

VITAMINS





What are vitamins?

- Organic molecules with a wide variety of functions
- Cofactors for enzymatic reactions
- Essential, supplied in the diet
- **Two distinct types: Fat soluble (A, D, E, K)**
- **Water soluble (B – complex, C)**

Vitamins are low molecular-weight organic molecules that are essential for normal health and growth. They are required in trace amounts and must be obtained from the diet because they are not synthesized in the body.



Why are they good for us?

- **Greater need due to worse environment**
- **Improve immunity**
- **Prevent illnesses**
- **Slower aging**



Role of Vitamins in Metabolism

- Vitamins have catalytic functions (**co-factors**) in the metabolic reactions and **do not act as building substances** (that is why the daily requirement is very small).
- Since each vitamin has **very specific function** in **metabolism**, therefore, its deficiency will adversely affect one or more biochemical reactions in certain organs and very characteristic deficiency symptoms will appeared.

Vitamins

Fat soluble

- Vitamin A
- Vitamin D
- Vitamin E
- Vitamin K

Water soluble

Non B-complex

- Vitamin C

B-complex

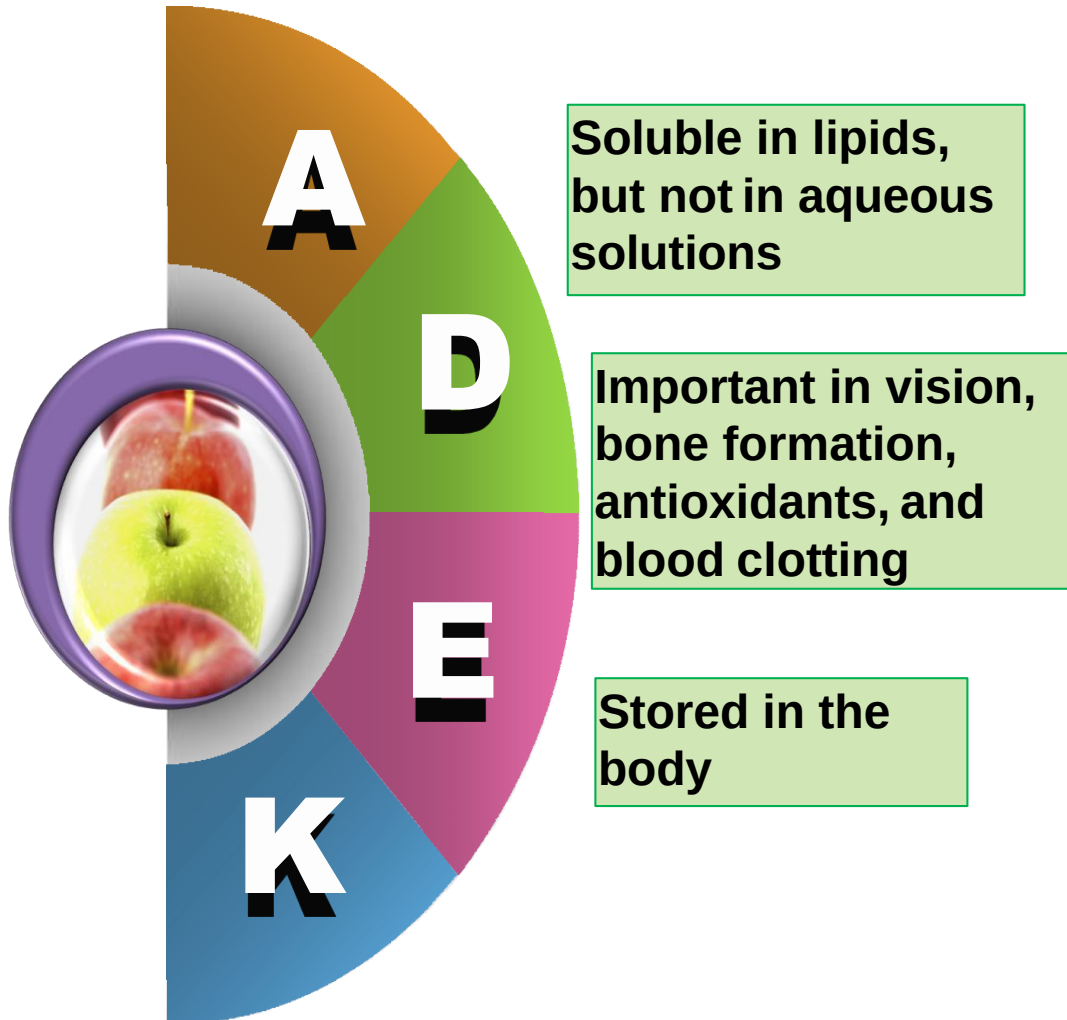
Energy-releasing

- Thiamine (B₁)
- Riboflavin (B₂)
- Niacin (B₃)
- Pyridoxine (B₆)
- Biotin (B₇)
- Pantothenic acid (B₅)

Hematopoietic

- Folic acid (B₉)
- Vitamin B₁₂
(cyanocobalamin)

Fat-Soluble Vitamins



Water- soluble vitamins

Soluble in aqueous solutions

Used as cofactors by many enzymes

Not stored in the body except B12, their deficiency appear quickly

1- Fat soluble vitamins

Vitamins	Medicinal applications
A	1. Lowered resistance to infections. 2. Dark-adaptation.
D	1. Prophylaxis and therapy of rickets. 2. Cases of bone atrophy. 3. Improves tooth consistency.
E	1. In cardiac, vascular and muscular disorders. 2. Fat with high levels of unsaturated fatty acids absorption disorders.
K	1. Disorders of blood coagulation.

