Raja Narendra Lal Khan Women's College(Autonomous)

DEPT. OF MICROBIOLOGY

SEM- 2ND

C3T

UNIT 6 – VITAMINS

Definition

Vitamins are organic chemical compound which are found in minute amounts in natural foodstuffs. They are distinct from fats, carbohydrates and proteins. They are counted as vital nutrient to sustain life as they play important roles in normal metabolic process, growth and vitality. They cannot be synthesised in the body but can be obtained from outside dietary sources or from vitamin supplements. They assist in the formation of hormones, blood vessels, nervous system chemicals and genetic material. Vitamins combine to proteins by acting as catalyst creating metabolically active enzymes catalyzing essential biological reactions. They causes specific defeciency syndrome when absent or underutilized.

VITAMERS: These are different forms of a particular vitamin, eg. Vitamins K1 and K2, Vitamins D2 and D3, retinol and retinal (Vitamin A), etc.

Origin and history

Beriberi: a historic disease prevalent in Asian population due to major consumption of polished rice.

1897, Christiaan Eijkman found antiberiberi factor in water or alcohol extracts of rice polishings.

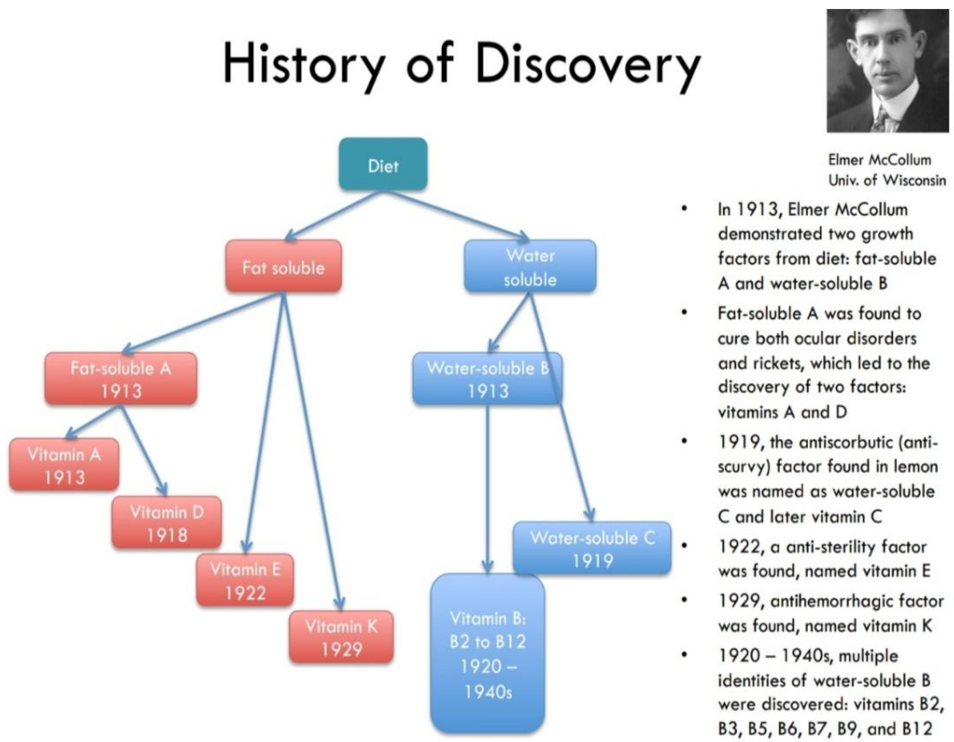
1901, Gerrit Grijns suggested beriberi-producing diets lack a certain substance that are important in central nervous system.

1911, Casimir Funk isolates amine-containing concentrate from rice polishings that cured beriberi in an animal model and names it as “vitamine” for “vital amine”. This was later found to be thiamine, vitamin B1.

1912, Funk published the vitamin theory: antiberiberi, antirickets, antiscurvy, and antipellagra vitamines.

