Vitamins

Vitamins are one of the micronutrients. The human body synthesises few vitamins: they must be obtained from food or manufactured supplements. Each vitamin has its own specific functions. Insufficient amounts of vitamins in the diet may cause deficiency diseases.

Classification of vitamins

Fat-soluble vitamins	Water-soluble vitamins
Normally found in food that contains fat. Can be stored in the body for several months.	Found in a wide variety of food. Not stored in the body (excess are excreted).
Vitamin A: retinol and beta-carotene. Vitamin D: cholcalciferol and ergocalciferol. Vitamin E: tocopherol. Vitamin K: naphthoquinones.	Vitamin C: ascorbic acid. B group vitamins: B1 thiamine. B6 pyrodoxine. B2 riboflavin. B12 Cobalamin. B3 niacin. folate/folic acid.

Fat-soluble vitamins

Vitamin A (retinol and beta-carotene)

Forms	
Retinol (pure vitamin A): easily absorbed. Stored in the liver.	Beta-carotene (pro-vitamin A): not easily absorbed. Converted to retinol in the lining of the intestine.
Properties of retinol (pure vitamin A)	Beta-carotene (pro-vitamin A)
A yellow, fat-soluble alcohol. Insoluble in water. Soluble in organic solvents, e.g., acetone. Heat stable, but affected by prolonged high temperatures. Destroyed by oxygen.	A yellow or orange fat-soluble oil. Insoluble in water. Soluble in fat solvents, e.g., alcohol. Heat stable, but affected by prolonged high temperatures. A powerful antioxidant that has the ability to counteract the damaging effects of free radicals (chemicals that can damage the human body).
Sources of retinol (pure vitamin A)	Sources of Beta-carotene (pro-vitamin A)
Found in animal food sources Fish liver oils Milk Eggs Butter Offal Cheese Margarine	Found in yellow, green and orange fruit and vegetables (carotenoids) Carrots Tomatoes Red peppers Leafy green vegetables Apricots Sweet potatoes

Oily fish	
Functions of vitamin A	Effects of deficiency of vitamin A
Required to manufacture the pigment rhodopsin found in the retina, which helps the eye to adapt to dim light.	Night blindness, whereby a person will struggle to see in dim light due to a lack of rhodopsin.
Helps maintain healthy skin and the mucous membranes of the body, e.g., the eyes.	Follicular hyperkeratosis, a condition that results in rough, dry skin and inflammed hair follicles. Xerophthalmia can occur on the surface of the eye due to lack of mucous. This causes eyes to dry out and become infected with bacteria and can eventually lead to blindness.
Aids the growth and development of children.	Stunted or delayed growth in children, leaving them smaller in height than the average for their age.
Beta-carotene acts as a powerful antioxidant that can counteract the damaging effects of free radicles.	Risk of damage to cells by free radicals, increasing the risk of some cancers, coronary heart disease and strokes.
Recommended Daily Allowance/Reference Intake (RI) of vitamin A	
Group	RDA
Children Adolescents and adults Pregnant women Lactating women	400-500 µg 600-700 µg 700 µg 950 µg

Vitamin D (calciferol)

Forms	
Cholecalciferol D3: an animal form of vitamin D. Created when UV light shines on the skin, converting 7-dehydrocholestrol in the epidermis to cholecalciferol.	Ergocalciferol D2: a plant form of vitamin D. Created when UV light shines on fungi and yeasts, converting ergosterol into ergocalciferol. Used in vitamin supplements.
Properties	
The most stable of all vitamins. Fat soluble. Insoluble in water. Heat stable: unaffected by cooking or preservation methods. Unaffected by acids, alkalis and oxygen.	
Food sources	Other sources

Oily fish Fortified milk Margarine Eggs Fish liver oils Butter	Sunlight (humans need approximately 20 minutes of sunshine per day to produce enough vitamin D).
Functions	Effects of deficiency
Controls the absorption of calcium and phosphorus into the blood.	Increased risk of bone diseases, such as rickets, osteoporosis and osteomalacia and tooth decay.
Regulates the amount of calcium and phosphorus in the bones and teeth, helping to maintain density and strength.	Increased risk of bone diseases and tooth decay.
Regulates calcium levels in the blood; if blood-calcium levels are too low, it stimulates the production of a calcium-binding protein needed to absorb more calcium.	Increased risk of bone diseases and tooth decay.
Recommended Daily Allowance (RDA)/Reference Intake (RI)	
Group	RDA/RI
Children, adults and pregnant or lactating women Adolescents	10 µg 15 µg

Vitamin D deficiency diseases

Rickets	A bone disease that affects children, causing their bones to become soft and weak. This can lead to an increased risk of fractures and bone deformities, e.g., bow legs.
Osteomalacia	A bone disease that affects adults, causing their bones to become soft and weak due to low bone mass. This can lead to an increased risk of fractures and bone pain.
Osteoporosis	A bone disease common in older people or post-menopausal women, causing their bones to become brittle and fragile due to a loss of bone mass. This can lead to an increased risk of fractures, stooped posture and back pain caused by a collapsed vertebra.