2- Water soluble vitamins

Vitamins	Medicinal applications
B1	1. Beri beri. 2. Nervous inflammations, neuralgias. 3. Cardiac dysfunction caused by alcoholism.
B2	1. Ariboflavinosis. 2. Photophobia and blurred vision. 3. Corneal vascularization and eye itching
B3	1. Pellagra. 2. Multiple B-complex deficiency syndrome.
B5	Dermatitis and seborrhea.

2- Water soluble vitamins

Vitamins	Medicinal applications
B6	1. Irritability and convulsion. 2. Hypochromic anemia. 3. Peripheral neuritis..
B9	Megaloblastic anemia.
B12	1. Juvenile pernicious anemia. 2. Gastrectomy and celiac disease. 3. Long term drug therapy as neomycin. 4. Inflammatory lesions.
C	1. Scurvy. 2. Poor wound healing.

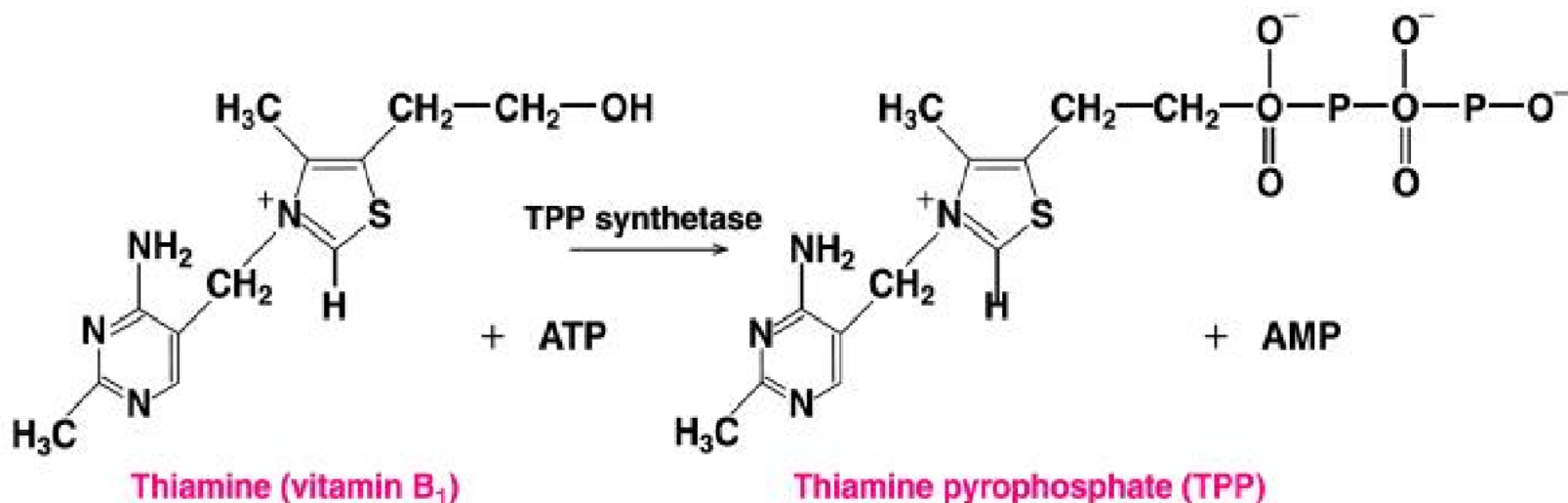
Water- soluble vitamins

Table 21.9 Vitamins and Function

Water-Soluble Vitamins	Coenzyme	Function
Thiamine (vitamin B ₁)	Thiamine pyrophosphate	Decarboxylation
Riboflavin (vitamin B ₂)	Flavin adenine dinucleotide (FAD); Flavin mononucleotide (FMN)	Electron transfer
Niacin (vitamin B ₃)	Nicotinamide adenine dinucleotide (NAD ⁺); Nicotinamide adenine dinucleotide phosphate (NADP ⁺)	Oxidation–reduction
Pantothenic acid (vitamin B ₅)	Coenzyme A	Acetyl group transfer
Pyridoxine (vitamin B ₆)	Pyridoxal phosphate	Transamination
Cobalamin (vitamin B ₁₂)	Methylcobalamin	Methyl group transfer
Ascorbic acid (vitamin C)	Vitamin C	Collagen synthesis, healing of wounds
Biotin	Biocytin	Carboxylation
Folic acid	Tetrahydrofolate	Methyl group transfer

Thiamine (Vitamin B₁)

- Was the first B vitamin identified.
- Is part of the coenzyme **thiamine pyrophosphate (TPP)**.

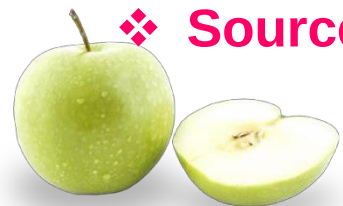


- TPP coenzyme** is required by enzymes in the decarboxylation of α -keto carboxylic acids.
- Deficiency results in **beriberi** (fatigue, weight loss, and nerve degeneration).