1920, Jack Drummond suggested to drop “e” from “vitamine” since not all of them are proven to be amines.

(See: Rosenfeld, L. (1997). Vitamine-vitamin. The early years of discovery. Clinical Chemistry.



Classification of Vitamins

Based on their ability to be absorbed in fat or water vitamins are classified as

1. Fat soluble vitamins.
2. Water soluble vitamins.

Fat soluble vitamins: These are usually oily and hydrophobic compounds, dissolves in fats. Since fat is easily stored in our body, fat soluble vitamins can be easily stored within our body by accumulating and be saved for later use.They are generally stored in the fatty tissues, adipose, muscles and liver. Since they are stored within the body, it takes time to reach a deficiency state. Over-dosage of fat soluble vitamins may likely to cause toxicity because of slow clearance from the body. Fat soluble vitamin deficiency may be due to mal absorption and is of particular significance in cystic fibrosis. The fat soluble vitamins are A,D,E and K.

Water soluble vitamins: These vitamins are not stored in the body and is therefore required daily in small amount. Because about 70% of our body consists of water these vitamins cam move through our body easily amd can also be flushed out of the body easily. Vitamins B complex and C are classified under water soluble vitamins. Vitamin B complex are a group of vitamins with different characteristics and are numbered as B1, B2, B3, B5, B6, B7, B9and B12.

Fat soluble vitamins:

Vitamin A

Retinol | Carotenoids

Vitamin A plays an important role in our vision, skin, genes, growth, and immune system. It supports developing embryo during the early stages of pregnancy. Infections and fevers increase the requirement for vitamin A. Three different forms of vitamin A are active in the body: retinol, retinal, and retinoic acid. These are known as retinoids.According to the requirement of the body retinal and retinol could be converted to other active forms of vitamin A.Specific forms of vitamin A has specific tasks to perform.

Retinol supports reproduction and is the major transport form of the vitamin. Retinal is active in vision and is also an intermediate in the conversion of retinol to retinoic acid. Retinoic acid acts like a hormone, regulating cell differentiation, growth, and embryonic development. Foods derived from animals provide retinol in a form that is easily digested and absorbed. Foods derived from plants provide carotenoids, some of which have vitamin A activity. The body can convert carotenoids like β-carotene, α-carotene and β-cryptoxanthin into vitamin A. The conversion rates from dietary carotene sources to vitamin A are 12:1 for β-carotene and 24: 1 for β-cryptoxanthin.

Source

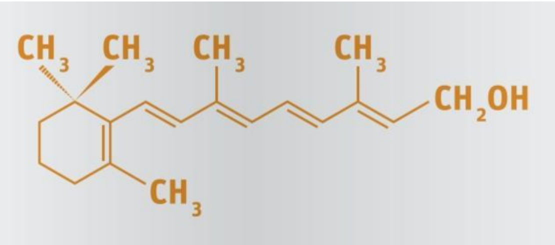
Major source of retinol is liver, egg yolk, butter, whole milk and cheese. Orange flesh, sweet potatoes, orange coloured flesh fruits like melon, mangoes and persimmons, green leafy vegetables, carrots, pumpkins and red palm oil are a great source of ceratenoids.

Bioavailability of vitamin A

The bioavailability of animal source derived vitamin A is high. Around 70 – 90% of the vitamin A ingested is absorbed by the body. Carotenoids from plant sources are absorbed at much lower rates – between 9% and 22% – and the proportion absorbed decreases as more carotenoids are consumed. Dietary fat enhances the absorption of vitamin A. Absorption of β-carotene is influenced by the food matrix. β-carotene from supplements is more readily absorbed than β-carotene from foods, while cooking carrots and spinach enhances the absorption of β-carotene. Diarrhoea or parasite infections of the gut are associated with vitamin A malabsorption.

Disease symptoms related to excess or less intake of vitamin A.

