

UNIT-VII

VITAMINS

- DEFINITION AND CLASSIFICATION WITH EXAMPLES
- SOURCES, CHEMICAL NATURE, FUNCTIONS, COENZYME FORM, RECOMMENDED DIETARY REQUIREMENTS, DEFICIENCY
- DISEASES OF FAT-AND WATER-SOLUBLE VITAMINS

DEFINITION AND CLASSIFICATION WITH EXAMPLES

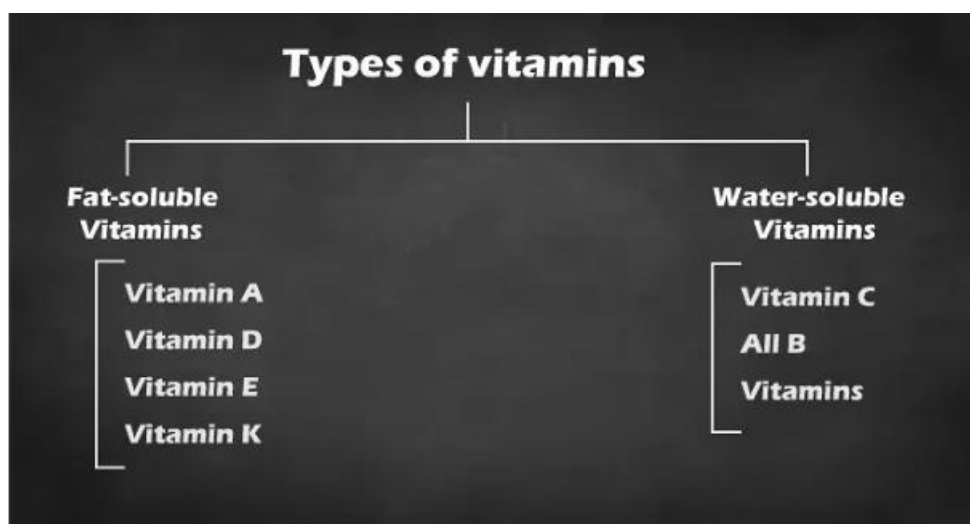
Vitamins are natural and essential nutrients, which plays a major role in growth and development of the human body. For proper growth, for strong bones and good development needs the right quantity of vitamins in our body. These vitamins are organic substances which work in groups for normal and smooth functioning of our body cells.

Types of Vitamins

There are two main types of vitamins.

1) Fat soluble Vitamins

2) Water soluble Vitamins



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1) Fat soluble Vitamins

As the name suggests, fat soluble vitamins are stored in fatty tissues and these vitamins can be stored for a long time in the body. The examples of these vitamins are **vitamin A, vitamin D, vitamin E, vitamin K.**

Vitamin A

1. Vitamin A is very important for an improved immune system.
2. It is also important for a better eyesight.
3. By good consumption of vitamin A in the body promotes healthy skin, skin becomes fresh and free from skin disorder.
4. This vitamin maintains the healthy growth of muscle tissue and healthy reproductive system.

Source of vitamin A : milk, meat, fish, vegetables like carrots, sweet potatoes.

Chemical Nature

The most active and well-known form of vitamin A is retinol, which is found in animal products such as liver, fish oil, and dairy products.

Chemically, retinol is a retinoid, which is a class of compounds derived from vitamin A. It is composed of a β -ionone ring and an isoprenoid chain. Retinol can be oxidized to form retinaldehyde, which is essential for vision as it is a component of the visual pigment rhodopsin.

Functions

1. **Vision:** Vitamin A is essential for the proper functioning of the retina in the eyes. It is a component of rhodopsin, a protein in the retina that helps detect light and facilitates vision in low-light conditions.
2. **Immune function:** Vitamin A supports the immune system by maintaining the integrity of mucosal surfaces, such as those in the respiratory, gastrointestinal, and urinary tracts. It also helps regulate immune responses to infections.
3. **Cell growth and differentiation:** Vitamin A is involved in regulating the growth and specialization of cells, particularly epithelial cells, which are found in the skin and mucous membranes. It plays a role in cell differentiation, ensuring that cells mature properly and perform their specialized functions.
4. **Reproduction and fetal development:** Vitamin A is important for reproductive health in both males and females. It is involved in the production of sperm, maintenance of normal menstrual cycles, and healthy pregnancy outcomes. Adequate vitamin A intake during pregnancy is essential for fetal development, particularly for the development of the eyes, central nervous system, and immune system of the fetus.
5. **Antioxidant activity:** Some forms of vitamin A, such as beta-carotene, have antioxidant properties, helping to neutralize harmful free radicals in the body and protect cells from oxidative damage.

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Coenzyme Form

The coenzyme form of vitamin A is known as retinyl phosphate. It is an active form of vitamin A that plays a crucial role in various metabolic processes within the body. Retinyl phosphate serves as a cofactor in certain enzymatic reactions involved in cellular metabolism and energy production.

Recommended Dietary Requirements

1. Infants (0-6 months): 400 mcg
2. Infants (7-12 months): 500 mcg
3. Children (1-3 years): 300 mcg
4. Children (4-8 years): 400 mcg
5. Children (9-13 years): 600 mcg
6. Adolescents and adults (males 14 years and older): 900 mcg
7. Adolescents and adults (females 14 years and older): 700 mcg
8. Pregnant adolescents and adults: 750 mcg
9. Breastfeeding adolescents and adults: 1,200 mcg

Deficiency

1. **Night blindness:** Vitamin A deficiency impairs the ability to see in low-light conditions, leading to night blindness, which can progress to more severe vision impairment if left untreated.
2. **Xerophthalmia:** A more severe consequence of vitamin A deficiency, xerophthalmia is characterized by dryness of the conjunctiva and cornea, which can lead to irreversible damage to the eyes and even blindness.
3. **Impaired immune function:** Vitamin A deficiency compromises the integrity of mucosal surfaces and impairs immune responses, increasing the risk of infections, particularly respiratory and gastrointestinal infections.
4. **Growth retardation:** Vitamin A deficiency can interfere with normal cell growth and differentiation, leading to stunted growth and delayed development in children.
5. **Increased susceptibility to certain diseases:** Vitamin A deficiency is associated with an increased risk of certain infectious diseases, such as measles and diarrheal illnesses, which can further exacerbate the deficiency.

VITAMIN D

Definition

Vitamin D is a fat-soluble vitamin that is essential for various physiological processes in the body. It exists in several forms, but the two major ones are vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol).

Source:

1. **Sunlight:** The body can produce vitamin D when the skin is exposed to sunlight.

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2. **Dietary Sources:** Foods rich in vitamin D include fatty fish (such as salmon, mackerel, and tuna), egg yolks, cheese, fortified milk, fortified cereals, and fortified orange juice.

Chemical Nature:

1. Vitamin D₂ (ergocalciferol) is derived from plant sources.
2. Vitamin D₃ (cholecalciferol) is primarily derived from animal sources and is also the form synthesized by the skin upon exposure to sunlight.

Functions:

1. **Calcium and Phosphorus Absorption:** Vitamin D helps regulate calcium and phosphorus absorption in the intestines, which is crucial for maintaining healthy bones and teeth.
2. **Bone Health:** Vitamin D plays a vital role in bone mineralization and bone growth, helping to prevent conditions like osteoporosis and rickets.
3. **Muscle Function:** Adequate vitamin D levels are important for maintaining muscle strength and function.
4. **Immune Function:** Vitamin D may also play a role in supporting the immune system, though further research is needed to fully understand its effects.

Coenzyme Form:

Vitamin D does not function directly as a coenzyme in the same way as some other vitamins. Instead, its active form (**Calcitriol**) acts as a hormone, exerting its effects by binding to specific receptors in target tissues.

Recommended Dietary Requirements:

1. The recommended dietary allowance (RDA) for vitamin D varies by age, sex, and life stage.
2. For most adults, including pregnant and lactating women, the RDA is 600 IU (15 mcg) per day.
3. Infants may require higher doses, and supplementation is often recommended, especially for breastfed infants.

Deficiency:

1. **Rickets:** Vitamin D deficiency can lead to soft, weak bones in children, a condition known as rickets.
2. **Osteomalacia:** In adults, severe vitamin D deficiency can result in osteomalacia, characterized by softening of the bones and an increased risk of fractures.
3. **Muscle Weakness:** Vitamin D deficiency may also contribute to muscle weakness and pain.
4. **Increased Risk of Chronic Diseases:** Some research suggests that vitamin D deficiency may be associated with an increased risk of certain chronic diseases, such as cardiovascular disease, autoimmune disorders, and certain cancers.

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VITAMIN E

Definition:

Vitamin E is a fat-soluble vitamin with antioxidant properties. It exists in several forms, with alpha-tocopherol being the most biologically active form.

Source

Dietary Sources: Vitamin E is found in various foods, including nuts (such as almonds, hazelnuts, and peanuts), seeds (such as sunflower seeds), vegetable oils (such as wheat germ oil, sunflower oil, and safflower oil), leafy green vegetables, and fortified cereals.

Chemical Nature

- **Alpha-Tocopherol:** The most biologically active form of vitamin E, found in dietary sources and commonly used in supplements.
- **Beta-Tocopherol, Gamma-Tocopherol, Delta-Tocopherol:** These are other forms of vitamin E, each with varying degrees of biological activity.

Functions

1. **Antioxidant Activity:** Vitamin E acts as an antioxidant, helping to neutralize free radicals and protect cells from oxidative damage. It helps prevent oxidative stress, which can contribute to aging and the development of chronic diseases.
2. **Immune Function:** Vitamin E supports immune function by protecting immune cells from oxidative damage and enhancing their function.
3. **Skin Health:** Vitamin E is involved in maintaining healthy skin, promoting wound healing, and protecting the skin from damage caused by ultraviolet (UV) radiation.
4. **Cardiovascular Health:** Some studies suggest that vitamin E may have a protective effect against cardiovascular disease by preventing the oxidation of LDL cholesterol and reducing inflammation.

Coenzyme Form

Vitamin E does not function directly as a coenzyme in metabolic reactions like some other vitamins. **Alpha-tocopherol** is the co enzyme form of it.

Recommended Dietary Requirements

1. The recommended dietary allowance (RDA) for vitamin E is expressed in milligrams of alpha-tocopherol equivalents (α -TE).
2. For adults, the RDA is 15 mg (22.4 IU) of alpha-tocopherol per day.
3. Pregnant and lactating women may require slightly higher amounts of vitamin E.

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Deficiency

1. Vitamin E deficiency is rare but can occur in individuals with certain medical conditions that impair fat absorption, such as cystic fibrosis, cholestatic liver disease, or conditions that affect the pancreas or gallbladder.
2. Symptoms of deficiency may include muscle weakness, impaired coordination, vision problems, and an increased susceptibility to infections.
3. Severe vitamin E deficiency can lead to neurological problems, such as peripheral neuropathy or ataxia.

VITAMIN K

Definition

Vitamin K is a fat-soluble vitamin that is essential for blood clotting and bone health. It exists in two main forms: vitamin K1 (phylloquinone) and vitamin K2 (menaquinone).

Source

1. **Vitamin K1:** Found primarily in green leafy vegetables such as kale, spinach, broccoli, and Brussels sprouts.
2. **Vitamin K2:** Found in fermented foods like cheese, natto (fermented soybeans), and in smaller amounts in meat and dairy products.

Chemical Nature

1. **Vitamin K1 (phylloquinone):** It is the primary form of vitamin K found in plants.
2. **Vitamin K2 (menaquinone):** This form of vitamin K is produced by bacteria in the intestines and is also found in animal-based foods.

Functions

1. **Blood Clotting:** Vitamin K is essential for the synthesis of certain proteins involved in blood clotting, such as prothrombin. Without adequate vitamin K, blood clotting would be impaired, leading to an increased risk of bleeding and hemorrhage.
2. **Bone Health:** Vitamin K plays a role in bone metabolism by supporting the mineralization of bone matrix proteins, which helps maintain bone density and reduce the risk of fractures.

Coenzyme Form

1. Phylloquinone (K1) and menaquinone (K2).
2. Vitamin K serves as a cofactor for the enzyme gamma-glutamyl carboxylase, which catalyzes the carboxylation of specific glutamate residues in vitamin K-dependent proteins. This carboxylation process is essential for the proper functioning of these proteins in blood clotting and bone metabolism.

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Recommended Dietary Requirements:

1. The recommended dietary allowance (RDA) for vitamin K varies by age and sex.
2. For adults, the Adequate Intake (AI) is 120 mcg per day for men and 90 mcg per day for women.

Deficiency

1. Vitamin K deficiency is relatively rare in healthy individuals but can occur in certain situations, such as malabsorption disorders, prolonged antibiotic use, or conditions that impair bile production.
2. Symptoms of deficiency may include easy bruising, excessive bleeding, and, in severe cases, hemorrhage.
3. Individuals at higher risk of deficiency include newborn infants (who have limited stores of vitamin K) and individuals with liver disease, inflammatory bowel disease, or other conditions affecting nutrient absorption.

Vitamin	Definition	Source	Chemical Nature	Functions	Coenzyme Form	Recommended Dietary Requirements	Deficiency
A	Fat-soluble vitamin	Liver, fish oil, dairy products, carrots, spinach	Retinol, retinal, retinoic acid	Vision, immune function, cell growth and differentiation, reproduction, antioxidant activity	Retinyl phosphate	Adults: 900 mcg (males), 700 mcg (females); varies by age and sex	Night blindness, xerophthalmia, impaired immune function, growth retardation, increased susceptibility to infections
D	Fat-soluble vitamin	Fatty fish, egg yolks, fortified foods	Vitamin D2, Vitamin D3	Calcium and phosphorus absorption, bone health, muscle function, immune function	Not a coenzyme	Adults: (15 mcg); varies by age and sex	Rickets, osteomalacia, muscle weakness, increased risk of chronic diseases
E	Fat-soluble vitamin	Nuts, seeds, vegetable oils, leafy green vegetables	Alpha-tocopherol	Antioxidant activity, immune function, skin health, cardiovascular health	Not a coenzyme	Adults: 15 mg of alpha-tocopherol; varies by age and sex	Muscle weakness, impaired coordination, vision problems, increased susceptibility to infections
K	Fat-soluble vitamin	Green leafy vegetables, fermented foods	Vitamin K1, Vitamin K2	Blood clotting, bone health	Not a coenzyme	Adults: 120 mcg (men), 90 mcg (women); varies by age and sex	Easy bruising, excessive bleeding, hemorrhage

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WATER SOLUBLE VITAMIN

Vitamin	Source	Chemical Nature	Functions	Coenzyme Form	Recommended Dietary Requirements	Deficiency
B1	Whole grains, legumes, pork, nuts	Thiamine	Energy metabolism, nerve function, carbohydrate metabolism	Thiamine pyrophosphate (TPP)	Adults: 1.2 mg for men, 1.1 mg for women; varies by age and sex	Beriberi (nerve damage, weakness, cardiovascular problems), Wernicke-Korsakoff syndrome (alcoholism-related)
B2	Dairy products, lean meats, leafy green vegetables	Riboflavin	Energy metabolism, antioxidant activity	Flavin adenine dinucleotide (FAD)	Adults: 1.3 mg for men, 1.1 mg for women; varies by age and sex	Dermatitis, cracks at the corners of the mouth, inflamed tongue
B3	Meat, fish, poultry, nuts, whole grains	Niacin	Energy metabolism, DNA repair, hormone synthesis	Nicotinamide adenine dinucleotide (NAD), Nicotinamide adenine dinucleotide phosphate (NADP)	Adults: 16 mg for men, 14 mg for women; varies by age and sex	Pellagra (skin rash, diarrhea, dementia), pellagra-like symptoms
B5	Meat, poultry, fish, whole grains, legumes	Pantothenic acid	Energy metabolism, synthesis of coenzyme A (CoA)	Coenzyme A	Adequate Intake: 5 mg for adults; varies by age and sex	Rare, but may include fatigue, irritability, gastrointestinal problems
B6	Meat, fish, poultry, bananas, potatoes	Pyridoxine	Amino acid metabolism, neurotransmitter synthesis, red blood cell production	Pyridoxal phosphate (PLP)	Adults: 1.3-1.7 mg for men, 1.3-1.5 mg for women; varies by age and sex	Anemia, neurological symptoms, depression, weakened immune function

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Vitamin	Source	Chemical Nature	Functions	Coenzyme Form	Recommended Dietary Requirements	Deficiency
B7	Egg yolks, liver, nuts, seeds, salmon	Biotin	Energy metabolism, fatty acid synthesis, gene expression	Biotin	Adults: 30 mcg; varies by age and sex	Rare, but may include hair loss, skin rash, neurological symptoms
B9	Leafy green vegetables, legumes, fortified grains	Folate (folic acid)	DNA synthesis and repair, red blood cell formation, fetal development	Tetrahydrofolate (THF)	Adults: 400 mcg for men and women; varies by age and sex	Megaloblastic anemia, neural tube defects (in pregnancy), weakness, fatigue
B12	Meat, fish, poultry, dairy products	Cobalamin	DNA synthesis, red blood cell formation, nerve function	Methylcobalamin, Adenosylcobalamin	Adults: 2.4 mcg for men and women; varies by age and sex	Pernicious anemia, neurological symptoms, fatigue, weakness
C	Citrus fruits, strawberries, bell peppers, broccoli	Ascorbic acid	Antioxidant activity, collagen synthesis, immune function, iron absorption	Not a coenzyme	Adults: 90 mg for men, 75 mg for women; varies by age and sex	