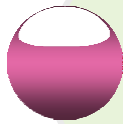


Thiamine (Vitamin B₁)

- ❖ **TPP** act as a coenzyme in carbohydrate, protein, lipid (production of NADPH and acetylCoA) and energy metabolism (ATP production)
- ❖ **TTP** has a role in nerve impulse transmission by regulation of Na and Cl⁻ channels and acetylcholine receptors.
- ❖ **VitB1** deficiency lead to decrease in ATP production from metabolism and impair cells function in nervous system, heart, muscles and gastrointestinal tract.
- ❖ **Thiamine is absorbed** from SI by active transport but can be transported by passive transport if it presents in food in high amount.
- ❖ **Sources:** yeasts, cereals, rice, liver, legumes



Riboflavin (Vitamin B2)



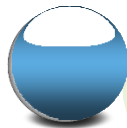
Made of the sugar alcohol *ribitol* and *flavin*

Part of the **coenzymes Flavin adenine dinucleotide (FAD) and flavin mononucleotide (FMN).**

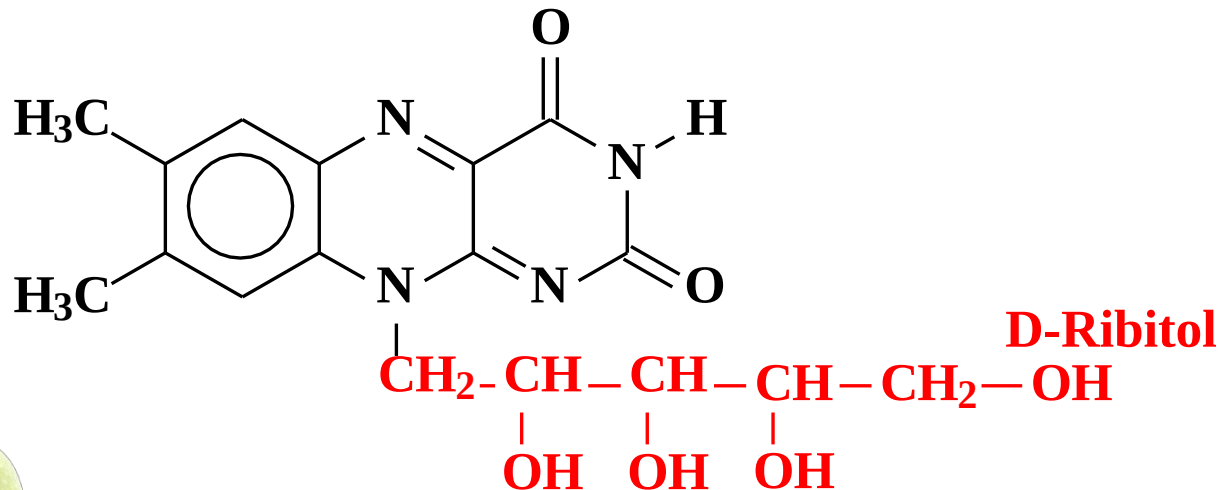


Needed for good vision and healthy skin

Support of sight function and Light sensitive



Sources: cereals, eggs, vegetables, dairy products, yeast, liver



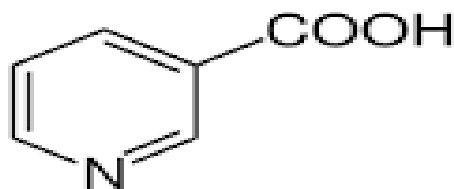
Riboflavin (Vitamin B2)

- **FMN and FAD** function act as coenzymes for many oxidation-reduction reactions in CHO, lipid and protein
- **FAD is required** for biosynthesis of the vitamin niacin from amino acid tryptophan and activation vitamin B6 and FADH₂ required for the synthesis of folate active form.
- **FAD has a role** in the synthesis of DNA and required for reduction of glutathione (GSSG) to form (GSH).
- **In respiratory** chain one mole of FADH₂ produce two mole of ATP.
- **Deficient of VitB2** leads skin (dermatitis) and eye problems (photophobia, corneal vascularization (bloodshot eyes) and dermatitis.
- **Riboflavin is absorbed** from SI by carrier mediated transporter
- **Sources:** cereals, eggs, vegetables, dairy products, yeast, liver

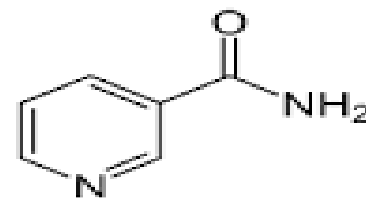


Niacin (Vitamin B₃)

- Two Types Niacinamide (Nicotinamide)
 Niacin (Nicotinic Acid)
- Niacin can be synthesized from tryptophan in liver in presence of B2, B6 and iron.
- It is a part of the coenzyme nicotinamide adenine dinucleotide (NAD⁺) involved in oxidation- reduction reactions.
- Nicotinamide and Nicotinic Acid are absorbed in Small intestine and stomach by carrier-mediated facilitated diffusion into the blood