Tooth decay	A condition where the tooth enamel, bone and cementum weaken, increasing the risk of dental decay.

Hypervitaminosis

Fat-soluble vitamins are stored in the liver for several months. If a diet contains an excessive intake of vitamins A or D they accumulate in the liver to toxic levels, leading to a harmful condition called hypervitaminosis. This condition is more likely to occur in people who over-use dietary supplements, such as cod liver oil, than those who over-eat foods rich in vitamins A or D.

Symptoms of Hypervitaminosis A	Symptoms of Hypervitaminosis D
Miscarriage Bone pain Birth defects Enlarged liver	Vomiting Weight loss Kidney damage Can lead to death

Vitamin E

Properties	
Fat soluble Insoluble in water Unstable to alkalis and light Antioxidant Stable to acids Heat stable	
Sources	
Nuts Wheat germ Seeds Avocados Vegetables Eggs	
Functions	Effects of deficiency
A powerful antioxidant that can counteract the damaging effects of free radicals.	Risk of damage to cells by free radicals, increasing the risk of some cancers, coronary heart disease and strokes.
Protects red and white blood cells from damage.	Anaemia, due to low levels of red blood cells, which are needed to transport oxygen. Reduced immunity, due to low levels of white blood cells which are needed to fight infection.

Protect the retain in the eyes of newborn babies.	Eye disorders in premature babies, which can lead to blindness

Vitamin K (naphthoquinones)

Forms	
Phylloquinone K1: made by plants. Menaquinone K2: made by intestinal bacteria. Menadione K3: a synthetic form.	
Properties	
Fat soluble Insoluble in water Heat stable Destroyed by light	
Food sources	Other sources
Leafy green vegetables Cereals Offal Oily fish Fish liver oils	Synthesised by bacteria in the small intestine.
Functions	Effects of deficiency
Aids the clotting of blood by synthesising prothrombin.	Slow blood clotting of ruptured blood vessels, leading to haemorrhaging. This is common in newborn babies, as their diet lacks vitamin K and their intestines may not have begun to produce it.
Regulates the level of calcium in bones.	Increased risk of bone fractures and bone diseases such as osteoporosis.

Water-soluble vitamins

Vitamin C (ascorbic acid)

Properties	
Most unstable of all vitamins Insoluble in fat Water soluble Antioxidant Acidic with a sharp or sour taste	
Sources	
Rosehips Peppers	

Blackcurrants Cabbage Kiwis Potatoes Oranges Broccoli Strawberries Tomatoes Lemons	
Functions	Effects of deficiency
Forms healthy gums and prevents inflammation.	Scurvy, a severe gum disease. Symptoms include inflamed or receding gums that cause teeth to become loose and fall out and haemorrhaging under the skin.
Forms collagen, which helps to hold cells together to form tissue, e.g., skin or blood vessels.	Can lead to weakened body tissues, e.g., blood vessels that rupture easily, leading to bruising and bleeding.
Promotes quick wound-healing.	Wounds can take longer to heal, increasing risk of infection.
Assists with the absorption of iron as it chemically changes ferric iron (non-haem iron) to ferrous iron (haem).	Anaemia may occur due to reduced absorption of iron needed to make haemoglobin.
Maintains the immune system by helping the white blood cells to fight illness and infection.	Increased susceptibility to illness and infection such as colds and flu.
A powerful antioxidant that can counteract the damaging effects of free radicals.	Risk of damage to cells by free radicals, increasing the risk of some cancers, coronary heart disease and strokes.
Recommended Daily Allowance (RDA)/ Reference Intake (RI)	
Group	RDA/RI
Children Adolescents Adults Pregnant or lactating women	45 mg 50-60 mg 60 mg 80 mg

B-group vitamins:

There are six main B-group vitamins.

Vitamin B1 thiamine. Vitamin B6 pyrodoxine.

Vitamin B2 riboflavin. