Topic | VITAMINS

A vitamin is an organic compound and a vital nutrient that an organism requires in limited amounts. They cannot be made by the body, so must be present in the diet. An organic chemical compound is called a vitamin. They are classified into two types i.e. fat soluble and water soluble. Water soluble vitamins are vitamins soluble in water. They include Bcomplex and C.B complex include $B_{1,}$ B2,$B_{3,}$ B4, B5, B6, $B_{7,}$ $B_{9,}$ $B_{12.}$ Fat soluble vitamins are vitamins soluble in fat. They include A, D, E, Kand F.

DIFFERENT BETWEEN FAT SOLUBLE AND WATER SOLUBLE.

CHARACTERISTIC	**FAT SOLUBLE**	**WATER SOLUBLE**
Solubility in fats	Soluble	Insoluble
Water solubility	Insoluble	Soluble
Absorption	Along with lipids	Direct into blood streams
Excretion	Not excreted	Excreted
Storage	Stored in liver	No appreciable storage
Deficiency	Manifests only when stores are depleted.	Manifests rapidly as there is no storage.
Treatment of deficiency	Single large doses may prevent deficiency	Regular dietary supply is required.
Toxicity	Hyper vitaminosis may result.	Unlikely
Stability	Stable	Not stable.

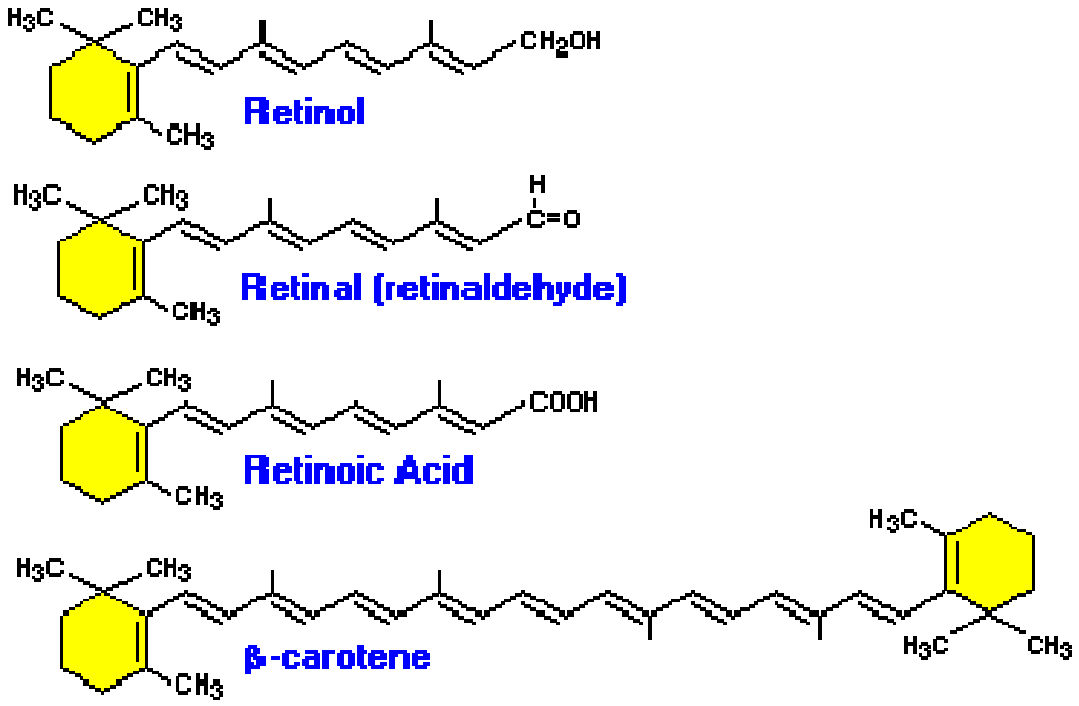
FAT SOLUBLE VITAMINS

Vitamin A

- Vitamin A is a fat-soluble vitamin that is naturally present in many foods. Vitamin A is important for normal vision, the immune system, and reproduction. Vitamin A also helps the heart, lungs, kidneys, and other organs work properly.
- There are two different types of vitamin A. The first type, preformed vitamin A (retinol, retinoic acid and retinal) , is found in meat, poultry, fish, and dairy products. The second type, is the provitamin A (Beta carotene) which is found in fruits, vegetables, and other plant-based products.
- In other words, it is a group of unsaturated nutritional organic compounds that includes retinol, retinal, retinoic acid, and several provitamin A carotenoids (most notably beta-carotene).
- Vitamin A has multiple functions: it is important for growth and development, for the maintenance of the immune system, and for good vision. Vitamin A is needed by the retina of the eye in the form of retinal, which combines with protein opsin to form rhodopsin, the light-absorbing molecule necessary for both low-light (scotopic vision) and color vision. Vitamin A also functions in a very different role as retinoic acid (an irreversibly oxidized form of retinol), which is an important hormone-like growth factor for epithelial and other cells.
- In foods of animal origin, the major form of vitamin A is an ester, primarily retinyl palmitate, which is converted to retinol (chemically an alcohol) in the small intestine. The retinol form functions as storage form of the vitamin, and can be converted to and from its visually active aldehyde form, retinal.
- Vitamin A is in three forms namely retinol, retinal, and retinoic acid. It is a fat soluble vitamin. It is most found in animal food sources and many plants are also rich in it as a precursor or a provitamin. Vitamin A is a colorless substance soluble in fat but stable in water. The most common form being beta-carotene. One of the vitamin is lost in cooking water, affected by heat and alkaline. The vitamin however is unstable to oxidation.

Structure of vitamin A

Vitamin A or **retinol** has a structure depicted to the right. 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. Vitamin A does not occur in plants, but many plants contain **carotenoids such as beta-carotene** that can be converted to vitamin A within the intestine and other tissues.



Vitamin A exists in three forms; retinol, retinal and retinoic acid

Retinol

One of the main forms of vitamin A in the body is retinol. Retinol works to keep the skin and mucous membranes -- the thin tissue that lines the nose and mouth -- strong and healthy, helping

the system stay free of pathogens. It also plays a role in healthy vision, and proves important for expectant mothers because it's central to healthy fetal development. The body can obtain retinol directly from some animal-based foods, and you can convert beta-carotene -- the type of vitamin A found in fruits and vegetables -- into retinol for use in your body.

Retinal

Retinal plays an important role in your visual system. Specialized cells found in the retinas, called cone cells, convert retinol to retinal to transmit visual information to your brain. The cone cells use retinal to make rhodopsin, a compound that allows them to detect even small amounts of light. When cone cells get exposed to light, the retinal gets released from rhodopsin and triggers a nerve impulse that sends visual information to the brain. Without sufficient retinal, the eyes would not be able to detect light properly. As a result, people with vitamin A deficiency suffer from poor vision, especially at night.

Retinoic Acid

Retinoic acid also plays a key role in health. It binds to a protein, called the retinoic acid receptor, that affects the activity of genes within the cells. Retinoic acid helps the cells grow and mature, so that they can contribute to tissue function. It nourishes the immune system by guiding the development of white blood cells -- the cells that seek out and engulf infectious agents to prevent and fight disease. Retinoic acid also plays an essential role in fetal growth, and helps guide the development of the limbs, eyes heart and ears.

PROPERTIES

- Vitamin A is thermally stable in oxygen –free environment.
- Can de oxidized.
- Can with stand the heat of $60,100^{0}$CBut at the air at higher temperatures it decomposes rapidly especially under acidic conditions
- Sun light also promotes vitamin A decomposition.

Sources of Vitamin A

Vitamin A is present in many animal tissues, and is readily absorbed from such dietary sources in the terminal small intestine. Liver is clearly the richest dietary source of vitamin A.

Plants do not contain vitamin A, but many dark-green or dark-yellow plants (including the famous carrot) contain carotenoids such as beta-carotene that serve as provitamins because they are converted within the intestinal mucosa to retinol during absorption.

Vitamin A is stored in the liver, predominantly within stellate cells, as retinyl esters and, when needed, exported into blood, where it is carried by retinol binding protein for delivery to other tissues.

FUNCTIONS.

Vitamin A (retinol) and its metabolites retinal and retinoic acid appear to serve a number of critical roles in physiology. Some of the functions include;

- **Vision:** Vitamin A is required for the maintenance of normal vision. A deficiency in vitamin A can lead to visual disturbances. In the eyes, a form of vitamin A called retinal is combined with a protein called opsin to give rhodopsin, an essential light absorbing molecule needed for color vision and seeing in dim light.
- **Resistance to infectious disease:** It also protects the body against infections by keeping health the skin and tissues in the mouth, stomach and intestines. In almost every infectious disease studied, vitamin A deficiency has been shown to increase the frequency and severity of disease. Several large trials with malnourished children have demonstrated dramatic reductions in mortality from diseases such as measles by the simple and inexpensive procedure of providing vitamin A supplementation. This "anti-infective" effect is undoubtedly complex, but is due, in part, to the necessity for vitamin A in normal immune responses. Additionally, many infections are associated with inflammatory reactions that lead to reduced synthesis of retinol-binding protein and thus, reduced circulating levels of retinol.

- **Epithelial cell "integrity":** Many epithelial cells appear to require vitamin A for proper differentiation and maintenance. 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.
- **Immunity**; It assists the immune system and because of its antioxidant properties protects against pollution and cancer formation and other diseases.Vitamin A is essential for maintaining healthy immune function and deficiency can lead to an impaired response to **infection.**
- **Growth:** One form of Vitamin A, retinoic acid is, a key hormone-like growth factor for epithelial cells and other cell types in the body.
- **Gene transcription and protein formation**: Vitamin A in the form of retinoic acid is essential for gene transcription. Retinol is taken up by the cell where it is oxidized to retinaldehyde (by retinol dehydrogenases), which is then oxidized to give retinoic acid. The conversion of retinal to retinoic acid is irreversible and the process is therefore tightly regulated because retinoic acid functions as a ligand for nuclear receptors. Retinoic acid binds to these nuclear receptors called in order to regulate gene transcription.
- **Skin health;** Retinoic acid also maintains skin health by activating genes that cause immature skin cells to develop into mature epidermal cells. The exact mechanism behind this is currently being researched to help develop treatments for dermatolgical diseases. Currently, the retinoic drug isotretinoin is the most commonly prescribed agent in the treatment of acne. This drug decreases the size of sebaceous glands and reduces their secretions. The agent also reduces the amount of bacteria present in the ducts and surface of the skin, which occurs as a result of reduced sebum, which bacteria rely on as a source of nutrients.

DIGESTION AND ABSORPATION

- Mechanisms involved in the digestion and absorption of dietary vitamin a require the participation of several proteins.
- Dietary retinal esters are hydrolyzed in the intestine by the pancreatic enzyme, pancreatictriglyceride lipase and intestine brush boundary enzymes, phospholipid B.an esterified retinal taken up by the enterocyte sites is complexed with cellular retinal binding protein type 2 and a complex substrate for re esterification of the retinal by enzyme lecithin. Retinal are acyltransferase(LRAT).The retinal esters are then in cooperated into chylomicrons,instentional lipoproteins containing other dietary lipids such as triglyeride,phospholipid and free esterified cholesterol and a polypolipro protein.
- Chylomicrons containing newly absorbed retinyl esters and then secreted into the lymph. Althoughunder normal dietary conditions much of the dietary vitamin a is absorbed via the chylomicrons or lympathetic route, it is also clear that under some circustamances there is substantialadsorption of an esterified retinal via the portal route.

EXCESSIVE INTAKE VITAMIN A

This is due to vitamin A thus it becomes toxic to the body especially the cells.It manifests by Joint pain, thicken of long bones, and loss of hair.

Symptoms

- Headache
- Nausea
- Diarrhea

NB: Vitamin A excess states, while not as common as deficiency, also lead to disease. Vitamin A and most retinoids are highly toxic when taken in large amounts, and the most common cause of this disorder in both man and animals is excessive supplementation. In contrast, excessive intake of carotinoids are not reported to cause disease - *you cannot use the excuse of potential vitamin A toxicity to avoid eating carrots or green vegetables!*

- Both hypovitaminosis A and hypervitaminosis A are known to cause congenital defects in animals and likely to have deleterious effects in humans. Pregnant women are advised

not to take excessive vitamin A supplements, and some medical authorities also recommend that they consume liver only in moderation, which is usually not a hard sell to make

DEFICIENCY

Primary vitamin A deficiency is usually caused by prolonged dietary deprivation. It is endemic in areas such as southern and eastern Asia, where rice, devoid of beta-carotene, is the staple food. Xerophthalmia due to primary deficiency is a common cause of blindness among young children in developing countries.

Secondary vitamin A deficiency may be due to decreased bioavailability of provitamin A carotenoids and interference with absorption, storage, or transport of vitamin A

Vitamin A deficiency symptoms will show up only after liver reserves have been depleted. They may result from low dietary intake, interference with absorption and storage interference with conversion of carotene to vitamin A or rapid loss of vitamin A.

Effects of deficiency

- Night blindness; In low intake the liver reverses drop followed a drop in blood levels and a drop in the amount available in retinal of the human eyes which shows up in the adaption and finally night blindness.
- **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 (xeropthalmia).
- **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.

- Xerophthalmia: dry, thickened conjunctiva and cornea
- Bitot spots: keratinized growths (metaplasia) on the conjunctivae causing hazy vision
- Keratomalacia: corneal erosions and ulceration

Vitamin A deficiency can also be recognised by its keratinising effect on the skin and mucous membranes.

- Dry, scaly, thickened skin with prominent follicular scale
- Dry lips and thickened tongue
- Keratinisation of the urinary, gastrointestinal and respiratory tracts

Other symptoms and signs

- Impaired immunity leading to gastrointestinal and respiratory tract infections
- Growth retardation in children

NB: Vitamin A deficiency can result from inadequate intake, fat malabsorption, or liver disorders. Deficiency impairs immunity and hematopoiesis and causes rashes and typical ocular effects (eg, xerophthalmia, night blindness). Diagnosis is based on typical ocular findings and low vitamin A levels. Treatment consists of vitamin A given orally or, if symptoms are severe or malabsorption is the cause, parenterally.

Vitamin A deficiency can also occur in adults with diseases of the gastrointestinal system that interfere with absorption of vitamin A. These include:

- Celiac disease
- Cirrhosis of the liver

- Pancreatic insufficiency
- Bile duct disorder
- Giardiasis
- Duodenal bypass

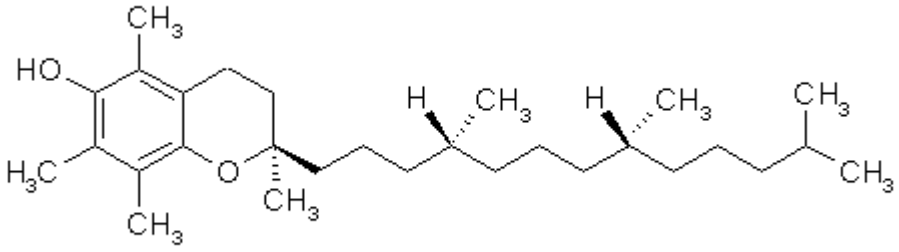
VITAMIN E (TOCOPHEROLS)

Vitamin E refers to a group of compounds that include both tocopherols and tocotrienols. Y-tocopherol is the most common found in corn oil, soybean oil.alpha-tocopherol is the most biologically active form, is the second common of the vitamin.E in the diet. Others are the delta and beta.

Vitamin E is a principle membrane associated anti-oxidant molecule in mammals. It plays a major role in preventing oxidation of cells especially the red blood cells by eliminating free radicals.

Mechanistically, when vitamin E absorbs a free radical it is converted to a radical its self. The resulting tocopherol radical is then reduced back to tocopherol by glutathione, vitamin c or other molecules.

Chemical structure



SOURCES; sunflower seeds,almonds,hazelnuts,wheat germ,mango,avocado,butter nut squash,broccoli,spinach,kiwi,tomato.

FUNCTIONS OF VITAMIN E.

- Provide some relief for menstrual pain, pre-menstructual syndrome, menopausal symptoms and muscle andjoint pain .Can reduce menstrual blood loss. It does this by balancing your hormones naturally and it helps to keep your menstrual cycle regulated.
- Thicken hair promotes circulation to the scalp. Oil can retain the nature moisture in your skin. Of invading bacteria
- The body also needs vitamin E to boost its immune system, so that it can fight of invading bacteria and. Viruses.
- It widens blood vessel through removing plague caused by the fat disposed in muscles and hence keeps blood from clotting within them.
- It may slowdown the worsening of memory loss and functional decline in people with moderately severe Alzheimer's disease,
- Vitamin E is essential for cardio vascular health and for sex organ functioning.
- As an antioxidant vitamin E intercepts free radicals and prevent cell damage it particularly protects red blood cells.
- Vitamin E also assist in the maintenance of vitamin A and C in the body since they can suffer oxidation.
- It works as a cancer fighting vitamin.
- Essential for final stage of prothrombin synthesis in liver.

DEFICIENCY

Vitamin E deficiency can cause:

- Myopathies
- Peripheral neuropathy
- Red blood cell destruction
- Retinopathy
- Skeletal myopathy
- Impairment of the immune response.

Other Low levels of vitamin E can lead to:

- **Muscle weakness**: Vitamin E is essential to the central nervous system. It is among the body's main antioxidants, and a deficiency results in oxidative stress, which can lead to muscle weakness.
- **Coordination and walking difficulties**: A deficiency can cause certain neurons, called the Purkinje neurons, to break down, harming their ability to transmit signals.
- **Numbness and tingling**: Damage to nerve fibers can prevent the nerves from transmitting signals correctly, resulting in these sensations, which are also called peripheral neuropathy.
- **Vision deterioration**: A vitamin E deficiency can weaken light receptors in the retina and other cells in the eye. This can lead to loss of vision over time.
- **Immune system problems**: Some research suggests that a lack of vitamin E can inhibit the immune cells. Older adults may be particularly at risk.
- Muscle weakness and difficulties with coordination are neurological symptoms that indicate damage to the central and peripheral nervous systems.
- The peripheral system is the network of nerves located beyond the brain and spinal cord. These neurons pass messages throughout the body.

Causes of vitamin E deficiency

Genetics

Vitamin E deficiency often runs in families.

Learning about family history can make diagnosing certain rare, inherited diseases easier. Two of these diseases, congenital abetalipoproteinemia and familial isolated vitamin E deficiency, are chronic and result in extremely low vitamin E levels.

Medical conditions

Vitamin E deficiency can also result from diseases that severely reduce the absorption of fat. This is because the body requires fat to absorb vitamin E correctly.

Some of these diseases include:

- chronic pancreatiti
- celiac disease
- cholestatic liver disease
- cystic fibrosis.

Deficiency is also common in newborns and babies born prematurely who have lower birth weights and less fat.

Premature infants are at particular risk because an immature digestive tract can interfere with fat and vitamin E absorption.

Vitamin E deficiencies in these infants can also lead to hemolytic anemia, which destroys red blood cells.

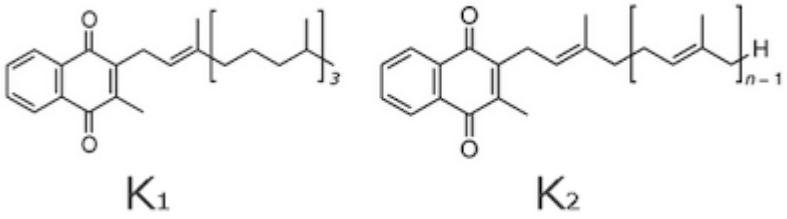
VITAMIN K (PHYLLOQUINONE)

The vitamin was discovered by a Danish scientists called Dr.Herrik Dan in 1929.Only two forms of the vitamin K occur naturally namely phylloquionone and vitamin K_3.phylloquinone forms in animals and manufactured by bacterial metabolism within the animal. Vitamin K is a necessary participant is synthesis of several proteins that mediate both coagulation and anticoagulation.

Vitamin K is actually a group of compounds. The most important of these compounds appears to be vitamin K1 and vitamin K2. Vitamin K1 is obtained from leafy greens and some other vegetables. Vitamin K2 is a group of compounds largely obtained from meats, cheeses, and eggs, and synthesized by bacteria.

Vitamin K1 is the main form of vitamin K supplement available

Chemical structure.



K_1 K_2

Properties

- Yellowish crystals.
- It's resistant to heat, air, moisture.
- It is destroyed by strong alkalis, acids and light

FUNCTIONS OF VITAMIN K

Vitamin K has only one major function in the body that is, it acts as an essential factor for blood clotting in the body. The blood clotting (coagulation) process is a complex series of reaction which involves the formation of the following;

- Proconversion protein conversion.
- Plasma thromboplasm component.
- Stuant factor
- Prothrombin

These are synthesized by the liver in the inactive forms .They can be activated by the conversion of glutamic acid residues to carboxyl glutamic acid in order to become biologically active. Prothrombin for example has 10 glutamic acids in the amino terminal region of the protein which are carboxylated.Without vitamin K, the carboxylation does not occur and the proteins that are synthesized are biologically inactive. It takes place in an oxidation reaction in which the SH group in fibrinogen is oxidized to the S.Sgroup to form the clot fibrin. As seen above, the body needs both types of vitamin K to produce prothrombin, a protein that plays crucial roles in blood

clotting, bone metabolism, and heart health. Vitamin K also helps facilitate energy production in the mitochondria of cells.

2. Vitamin K has antioxidant properties. It protects cellular membranes from damage due to excess free radicals, in a process known as peroxidation. Blood thinning medication, such as warfarin, can lower the antioxidative potential of vitamin K.

3. Heart health

Vitamin K-2 may lower the risk of cardiovascular damage and improve overall heart health.

According to a 2015 review article, K-2 activates a protein that prevents calcium deposits from forming in the walls of blood vessels. The author cited findings suggesting that a diet high in natural vitamin K2 may decrease the risk of coronary heart disease.

4. Bone health

Vitamin K-2 promotes healthy bone mineral density by carboxylating osteocalcin, a protein that binds calcium to bones.

5. Anxiety and depression

High blood glucose levels may increase a person's risk of developing depression, anxiety, and cognitive impairment. Vitamin K has only one major function in the body that is, it acts as an essential factor for blood clotting in the body. The blood clotting (coagulation) process is a complex series of reaction which involves the formation of the following;

- Proconversion protein conversion.
- Plasma thromboplasm component.
- Stuant factor
- Prothrombin

These are synthesized by the liver in the inactive forms .They can be activated by the conversion of glutamic acid residues to carboxyl glutamic acid in order to become biologically active.

Prothrombin for example has 10 glutamic acids in the amino terminal region of the protein which are carboxylated.Without vitamin K, the carboxylation does not occur and the proteins that are synthesized are biologically inactive. It takes place in an oxidation reaction in which the SH group in fibrinogen is oxidized to the S.Sgroup to form the clot fibrin.Vitamin K-2 can reduce high blood glucose levels and symptoms of anxiety, depression, and memory deficit.

