite 24,25-(OH)2-D3 appears to be active in kidney. Thus decreasing calcium excreation in urine.*

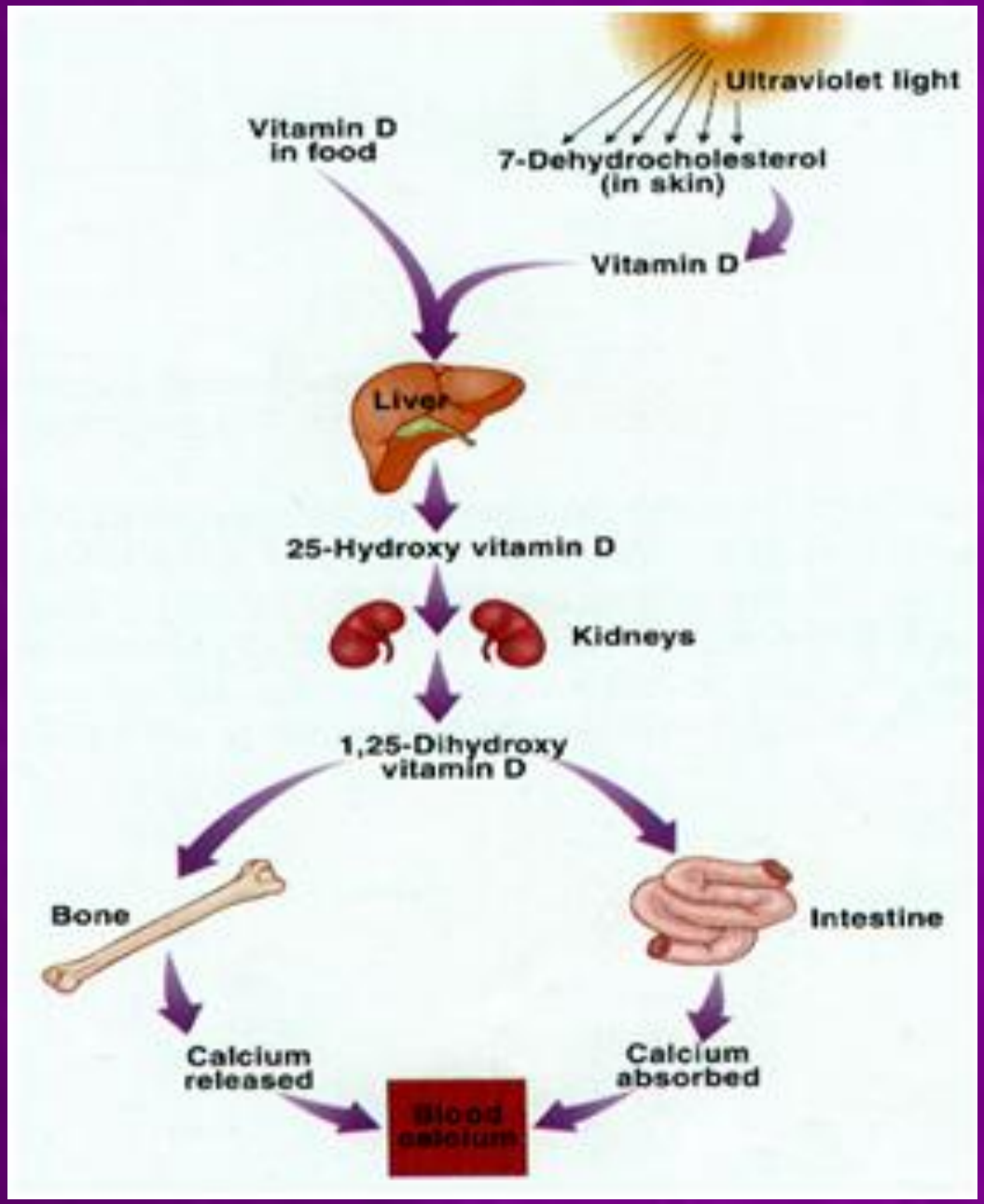
3-It stimulates calcium and phosphorous deposition in both bones and teeth by the last 2 procedures.

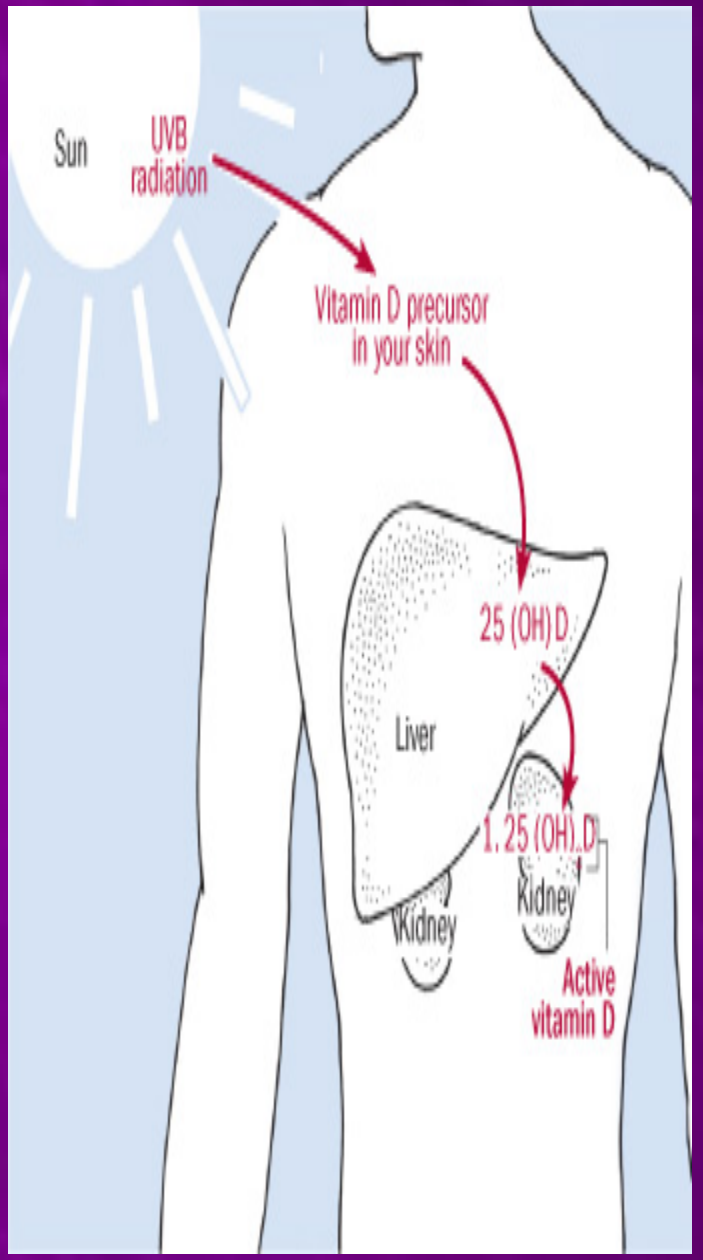
4-Vitamine D controls the transfere of divalent cations mostly Ca++and Mg++by many tissues including the liver, heart and skeletal muscles.

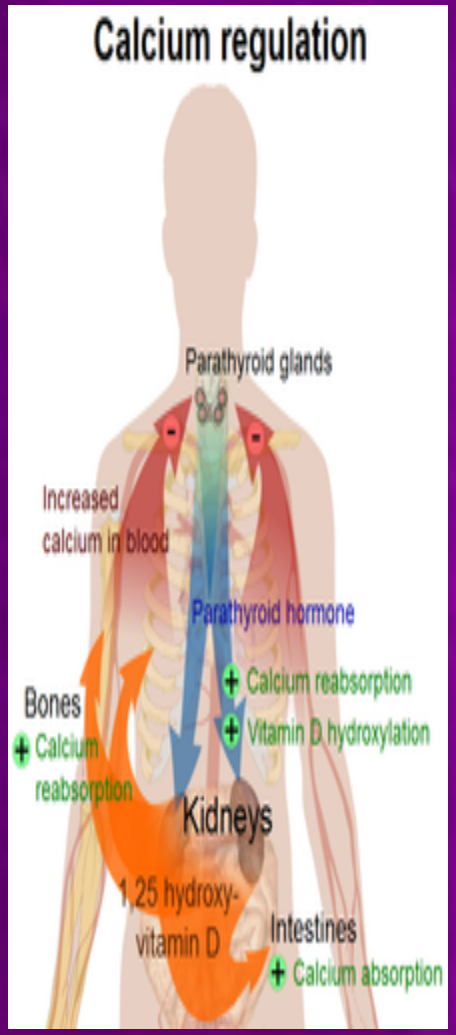
5-It regulates the calcium and phosphorus levels in blood.

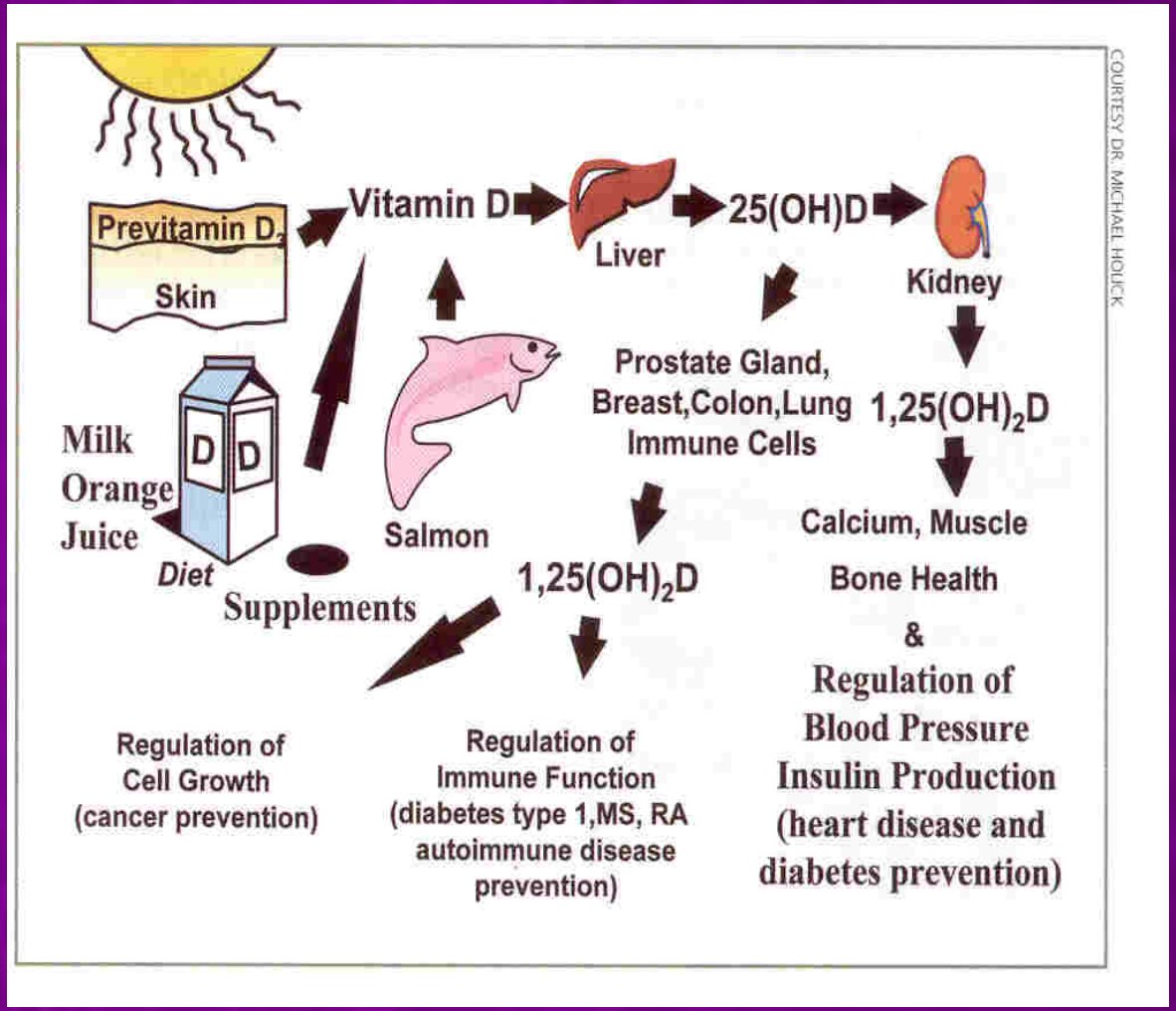
6-It inhibits action of phytic acid and so prevents the formation of insoluble calcium phytate.


Sun
UVB
ProD3
PreD3
Vitamin D3
Skin
Liver
Diet
Vitamin D3
Vitamin D2
25(OH)D
Kidney
Intestine
Increase calcium and phosphorus absorption
1,25(OH)2D
Bone
Mobilize calcium stores
Maintain serum calcium and phosphorus
Metabolic functions
Bone health
Neuromuscular functions


Ultraviolet light
Vitamin D in food
7-Dehydrocholesterol (in skin)
Vitamin D
Liver
25-Hydroxy vitamin D
Kidneys
1,25-Dihydroxy vitamin D
Bone
Intestine
Calcium released
Calcium absorbed
Blood calcium

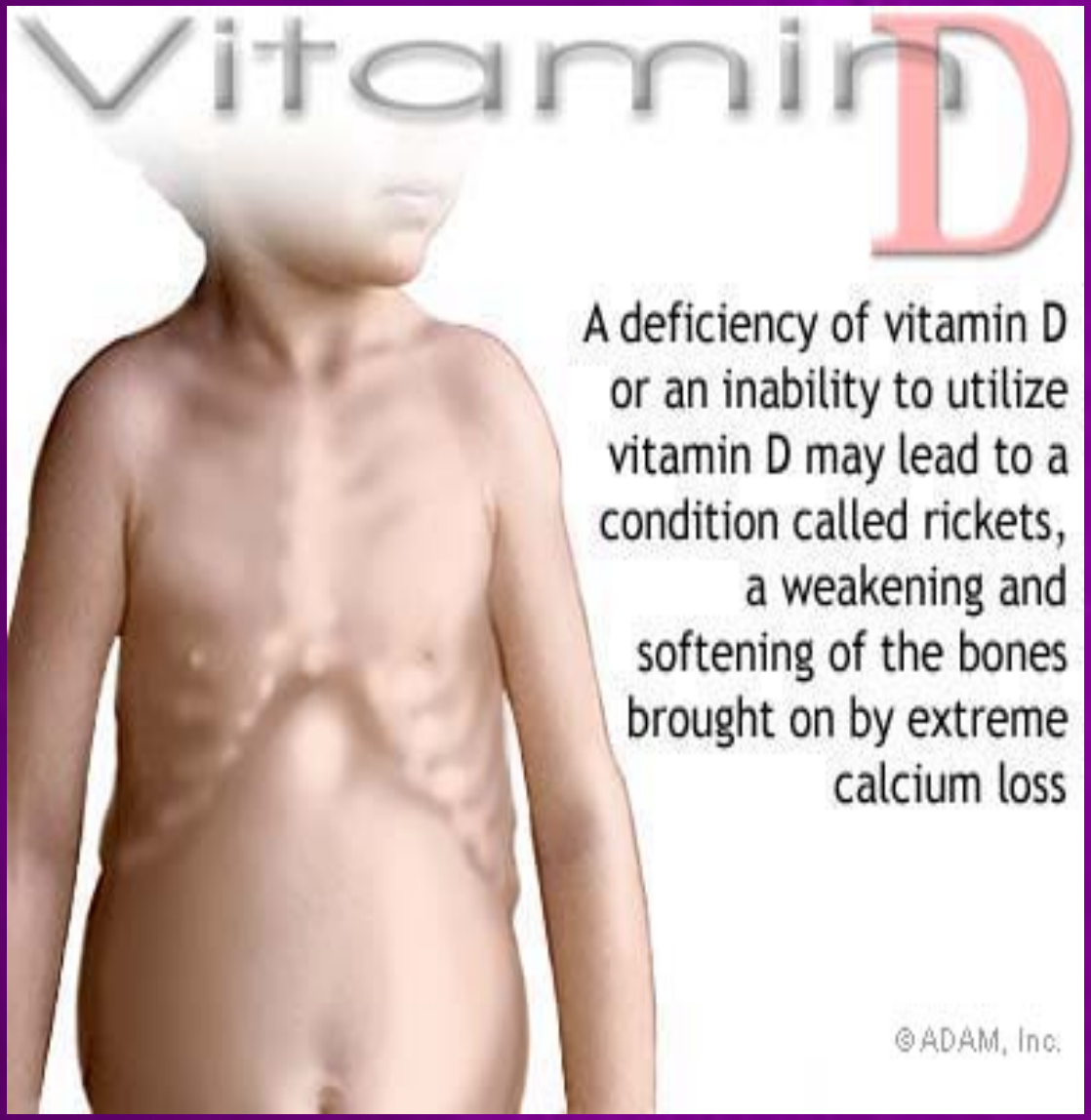

Sun
UVB radiation
Vitamin D precursor in your skin
25 (OH) D
Liver
1, 25 (OH)2 D
Kidney
Kidney
Active vitamin D


Calcium regulation
Parathyroid glands
Increased calcium in blood
Parathyroid hormone
+ Calcium reabsorption
+ Vitamin D hydroxylation
Bones
+ Calcium reabsorption
Kidneys
1,25 hydroxy-vitamin D
Intestines
+ Calcium absorption


Previtamin D_3
Skin
Vitamin D
Liver
25(OH)D
Kidney
Milk
Orange Juice
D D
Diet
Supplements
Salmon
Prostate Gland, Breast,Colon,Lung Immune Cells
$1,25(OH)_2D$
Calcium, Muscle
Bone Health
&
Regulation of Blood Pressure
Insulin Production
(heart disease and diabetes prevention)
$1,25(OH)_2D$
Regulation of Cell Growth (cancer prevention)