**Niacin or
nicotinic acid**



Nicotinamide



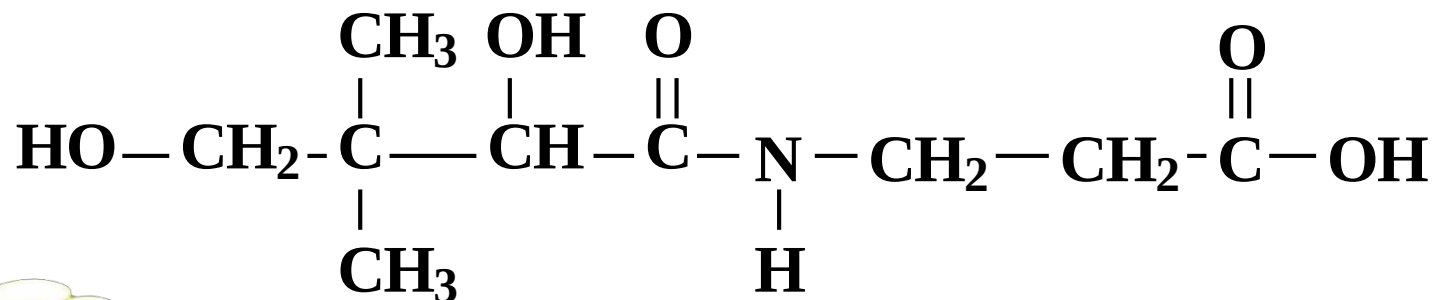
Niacin (Vitamin B₃)

- NAD and NADP act as Co-enzyme in oxidation reduction reaction in CHO, lipid, protein metabolism
- NAD has a role in DNA repair mechanism
- One NADH+H enter respiratory chain produces 3 ATP
- Niacin used for treatment of lipid disorders
- Deficiency can result in **Pellegra** (dermatitis, Diarrhea, Depression), muscle fatigue, and loss of appetite.
- It is found in meats, rice, and whole grains.



Pantothenic Acid (Vitamin B₅)

- Pantothenic acid is composed of β-alanine and pantoic acid joined by peptide bond.
- It is absorbed from small intestine into blood by active and passive transporters
- Deficiency can result in fatigue, retarded growth and anemia, paresthesia of hand that may result from defect in acetylcholine synthesis or impaired myelin synthesis, depression.



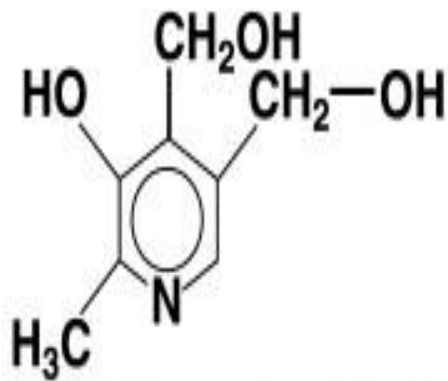
Pantothenic Acid (Vitamin B₅)

- It is a part of **coenzyme A** needed for
 - 1- energy production in catabolic reaction
 - 2- synthesis reaction to produce glucose and cholesterol synthesis.
 - 3- Acetylation of choline to form acetylcholine
 - 4- Acetylation of sugar to form acetyl glucosamine
 - 5- Acetylation of threonine to form myelin
- It act as coenzyme (**ACP acyl carrier protein**) for fatty acid synthase in fatty acid biosynthesis
- Sources: whole grains, and vegetables ,eggs,liver, heart, yeast

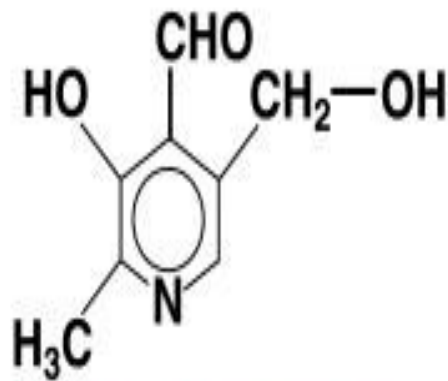


Pyridoxine (Vitamin B₆)

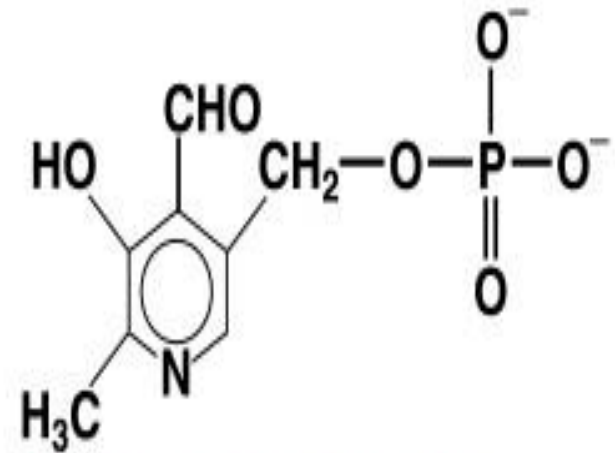
- **Pyridoxine** and **pyridoxal** are two forms of vitamin B₆, which are converted to the coenzyme pyridoxal phosphate (PLP).



Pyridoxine (vitamin B₆)



Pyridoxal (vitamin B₆)



Pyridoxal phosphate (PLP)

- B6 is absorbed in small intestine by passive transporter
- **Sources:** Meats, liver, egg, whole grains, vegetables and nuts.



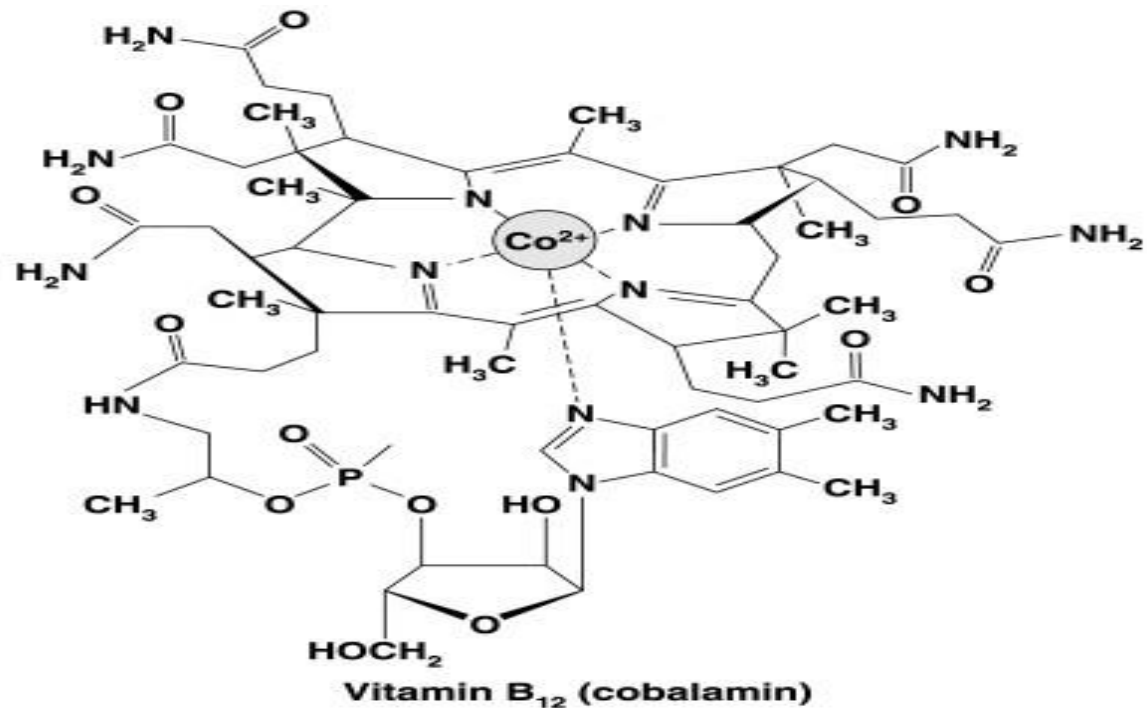
Pyridoxine (Vitamin B₆)

- PLP is a coenzyme required in the transamination of amino acids and decarboxylation of carboxylic acids.
- PLP act as a coenzyme for glycogen phosphorylase (breakdown of glycogen)
- PLP act as a coenzyme for formation of niacin
- It has a role in synthesis of neurotransmitters
- PLP act as a coenzyme in heme synthesis
- It is important in production of red blood cells, conversion of tryptophan to niacin (B-3), immunity, and nervous system functions
- Deficiency of pyridoxine may lead to dermatitis, fatigue, and anemia.



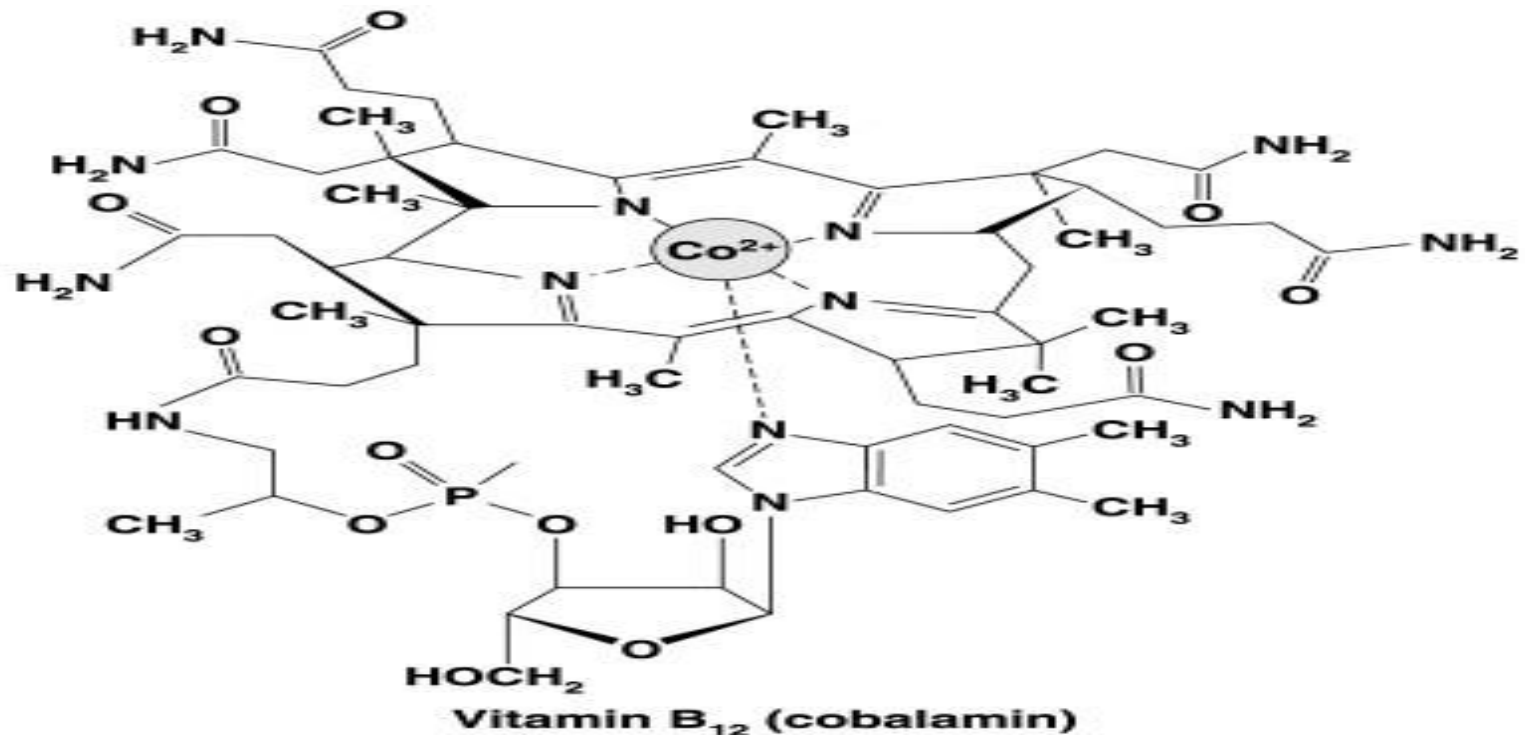
Cobalamin (Vitamin B₁₂)