Liver stores about 90% of vitamin A. Sufficient intake of deeply coloured fruits and vegetables, with fortified foods or both is helpful for vegetarians in meeting up their vitamin A requirements.Vitamin A deficiency is a major problem when diets consist of starchy staples, which are not good sources of retinol or β-carotene, and when the consumption of deeply colored fruits and vegetables, animal-source foods, or fortified foods is low. Deficiency of vitamin A may lead to compromisee in iron status as it plays a vital role in mobilizing iron from liver. Hypervitaminosis is due to excessive intake of pre formed vitamin A which tends to increase the levels of vitamin in the liver.No such risk has been observed with high β-carotene intakes.



Vitamin D

Calciferol

Vitamin D is synthesized in the body from a cholesterol derived precursor in the presence of sunlight. Vitamin D is therefore not an essential micronutrient, given the right season and enough time in the sun. The active from of vitamin D is actually a hormone that targets organs – most notably the intestines, kidneys, and bones.Vitamin D in the bones helps in the absorption of calcium and phosphorus, for the growth of denser and stronger bones by absorption and deposition of these minerals.

Source

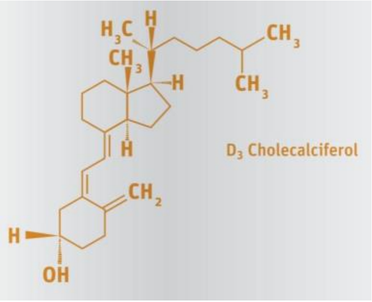
Sunlight – exposure to ultraviolet B (UVB) rays is necessary for the body to synthesize vitamin D from the precursor in the skin. There are a few foods that are natural sources of vitamin D. These sources are oily fish, egg yolk, veal, beef, and mushrooms.

Bioavailability of vitamin D

There is very little information on the bioavailability of vitamin D.Bioavailability also varies among individuals and depends on the level ofcirculating vitamin-D-binding protein.

Disease symptoms related to excess or less intake of vitamin D

Less exposure to sunlight is the major risk factor for poor vitamin D status. The use of sunscreen, higher levels of melanin in skin (i.e., dark skin), skin coverings (clothes, veils), and time of day are factors that decrease exposure to UVB rays. Breast milk is a poor source of vitamin D which is why AAP recommends all breast fed infants receive supplementary vitamin D by vitamin drops.Children who are exclusively breastfed and have no or little sun exposure require vitamin D supplements to meet their vitamin D requirements.Vitamin D deficiency leads to calcium deficiency, which may result in causing rickets and adversely affecting the peak bone mass specially in children and adolescents. In adults, vitamin D deficiency increases the risk of osteomalacia and osteoporosis.



Vitamin E

α-Tocopherol

The most active form of vitamin E is α-tocopherol, which acts as an antioxidant (i.e., stops the chain reaction of free radicals producing more free radicals). Vitamin E protects cell membranes, proteins, and DNA from oxidation and thereby contributes to cellular health. It prevents oxidation of the polyunsaturated fatty acids and lipids in the cells. Vitamin E is stored in the liver and is safe even at high intakes.

Source

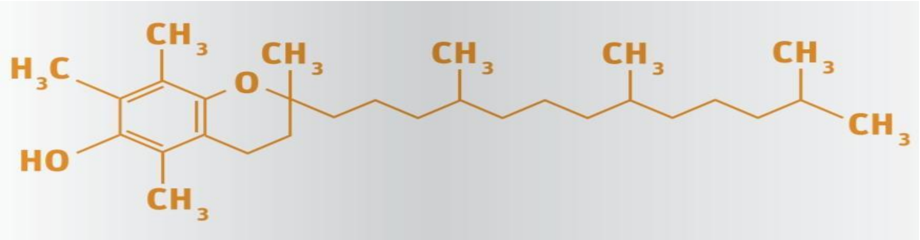
Vitamin E in the α-tocopherol form is found in edible vegetable oils, especially wheat germ, and sunflower and rapeseed oil. Other good sources of vitamin E are leafy green vegetables (i.e., spinach, chard), nuts (almonds, peanuts) and nut spreads, avocados, sunflower seeds, mango and kiwifruit.

Bioavailability of vitamin E

Vitamin E is a fat-soluble nutrient. As such, absorption of this vitamin is enhanced in the presence of fat in a meal.

Disease symptoms related to excess or less intake of vitamin E

Diets mainly of starchy staples with less amount of edible oils are at a higher risk of vitamin E intake. Inadequate absorption of the vitamin may lead to red blood cell breakage and nerve damage. Vitamin E deficiency may also lead to miscarriage in pregnancy. Studies also reveal that vitamin E supplementation has been successfully used for the treatment of non-alcoholic fatty liver disease, a condition widespread in overweight and obese people. Excessive intake of vitamin E from food is very rare.



Vitamin K

Phylloquinone | Menaquinones

Vitamin K acts primarily in blood clotting, where its absence can make the difference between life and death. Many more different proteins and the mineral calcium are involved in making a blood clot. Vitamin K is essential for the activation of several of these proteins. Absence of any of these clotting factors may lead to haemorrhagic disease (uncontrolled bleeding.). Osteocalcin – bone protein, metabolism also occurs in participation of vitamin K. Without vitamin K, osteocalcin cannot bind to the minerals that normally form bones, resulting in poor bone mineralization. Vitamin K is stored in the liver.

Source

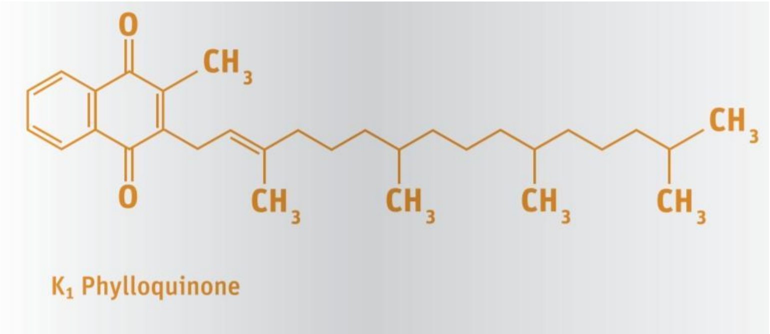
Vitamin K is found in plant foods as phylloquinone (K1). Bacteria in the lower intestine can synthesize vitamin K as menaquinone (K2), which is absorbed by the body. Green leafy vegetables like parsley, spinach, collard green and salad greens, cabbage and vegetable oils like soyabean, canola and olive oils are greaat sources of vitamin K. Menaquinones are also found in fermented foods such as fermented cheese, curds, and natto (fermented soybeans).

Bioavailability of vitamin K

Dietary fat enhances the absorption of vitamin K in the body.

Disease related to excess or less intake of vitamin K

New born infants are at a high risk of bleeding as vitamin K is poorly transferred via placenta and is not significantly present in breast milk. This innate vitamin K deficiency is treated with intramuscular injection or oral administrationof phylloquinone. Vitamin K suppplementation is found to bee beneficial in improving bone density in adults with osteoporosis because it enhances the synthesis of special protein called matrix Gla protein



Water soluble vitamins:

Vitamin C

Ascorbic Acid

Vitamin C parts company with the B-vitamins in its mode of action. It acts as an antioxidant or as a cofactor, helping a specific enzyme perform its job. High levels of vitamin C are found in pituitary and adrenal glands, eyes, white blood cells, and the brain. Vitamin C has multiple roles - in the synthesis of collagen, absorption of iron, free radical scavenging, and defense against infections andinflammation

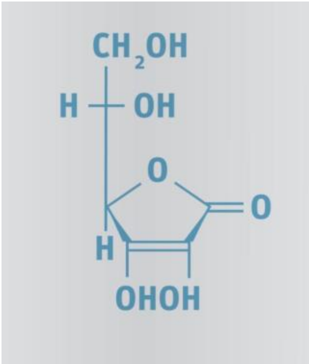
The primary sources of vitamin C

Fruits (especially citrus fruits), cabbage-type vegetables, green leafy vegetables, lettuce, tomatoes, potatoes, and liver (ox /calf).

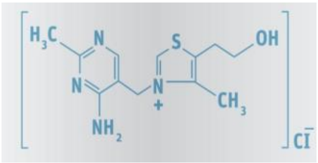
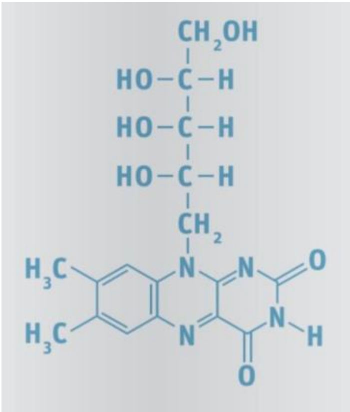
Bioavailability of vitamin C

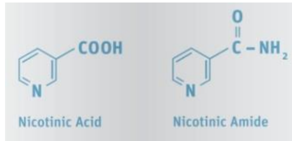
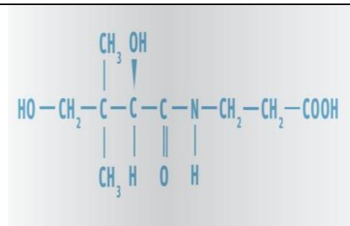
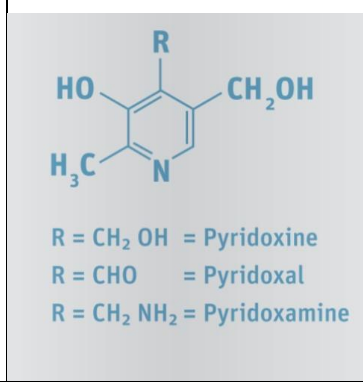
Levels of vitamin C in foods depend on the growing conditions, season, stage of maturity, cooking practices, and storage time prior to consumption. Vitamin C is easily destroyed by heat and oxygen. Absorption levels depend on the amounts consumed. About 70–90% of vitamin C is absorbed. If intakes exceed 1000 mg/day, absorption levels drop to 50%.

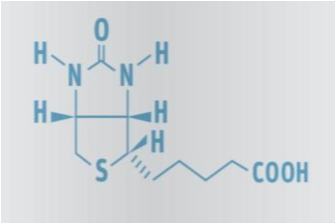
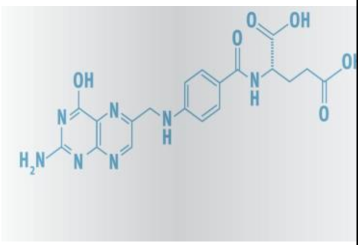
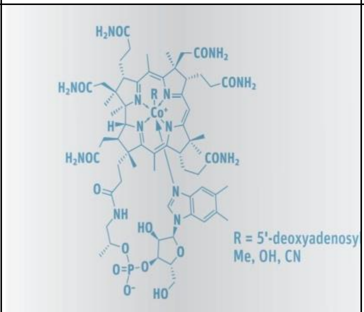
Risks related to inadequate intake of vitamin C Individuals who do not consume sufficient quantities of fruits and vegetables are at risk for inadequate intakes of vitamin C. Because smoking generates free radicals, individuals who smoke have elevated requirements for vitamin C. Vitamin C deficiency can cause scurvy; signs of scurvy are bleeding gums, small hemorrhages below the skin, fatigue, loss of appetite and weight, and lowered resistance to infections.



Vitamin B

Vitamin	Name	Molecular structure	Description	Molecular function
Vitamin B_1	Thiamine		Acts as coenzyme in the catabolism of sugars and amino acids	Thiamine plays a central role in the release of energy from carbohydrates. It is involved in RNA and DNA production, as well as nerve function. Its active form is a coenzyme called thiamine pyrophosphate (TPP), which takes part in the conversion of pyruvate to acetyl coenzyme A in metabolism
Vitamin B_2	Riboflavin		A precursor of co enzymes called FAD and FMN, which are needed for flavoprotein enzyme reactions, including activation of other vitamins.	Riboflavin is involved in release of energy in the electron transport chain, the citric acid cycle, as well as the catabolism of fatty acids (beta oxidation).

Vitamin B_3	Niacin, Nicotinamide, nicotinamide riboside		A precursor of coenzymes called NAD and NADP, which are needed in many metabolic processes.	Niacin is composed of two structures: nicotinic acid and nicotinamide. There are two co-enzyme forms of niacin: nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP). Both play an important role in energy transfer reactions in the metabolism of glucose, fat and alcohol.[3] NAD carries hydrogens and their electrons during metabolic reactions, including the pathway from the citric acid cycle to the electron transport chain. NADP is a coenzyme in lipid and nucleic acid synthesis.
Vitamin B_5	Pantothenic acid		A precursor of coenzyme A and therefore needed to metabolize many molecules.	Pantothenic acid is involved in the oxidation of fatty acids and carbohydrates. Coenzyme A, which can be synthesised from pantothenic acid, is involved in the synthesis of amino acids, fatty acids, ketone bodies, cholesterol,[5] phospholipids, steroid hormones, neurotransmitters (such as acetylcholine), and antibodies.
Vitamin B_6	Pyridoxine, pyridoxal, pyridoxamine		A coenzyme in many enzymatic reactions in metabolism.	The active form pyridoxal 5'-phosphate (PLP) (depicted) serves as a cofactor in many enzyme reactions mainly in amino acid metabolism including biosynthesis of neurotransmitters.

Vitamin B_7	Biotin		A coenzyme for carboxylase enzymes, needed for synthesis of fatty acids and in gluconeogenesis	Biotin plays a key role in the metabolism of lipids, proteins and carbohydrates. It is a critical co-enzyme of four carboxylases: acetyl CoA carboxylase, which is involved in the synthesis of fatty acids from acetate; pyruvate CoA carboxylase, involved in gluconeogenesis; β-methylcrotonyl CoA carboxylase, involved in the metabolism of leucine; and propionyl CoA carboxylase, which is involved in the metabolism of energy, amino acids and cholesterol.
Vitamin B_9	Folate		A precursor needed to make, repair, and methylate DNA; a cofactor in various reactions; especially important in aiding rapid cell division and growth, such as in infancy and pregnancy.	Folate acts as a co-enzyme in the form of tetrahydrofolate (THF), which is involved in the transfer of single-carbon units in the metabolism of nucleic acids and amino acids. THF is involved in pyrimidine nucleotide synthesis, so is needed for normal cell division, especially during pregnancy and infancy, which are times of rapid growth. Folate also aids in erythropoiesis, the production of red blood cells.
Vitamin B_{12}	Cobalamin		A coenzyme involved in the metabolism of every cell of the human body, especially affecting DNA synthesis and regulation, but also fatty acid metabolism and amino acid metabolism.	Vitamin B_{12} is involved in the cellular metabolism of carbohydrates, proteins and lipids. It is essential in the production of blood cells in bone marrow, and for nerve sheaths and proteins.[9] Vitamin B_{12} functions as a co-enzyme in intermediary metabolism for the methionine synthase reaction with methylcobalamin, and the methylmalonyl CoA mutase reaction with adenosylcobalamin.

Vitamin	Name	Source	Defeciency disease
Vitamin B_1	Thiamine	Offal (liver, kidneys, heart), fish, meat (pork), whole grain cereals, leafy green vegetables, asparagus, eggplant, fruits , legumes (beans and lentils), nuts, soymilk, squash, brewer's yeast.	Deficiency causes beriberi. Symptoms of this disease of the nervous system include weight loss, emotional disturbances, impaired sensory perception, weakness and pain in the limbs, periods of irregular heartbeat, and edema (swelling of bodily tissues). Heart failure and death may occur in advanced cases. Chronic thiamin deficiency can also cause alcoholic Korsakoff syndrome, an irreversible dementia characterized by amnesia andcompensatory confabulation.
Vitamin B_2	Riboflavin	Vitamin B2 is found in offal (liver, kidneys, heart), eggs, meat, milk, yogurt, cheeses, whole grain cereals, dark green leafy vegetables, and brewer's yeast.	Riboflavin deficiency can cause ariboflavinosis, which may result in cheilosis (cracks in the lips), high sensitivity to sunlight, angular cheilitis, glossitis (inflammation of the tongue), seborrheic dermatitis or pseudo-syphilis (particularly affecting the scrotum or labia majora and the mouth), pharyngitis (sore throat), hyperemia, and edema of the pharyngeal and oral mucosa.
Vitamin B_3	Niacin, Nicotinamide, nicotinamide riboside	Primary sources are offal (liver), fish, meat, milk, eggs, whole grain cereals, legumes, fruit (avocados, figs, dates, prunes), and nuts.	Deficiency, along with a deficiency of tryptophan, causes pellagra. Symptoms include aggression, dermatitis, insomnia, weakness, mental confusion, and diarrhea. In advanced cases, pellagra may lead to dementia and death (the 3(+1) D's: dermatitis, diarrhea, dementia, and death).
Vitamin B_5	Pantothenic acid	Vitamin B5 is found in offal (liver, kidneys), meat (chicken, beef), egg yolk, milk, fish, whole grain cereals, potatoes, tomatoes, broccoli, mushrooms.	Deficiency can result in acne and paresthesia, although it is uncommon.
Vitamin B_6	Pyridoxine, pyridoxal, pyridoxamine	There are many good sources of vitamin B6, including chicken, liver (cattle, pig), fish (salmon, tuna). Nuts (walnut, peanut), chickpeas, maize and whole grain cereals, and vegetables (especially green leafy vegetables), bananas, potatoes and other starchy vegetables are also good sources.	Vitamin B_6 deficiency causes seborrhoeic dermatitis-like eruptions, pink eye and neurological symptoms (e.g. epilepsy).

Vitamin B7	Biotin	The primary sources of vitamin B7Eggs, milk, vegetables, cereals, nuts (almonds, walnuts, peanuts), liver, kidney, yeast, soybeans.	Deficiency of Vitamin B7 does not typically cause symptoms in adults, other than cosmetic issues such as decreased hair and nail growth. However it may lead to impaired growth and neurological disorders in infants. Multiple carboxylase deficiency which is an inborn error of metabolism. It can lead to biotin deficiency even when dietary biotin intake is normal.
Vitamin B9	Folate	Dark green leafy vegetables, beans, lentils, asparagus, wheat germ, yeast, peanuts, oranges, strawberries.	Deficiency of Vitamin B9 results in a macrocytic anemia, and elevated levels of homocysteine. Deficiency in pregnant women can lead to birth defects.
Vitamin B12	Cobalamin	Vitamin B12 is found only in foods of animal origin, except where plant-based foods have been fortified. Rich sources of vitamin B12 include shellfish, liver, game meat (venison and rabbit), some fish (herring, sardines, salmon, trout), milk and milk products.	Deficiency results in a macrocytic anemia, elevated methylmalonic acid and homocysteine, peripheral neuropathy, memory loss and other cognitive deficits. It is most likely to occur among elderly people, as absorption through the gut declines with age. The autoimmune disease pernicious anemia is another common cause. It can also cause symptoms of mania and psychosis. In rare extreme cases, paralysis can result.

Reference

- Information taken from Wilepedia
- Book:--- Vitamins and Minerals:A brief guide. A sight and life publication.
- Book:--- Biochemestry by D. Das