6. Cancer

Vitamin K-2 has antioxidant properties that can help protect against cancer. In addition, findings suggest that K-2 may suppress genetic processes that lead to tumor growth. A 2019 study suggests that K-2 significantly reduces the activity of cancer cells.

DEFICIENCY

It is rare because the vitamin is synthesized in the body in thebody. It is common in new born babies because they lack the mechanisms of synthesizing the vitamins. However to avoid hemorrhagic diseases, as injection of 1 milligram of vitamin k is given.

Other causes include; sulfa-drugs and antibiotics.

Low levels of vitamin K can raise the risk of uncontrolled bleeding. While vitamin K deficiencies are rare in adults, they are very common in newborn infants. A single injection of vitamin K for newborns is standard. Vitamin K is also used to counteract an overdose of the blood thinner Coumadin.

While vitamin K deficiencies are uncommon, you may be at higher risk if you:

- Have a disease that affects absorption in the digestive tract, such as Crohn's disease or active celiac disease
- Take drugs that interfere with vitamin K absorption
- Are severely malnourished
- Drink alcohol heavily

Sources

Bacteria in the gastrointestinal tract naturally make vitamin K. Dietary sources of vitamin K include green leafy vegetables — collards, green leaf lettuce, kale, mustard greens, parsley, romaine lettuce, spinach, Swiss chard and turnip greens — as well as vegetables such as broccoli, Brussels sprouts, cauliflower and cabbage. Other sources that are less rich in vitamin K include meats, fish, liver, eggs and cereals.

Dietary sources of vitamin K-1 include:

- dark leafy green vegetables, such as spinach, kale, and collards
- lettuce
- turnips
- broccoli
- carrots
- vegetable oils
- blueberries
- grapes

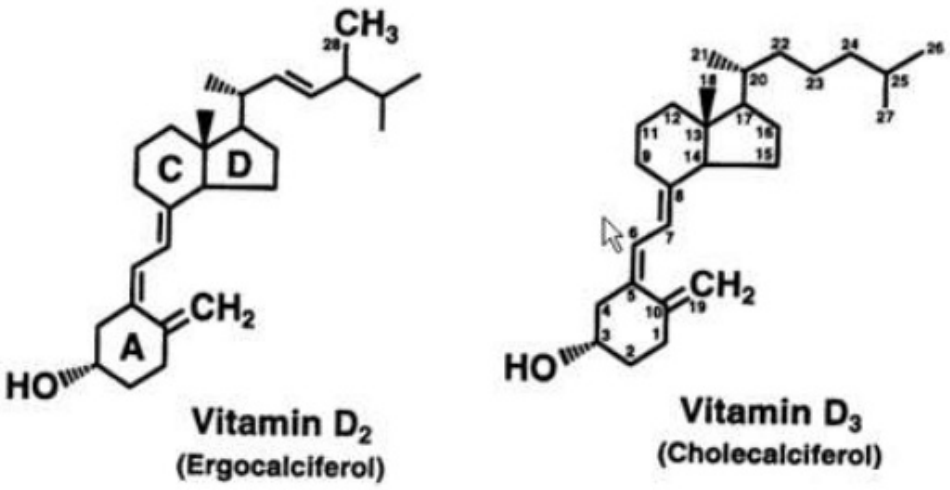
Dietary sources of vitamin K-2 include:

- natto, a traditional Japanese dish of fermented soybeans
- sauerkraut
- dairy products, especially hard cheeses
- liver and other organ meats
- beef
- pork
- egg yolks
- chicken
- fatty fish, such as salmon

VITAMIN D

Bio active Vitamin D is a steroid hormone that has long been known for its important role in regulating body level of calcium and phosphorous and in mineralization of bone.More recently, it has become clear that receptors for vitamin D are present in a wide variety of cells and that this hormone has biologic effects which extend far beyond control of mineral metabolism. Other forms include: D1, D2 (ergocalciferol) D3 (cholecalciferol). D4 (22-dihydroerogocalciferol) D5 (sitocalciferol)

Structure



Exposure to sunlight converts 7-dehydrocholestrol in animal skins to cholecalciferol and ergo sterol contained in plant for example yeast to ergocalciferol Vitamin D is essential for all animals with a bone skeleton since it facilitates absorption and utilization of calcium and phosphorous for normal bone formation.

SOURCES; one of the most available sources are the sunlight rays.

FUNCTIONS OF VITAMIN D

- It increases absorption of dietary calcium and phosphorus from the small intestines
- It plays a role in building strong bones and teeth by mineralization. Vitamin D works hand in hand with phosphorus and calcium and is very important in the diet of expectant mothers and early childhood as it helps in strengthening and proper formation of bones and milk production.
- Vitamin D stimulates the release of reserve calcium from the bones into the blood where the calcium ions play a role in blood clotting
- Vitamin D prevents dental carries (decay)
- It initiates the synthesis of calcium binding proteins which also increase the absorption of the vitamin and carry it to the site where needed

METABOLISM OF THE VITAMIN D

The vitamin performs its function after it has been activated. This occurs when the vitamin is hydroxylated (addition of hydroxyl ions). Cholecalciferol is converted to hydroxycholecalciferol (HCC) by specific enzymes.

HCC is transported to the kidney by a specific transport protein where the HCC is converted to dihydroxycholecalciferol(DHCC).

DHCC is very active in depositing calcium ions (mineralises the bones and teeth which results in skeleton development and growth)

NOTE; parathyroid hormone produced from the parathyroid gland regulates the metabolism of vitamin D. When blood levels of calcium decrease, the parathyroid hormone stimulates hydroxylases to convert HCC to DHCC which increases absorption of calcium

Cholecaliceferol is produced under the skin and it is converted to hydroxycholecalciferol (HCC) by specific enzymes in the liver. HCCis **then transported to the kidney where it is** is converted to dihydroxycholecalciferol(DHCC) the active form of vitamin D. in this form it is transported in the blood stream to the target tissue. This is the reason why vitamin D is known as an enzyme.