- Consists of four pyrrole rings with a Co²⁺.
- Is a coenzyme for enzymes that transfer methyl groups and produce red blood cells.
- Deficiency can lead to **pernicious anemia** and nerve damage.



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Cobalamin (Vitamin B₁₂)

- Important in: proper nerve function, production of red blood cells, metabolizing fats and proteins, prevention of anemia, DNA reproduction
- Vitamin B12 is stored in liver
- Deficiency can lead to **pernicious anemia** and nerve damage and hypersensitive skin.

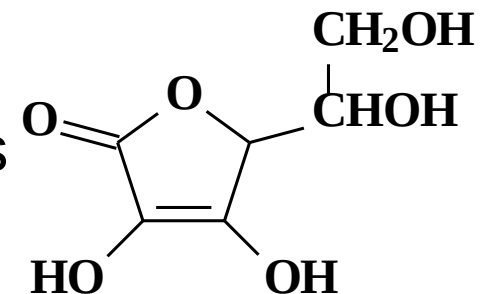


Ascorbic Acid (Vitamin C)

- Vitamin C is a six carbon compound, it synthesized from glucose and galactose by plants and animals but can not by human
- It absorbed in small intestine by active transport and passive transport into blood
- It act as a coenzyme in reaction involved in collagen synthesis

- Act as a coenzyme for carnitine synthesis

Carnitine is important in lipid metabolism



Ascorbic Acid (Vitamin C)

- It act as coenzyme for Tyrosine and Neurotransmitters synthesis.
- It has a role in absorption of iron in intestine by reduced ferric to ferrous
- It has a role in bile acids synthesis and aldosterone and cortisol synthesis
- It act as a high powerful antioxidant
- It has a role in immunity by different mechanism that induce proliferation of lymphocytes and complement synthesis



Ascorbic Acid (Vitamin C)

- Deficiency can lead to weakened connective tissue, slow-healing wounds, and anemia.
- Hypervitaminosis: addiction, diarrhea
- Hypovitaminosis: scurvy
- Sources: found in Indian gooseberries, blueberries, citrus fruits, tomatoes, broccoli, red and green vegetables