Regulation of Immune Function (diabetes type 1,MS, RA autoimmune disease prevention)
COURTESY DR. MICHAEL HOLICK

Deficiency:

- In adults:
  - Its deficiency leads to osteomalacia which is characterized by bone deformation. Low blood calcium and phosphorous common after repeated pregnncies and lactation.
- In young infants:
  - its deficiency causes Rickets which is manifested by:
  - Softening and deformities of bones, and characterized by:
  - Legs: bowed.
  - Skull: boxy skull.
  - Chest: pigeon chest.
  - Pelvis: contracted.
  - Knees: knock.
- Delayed teething, standind and walking.
- Low blood calcium and phosphorus with high alkaline phosphatase level.


Vitamin D
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
©ADAM, Inc.

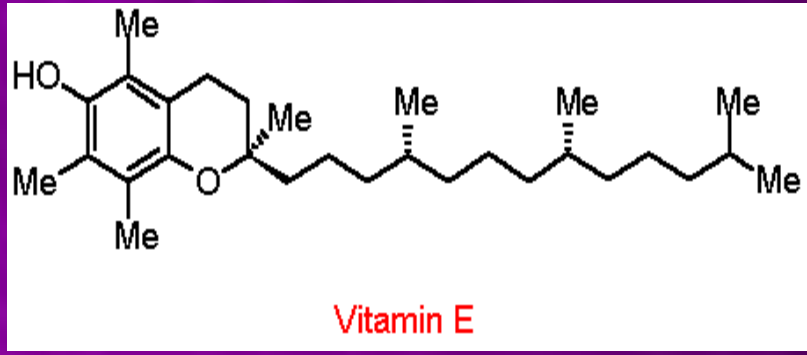

Child with Rickets

- *Excess of vitamin D:*
- *Early symptoms: anorexi, nausia, vomiting and polyuria (increase of urine).*
- *Late symptoms: abnormal calcification of the tissues (due to deposition of calcium and phosphorous) as lungs and kidneys.*
- *Requirements:*
- *For infants and children 400 IU/day.*
- *For pregnant and lactating women 800 IU/day.*

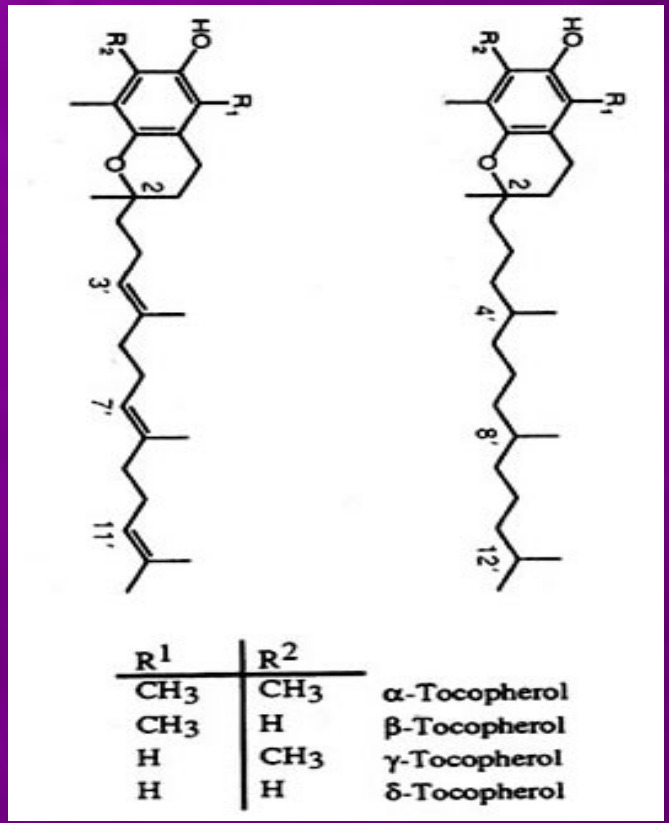
Vitamin E

Vitamin E

- Vitamin E is a tocopherols that contain tocol nucleus.
- Vitamin E is a family of α-, β-, γ-, and δ-tocopherols differing in the number and position of methyl group on the ring of tocol nucleus.
- All tocopherols contain a side chain formed from 12 carbon atoms attached to carbon number 2.
- All contain a hydroxyle group at carbon 6.



Vitamin E



Properties:

- *They are insoluble in water and soluble in fat solvents and inorganic solvents.*
- *They are oxidized very easy due to the presence of this hydroxyl group.*
- *This is the cause of its antioxidant activity as they are oxidized very easy protecting other less susceptible compounds from being destroyed by oxidation e.g. lipids and vitamin A are protected by addition of small amounts of vitamin E.*
- *Vitamins E loss their biological activity by:*
- *Oxidation and ultraviolet rays.*

- *Food sources of Vitamin E:*
  - *Particularly high levels of vitamin E can be found in the following foods:*
    - *Asparagus*
    - *Avocado*
    - *Egg yolk.*
    - *Liver and colostrum.*
    - *Milk*
    - *Nuts, such as almonds or hazelnuts*
    - *Seeds (α- and γ–tocopherols in cotton seed oil)*
    - *Spinach and other green leafy vegetables .*
    - *Unheated vegetable oils*
    - *Wheat germ (α- and β–tocopherols in wheat germ oil).*
    - *δ–tocopherols in soybean oil.*
    - *Wholegrain foods.*

- *Absorption:*
  - *From small intestine.*
  - *Bill salt are necessary for absorption.*
- *Storage:*
  - *They are stored in liver.*

- *Excretion:*
  - *Only after large doses of vitamin E. it is excreted by the stools and traces appear in urine.*
  - *Requirements:*
  - *Adults: 25-30 mg/day.*

- *Function:*
  - *It acts as a cofactor in transfer system of the mitochondria.*
  - *Due to its antioxidant power it prevents destruction of polyunsaturated fatty acids and vitamin A. also it inhibits lung tissue damage from air oxidants.*
  - *It increases RBCs resistance to haemolysis.*
  - *It prevents a type of anemia described as maturation arrest in which the maturation of red cells is arrested or stopped.*
  - *In rats: acts as antisterility.*

Deficiency:

1. *In male rats, vit E deficiency leads to sterility but in female pregnant rats leads to death of the fetus.*
2. *Degenerative change in skeletal muscles of rats, rabbits and guinea pigs.*
3. *Creatinurea occurs due to impaired creatine phosphate utilization by muscles.*
4. *Hepatic necrosis: this occurs to animals kept on diet poor in selenium, both vitamin E and selenium are being important to protect polyunsaturated fatty acids and cell membranes against the destructive action of H2O2.*
5. *Hemolytic anemia.*


Thank You