Toxicity of Vitamin D

Excessive intake of vitamin D leads to a condition known hyper vitaminous D.occurs mostly when normal intake is topped up with vitamin D supplements.

Signs

- Hypercalcemia(high levels of calcium in blood)
- Nausea
- Loss of appetite.
- Loss of weight.
- Dental carries occur

DEFICIENCY

1. **Rickets**

Rickets, a child hooddisease, is characterized by impeded growth and soft, weak, deformed long bones that bend and bow under their weight as children start to walk.

2. **Osteomalacia**

- Osteomalacia is a disease in adults from vitamin D deficiency. Characteristics of the disease are softening of the bones ,
- lending to bending to the spine
- ,pains in the leg bones

In direct causes of deficiency;

- Endocrine disorder
- Kidney and liver diseases
- Medical drugs.

FAT SOLUBLE VITAMINS SUMMARY

Fat-soluble			
Vitamin	Scientific name	Function	Deficiency
vitamin A	retinol, retinal, retinoic acid, beta-carotene (plant version)	normal vision, integrity of epithelial cells (mucous membranes and skin), reproduction, embryonic development, growth, immune response	ocular disturbances leading to blindness, growth retardation, dry skin, diarrhea, vulnerability to infection
vitamin D	calciferol, calatriol (1,25-dihydroxy vitamin D_1 or vitamin D hormone), cholecalciferol (D_3; plant version), ergocalciferol (D_2; animal version)	maintenance of blood calcium and phosphorus levels, proper mineralization of bones	defective bone growth in children, soft bones in adults
vitamin E	alpha-tocopherol, tocopherol, tocotrienol	antioxidant; interruption of free radical chain reactions; protection of polyunsaturated fatty acids, cell membranes	peripheral neuropathy, breakdown of red blood cells
vitamin K	phylloquinone, menaquinone, menadione, naphthoquinone	synthesis of proteins involved in blood coagulation and bone metabolism	impaired clotting of the blood and internal bleeding

VITAMIN A

WATER SOLUBLE VITAMINS

WATER SOLUBLE VITAMINS summary

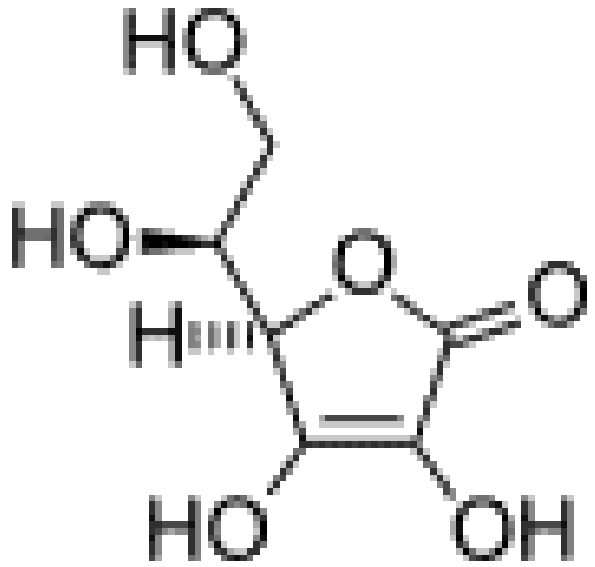
vitamin	alternative names/forms	biological function	symptoms of deficiency
Water-soluble			

vitamin	alternative names/forms	biological function	symptoms of deficiency
Water-soluble			
thiamin	vitamin B_1	component of a coenzyme in carbohydrate metabolism; supports normal nerve function	impairment of the nerves and heart muscle wasting
riboflavin	vitamin B_2	component of coenzymes required for energy production and lipid, vitamin, mineral, and drug metabolism; antioxidant	inflammation of the skin, tongue, and lips; ocular disturbances; nervous symptoms
niacin	nicotinic acid, nicotinamide	component of coenzymes used broadly in cellular metabolism, oxidation of fuel molecules, and fatty acid and steroid synthesis	skin lesions, gastrointestinal disturbances, nervous symptoms
vitamin B_6	pyridoxine, pyridoxal, pyridoxamine	component of coenzymes in metabolism of amino acids and other nitrogen-containing compounds; synthesis of hemoglobin, neurotransmitters; regulation of blood glucose levels	dermatitis, mental depression, confusion, convulsions, anemia
folic acid	folate, folacin, pteroylglutamic acid	component of coenzymes in DNA synthesis, metabolism of amino acids; required for cell division, maturation of red blood cells	impaired formation of red blood cells, weakness, irritability, headache, palpitations, inflammation of mouth, neural tube defects in fetus
vitamin B_{12}	cobalamin, cyanocobalamin	cofactor for enzymes in metabolism of amino acids (including folic acid) and fatty	smoothness of the tongue, gastrointestinal disturbances, nervous symptoms

vitamin	alternative names/forms	biological function	symptoms of deficiency
Water-soluble			
		acids; required for new cell synthesis, normal blood formation, and neurological function	
pantothenic acid		as component of coenzyme A, essential for metabolism of carbohydrate, protein, and fat; cofactor for elongation of fatty acids	weakness, gastrointestinal disturbances, nervous symptoms, fatigue, sleep disturbances, restlessness, nausea
biotin		cofactor in carbohydrate, fatty acid, and amino acid metabolism	dermatitis, hair loss, conjunctivitis, neurological symptoms
vitamin C	ascorbic acid	antioxidant; synthesis of collagen, carnitine, amino acids, and hormones; immune function; enhances absorption of non-heme iron (from plant foods)	swollen and bleeding gums, soreness and stiffness of the joints and lower extremities, bleeding under the skin and in deep tissues, slow wound healing, anemia