Fat-Soluble Vitamins

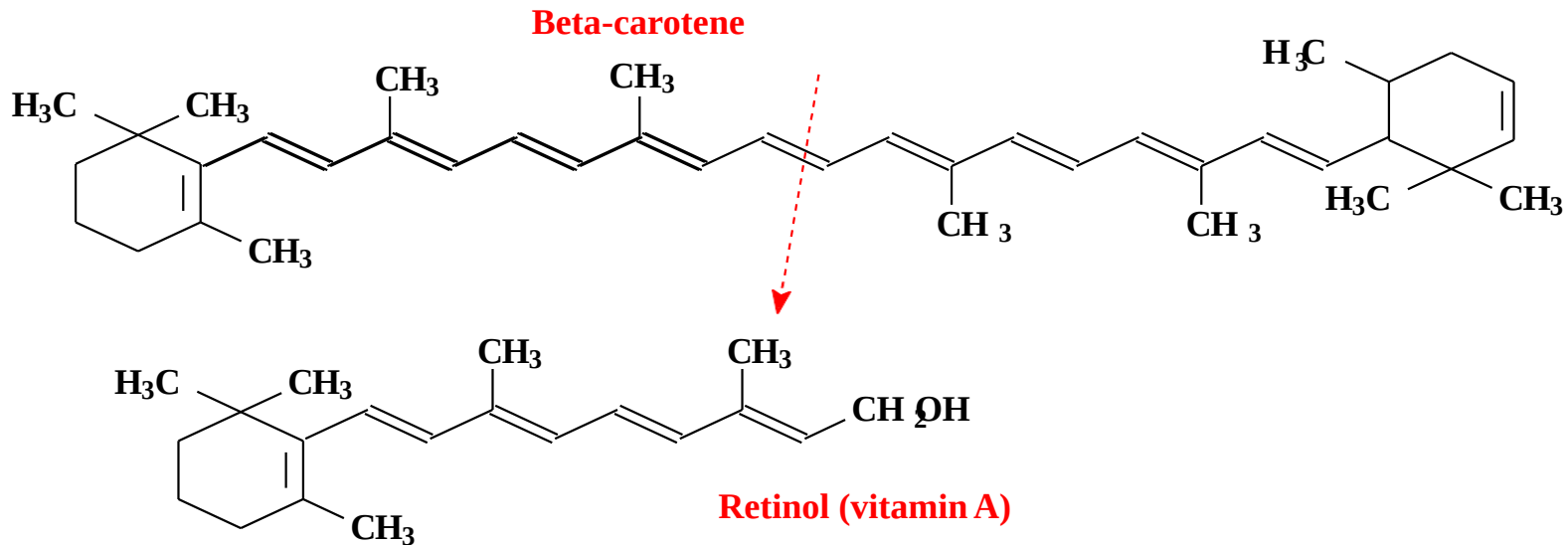
Fat-Soluble Vitamins

Vitamin A	Formation of visual pigments; development of epithelial cells
Vitamin D	Absorption of calcium and phosphate; deposition of calcium and phosphate in bone
Vitamin E	Antioxidant; prevents oxidation of vitamin A and unsaturated fatty acids
Vitamin K	Synthesis of prothrombin for blood clotting



Vitamin A

- Vitamin has three active forms: retinol, retinal and retinoic acid. These active forms exist in animal product but in plant found as provitamin.



- It is digested and absorbed as lipid



Vitamin A

- **Vitamin A** is obtained from meats and beta-carotenes in plants.
- Beta-carotenes are converted by liver enzymes to vitamin A(retinol).



Vitamin A is essential for vision (night vision)

It has a role in cellular differentiation

It has role in growth, reproduction, bone development and immune system action

Vitamin A can be stored in liver, adipose tissue, lung and kidney



Vitamin A and provitaminA

- **Retinol**
- Cancer cure and prevention
- Skin, eyes, genital glands
- Provitamin changes to A vitamin in liver
- Sources: liver, egg yolks, dairy products
- provitamin: carrots, pepper, spinach, yellow fruits



Vitamin D

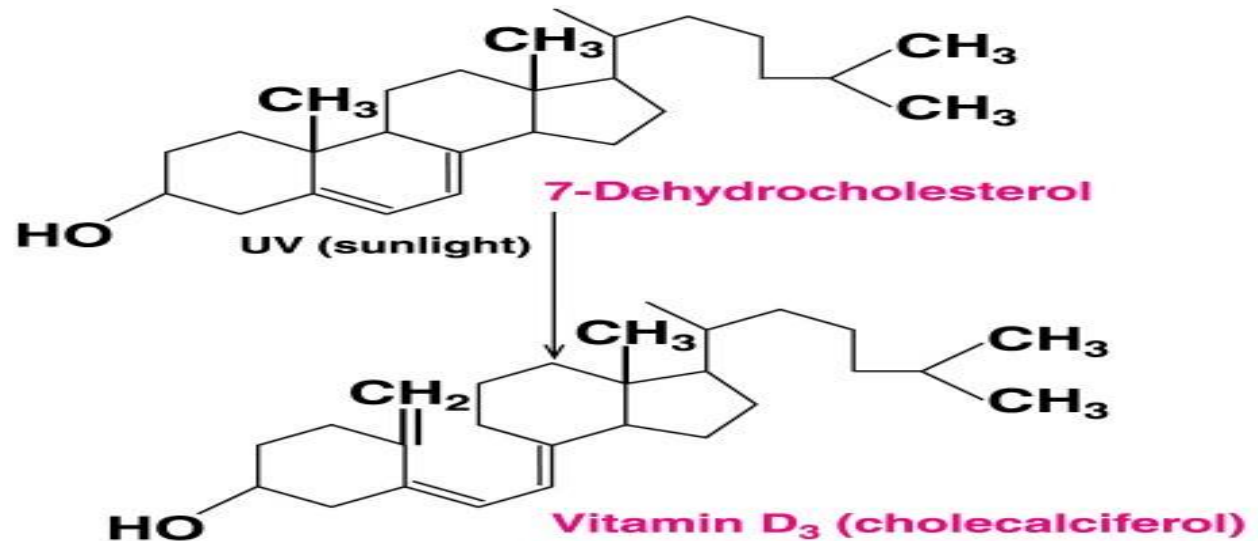
Vitamin D (D₃):

- Is synthesized in skin exposed to sunlight from cholesterol and act as a hormone
- Storage in liver and adipose tissue
- Regulates the absorption of phosphorus and calcium during bone growth.
- Deficiency can result in weakened bones, Rickets (failure in mineralization of growing bone), Osteomalacia (failure in mineralization of mature bone).
- Sources include cod liver oil, egg yolk, and enriched milk.



Vitamin D

- Toxicity of Vitamin D when dietary intake of it exceeds 250 μg per day, but not affected by excessive exposure to sunlight.
- Vitamin D is low in Dark skin people, obese persons, and in chronic renal failure (why).