VITAMIN C

Vitamin C, also called **ascorbic acid**, water-soluble, carbohydrate-like substance that is involved in certain metabolic processes of animals. Ascorbic acid is an organic compound with formula $C_6H_8O_6$, originally called hexuronic acid. It is a white solid, but impure samples can appear yellowish. It dissolves well in water to give mildly acidic solutions. It is a mild reducing agent. Although most animals can synthesize vitamin C, it is necessary in the diet of some, including humans and other primates, in order to prevent scurvy, a disease characterized by soreness and stiffness of the joints and lower extremities, rigidity, swollen and bloody gums, and hemorrhages in the tissues of the body. First isolated in 1928, vitamin C was identified as the curative agent for scurvy in 1932



Properties

- It is water soluble
- Stable when dry for instance the vitamin c tablets
- It is the least stable vitamin in water
- It is easily destroyed (oxidized) in light ,air, heat and in alkaline solutions
- It is easily oxidized in presence of copper and iron- That is why copper saucepans are not good for cooking vegetables because copper catalyzes the destruction of vitamin c

The above factors affect activities during the preparation and storage of foods containing vitamin c

Food sources

Fruits in particular, citrus fruits, black currents, tomatoes, water melon, then vegetables like cabbages, lettuce.

NB; vitamin C is easily oxidized (destroyed) in light air and heat. Destruction is catalyzed by presence of copper and iron.

Use very sharp knife to cut or peel the vegetable as blunt knife bruise the vegetable and expose and oxidized that catalyzed destruction of vitamin c.

1. Cook veg immediately after cutting because long exposure causes greater loss of vitamin c.
2. Do not use baking soda because it destroys vitamin c although it retains the good color of vegetables.

3. Use minimum amount of boiling water. put the vegetables after the water has boiled because;

I. Exposed. Oxidases are destroyed immediately.

II. Boiling expels air which may cause oxidation.

4. Cover the vegetables they are cooking and avoid over cooking
5. Use the cooking liquid as soup/ sauces.
6. Prepare the vegetable/fruits just before serving.
7. Use very fresh vegetables/ fruits straight from the garden
8. Do not soak vegetables
9. Wash under running water in a coriander and cut vegetables after washing.

Absorption

- It is easily absorbed into the mucosal cells in the small intestines
- It is transported to the liver via the hepatic portal vein and distributed to tissues throughout the body.
- Body stores to total of about 1500mg
- Moderate reserves found in liver and spleen.
- High but small concentration are formed in the adrenal gland
- Serum and tissue concentration appears to be on equilibrium
- Body stores of vitamin c are limited.
- It is excreted through the kidney as ascorbic acid and oxalic acid.
    - Excretion is increased by the following;
    - Adrenal steroids
    - Salicylates
    - Sulfonamides
    - Tetracycline
    - Smoking reduces serum levels

Functions in the body.

- It is required for healthy tissues, the skin., the gums, Bones and teeth,muscle tissues, Tendons, Cornea, etc.

- **As reducing and capping agent**

  Ascorbic acid acts as a reducing and capping agent for the synthesis of metal nanoparticles such as silver, gold, copper, etc. Ascorbic acid molecules can cap or surround the particle and prevent the uncontrolled growth of the particles to micron-sized dimensions.

- **Antioxidant activity**

  One of the important properties of vitamin C is its antioxidant activity. Antioxidant activity of vitamin C helps to prevent certain diseases such as cancer, cardiovascular diseases, common cold, age-related muscular degeneration and cataract.

- **In cancer treatment**

  Since 1970, it has been known that high dose of vitamin C has beneficial effects on the survival time in patients with terminal cancer, which was reported by Cameron, Campbell, and Pauling. Research is undergoing in detail for using vitamin C in cancer treatment. One of the studies suggests that pharmacologic doses of vitamin C might show promising effects on the treatment of tumours. Vitamin C can act as pro-oxidant and it can generate hydrogen peroxide. Administration of high dose of vitamin C gives long survival times for patients with advanced cancers.

- **In cardiovascular diseases**

  The antioxidant property of vitamin C helps for the treatment of cardiovascular diseases. Vitamin C has the capability for reducing monocyte adherence to the endothelium, improving endothelium-dependent nitric oxide production and vasodilation and reducing

vascular smooth-muscle-cell apoptosis, which prevents plaque instability in atherosclerosis.

- **In common cold**

  Vitamin C can be used for the treatment of common cold. There are so many reports in Cochrane Database Syst. Review showing the use of prophylactic vitamin C reduces the cold duration in adults and children. The use of vitamin C might reduce the duration of common cold due to its anti-histamine effect of high dose of vitamin C.

- **In age-related macular degeneration (AMD) and cataract**

  Age-related macular degeneration (AMD) and cataracts are two of the main causes of vision loss in older. Oxidative stress might contribute to the aetiology of both conditions. There are many reports to study the role of vitamin C in AMD and cataract treatment and prevention.

- **Antioxidant**

  Vitamins C can protect the body against the destructive effects of free radicals. Antioxidants neutralize free radicals by donating one of their own electrons, ending the electron-stealing reaction. The antioxidant nutrients themselves do not become free radicals by donating an electron because they are stable in either form or act as scavengers, helping to prevent cell and tissue damage that could lead to cellular damage and disease.

- Ascorbic acid reacts with free radicals undergoing single-electron oxidation to produce a relatively poor reactive intermediate, the ascorbyl radical, which disproportionates to ascorbate and dehydroascorbate. Thus, ascorbic acid can reduce toxic, reactive oxygen species superoxide anion ($O_2^{\bullet}$) and hydroxyl radical ($OH^{\bullet}$), as well as organic (RO_2) and nitrogen ($NO_2^{\bullet}$) oxy radicals.

- Vitamin C also has role in protecting other vitamins (vitamin A and vitamin E) from the harmful effects of oxidation. Vitamin C helps in protecting gums and retards ageing. It strengthens the general physical condition by removing toxic metals from the body. Vitamin C reduces the formation of cataract and hence useful in the treatment of glaucoma.