Vitamin E

Vitamin E has two types :Tocopherols and tocotrienols

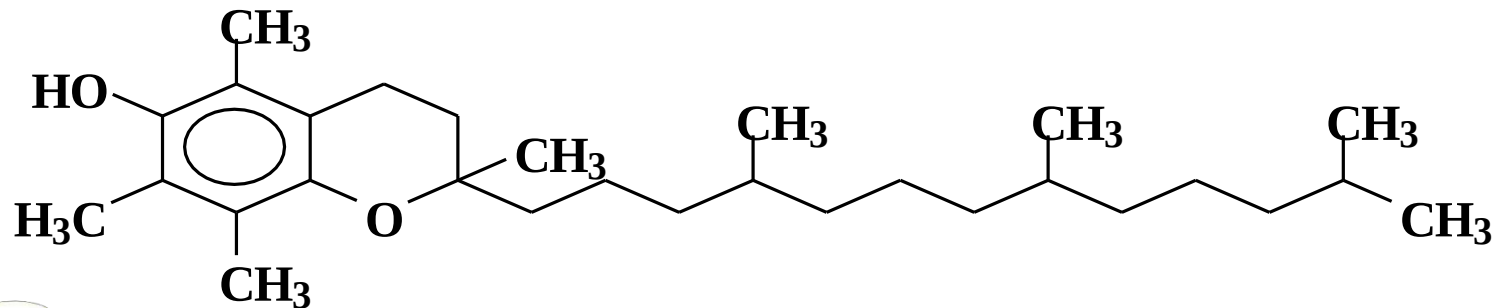
It is absorbed in small intestine as lipid .

Is an antioxidant in cells. May prevent the oxidation of unsaturated fatty acids. improves immunity

Deficiency is rare in human.

Cures muscle, heart and skin diseases, burns

It is found in vegetable oils, whole grains, and vegetables.



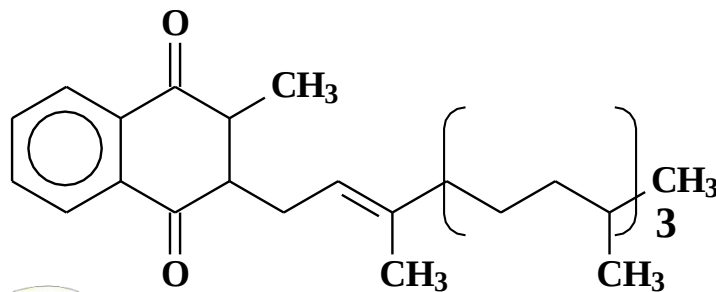
Vitamin K

- Vitamin K₁ (phyloquinone) in plants has a saturated side chain.
- Vitamin K₂ (menaquinone) in animals has a long unsaturated side chain. (it can be synthesized by intestinal bacteria
- Vitamin K₂ is needed for the synthesis of zymogens for blood clotting.
- Vitamin K₃ (Menadione) is synthetic compound

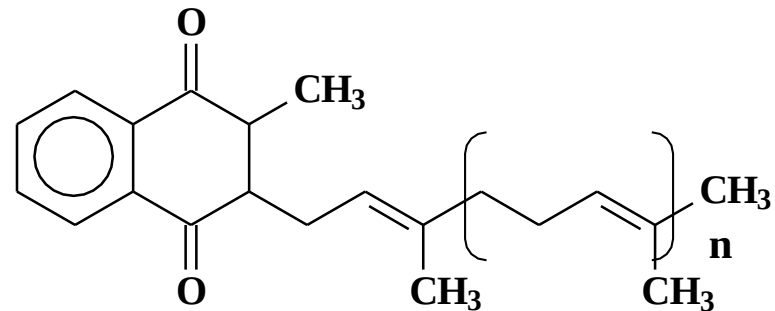


Vitamin K

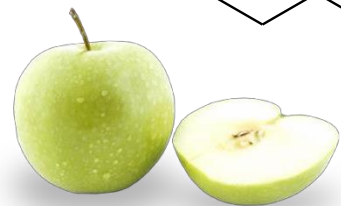
- Higher need by newborns, people with liver diseases, or fat malabsorption
- It absorbed incorporated into chylomicrones which transport from intestine to blood to liver and can be transported to extrahepatic tissue by VLDL.
- It can be stored by liver tissue and in adipose tissue



Vitamin K₁ (phylloquinone)



Vitamin K₂ (menaquinone)



Vitamin K

- Vitamin K has a role in blood coagulation
- It has a role in bone formation
- It can be stored by liver tissue and in adipose tissue
- Severe deficiency of vitamin K is associated with bleeding and haemorrhage
- Vit K3 is toxic upon the high dose and cause haemolytic anaemia and jaundice in infants



Daily values:

Vitamin:		Daily values [mg]:
A (retinol)		1-3
B1 (thiamine)		30 - 200
B2 (riboflavin)		25 - 200
B3 (niacin, niacinamid)		30 - 100
B5 (Pantothenic acid)		20 - 500
B6 (pyridoxine)		10 - 15
B12 (Cynocobalamine)		5 - 8
H (Biotin)		300 - 5000
C (Ascorbic acid)		2 - 12 g
D (cholecalciferol)		10
E (tokoferol)		400 - 2000
K		80





Thank You