- **Synthesis of protein**

  Another important function of vitamin C is its role in the synthesis of protein. Vitamin C helps in the synthesis of collagen. Collagen protects our skin from wrinkling and makes our skin firm and strong. Collagen also protects and supports organs and other soft tissues.

- ***Photoprotection***

  Vitamin C reduces the damage caused by UV-light exposure. It cannot act as a sunscreen since it cannot absorb UV light. But the antioxidant activity of vitamin C helps to protect UV damage caused by free radicals.

- ***Wound healing***

  Vitamin C plays a key role in healing wound by the formation of collagen, connective tissue. The new tissue is rebuilt with the help of collagen framework. This function is supported by its co-factor vitamin C. Besides this, vitamin C performs as a strong antioxidant and immune system modulator

Note:

- Vitamin C is essential for the synthesis of collagen, a protein important in the formation of connective tissue and in wound healing.

- It acts as an antioxidant, protecting against damage by reactive molecules called free radicals.

- The vitamin also helps in stimulating the immune system. It has been shown in animal trials that vitamin C has some anticarcinogenic activity.

- It is required in the transportation of proline and lysine into hydroxyl protein and hydroxyl sine respectively.

- The hydroxylated amino acids provide the tertiary structures which gives stability to the collagen molecule. This explains the major symptom of scurry (spongy and bleeding gums) which results in the breakdown of connective tissue
  It is required for quick healing of wounds and fractures (it is required for formation of collagen)

  It assists the absorption of iron (non haem iron) from the small intestines

- It helps to reduce high blood pressure in hypertensive patients; large amounts of blood lowers cholesterol levels reducing risk of arteriosclerosis and high blood pressure.
- Vitamin C, also known as ascorbic acid, is necessary for the growth, development and repair of all **body** tissues

Summary

Vitamin C plays a pivotal role in body-building process and in disease prevention. The various functions of vitamin C, including the antioxidant activity, formation of protein, tendons, ligaments and blood vessels, for healing wounds and form scar tissue, for repairing and maintaining cartilage, bone, and teeth, and aiding in the absorption of iron, were discussed. This chapter will definitely benefit the students, researchers and technologists globally.

Effects of deficiency:

- Results in the poor or delayed healing of wound and fractures
- Growth in children is retarded
- Anemia because of incomplete absorption of iron from small intestine
- Immunity to infections is lowered
- Dry scaly skin
- Severe deficiency causes scurry (a disease of the gum, teeth and skin)

Symptoms of deficiency;

- Lassitude and general weakness
- Swollen joints
- Aching bones
- Dry scaly skin
- Retard growth in children
- Susceptibility to diseases
- Anemia
- Bad breath and dental carries
- Spongy and bloody gums (this is when deficiency is severe –scurry)

Other symptoms can include:

- Dry skin.
- Splitting hair.
- Swelling and discoloration of your gums.
- Sudden and unexpected bleeding from your gums.
- Nosebleeds.
- Poor healing of wounds.
- Problems fighting infections.
- Bleeding into joints, causing severe joint pains.

Scurvy

Scurvy is a disease resulting from a lack of vitamin C (ascorbic acid). Early symptoms of deficiency include weakness, feeling tired and sore arms and legs. Without treatment, decreased red blood cells, gum disease, changes to hair, and bleeding from the skin may occur. **Scurvy** happens when there is a lack of vitamin C, or ascorbic acid. The deficiency leads to symptoms of weakness, anemia, gum disease, and skin problems. This is because vitamin C is needed for making collagen, an important component in connective tissues

Scurvy happens when there is a lack of vitamin C, or ascorbic acid. The deficiency leads to symptoms of weakness, anemia, gum disease, and skin problems.

This is because vitamin C is needed for making collagen, an important component in connective tissues. Connective tissues are essential for structure and support in the body, including the structure of blood vessels.

A lack of vitamin C will also affect the immune system, absorption of iron, metabolism of cholesterol and other functions.

Symptoms

One of the more notable symptoms of scurvy is the loss of and damage to teeth

Vitamin C is a necessary nutrient that helps the body absorb iron and produce collagen.

If the body does not produce enough collagen, tissues will start to break down.

It is also needed for synthesizing dopamine, norepinephrine, epinephrine, and carnitine, needed for energy production.

Symptoms of vitamin C deficiency can start to appear after 8 to 12 weeks. Early signs include a loss of appetite, weight loss, fatigue, irritability, and lethargy.

Within 1 to 3 months, there may be signs of:

- swollen, spongy and purplish gums that are prone to bleeding.
- loose teeth.
- bulging eyes (proptosis)
- bleeding into the skin (severe and easy bruising)
- scaly, dry and brownish skin.
- very dry hair that curls and breaks off close to the skin.
- anemia
- myalgia, or pain, including bone pain
- swelling, or edema
- petechiae, or small red spots resulting from bleeding under the skin
- corkscrew hairs
- gum disease and loss of teeth
- poor wound healing
- shortness of breath
- mood changes, and depression

In time, the person will show signs of generalized edema, severe jaundice, destruction of red blood cells, known as hemolysis, sudden and spontaneous bleeding, neuropathy, fever, and convulsions. It can be fatal.

Infants with scurvy will become anxious and irritable. They may experience pain that causes them to assume a frog-leg posture for comfort.

There may also be subperiosteal hemorrhage, a type of bleeding that occurs at the ends of the long bones.

Animal studies have shown that vitamin C deficiency in a woman during pregnancy can lead to problems with fetal brain development.

Causes

The main cause is an insufficient intake of vitamin C, or ascorbic acid.

Toxicity:

- Because of its high solubility in water, toxicity is rare.
- Mega dozes can cause kidney stones, gut (painful swellings in joints, fingers knees, toes)
- Large dozes also acidity the urine and cause burning sensations during urinations.

RDA

90Mg per day for adult men

75mg per day for women

Generally not more than 2,000mg per day (2g)

The right RDA is still being debated about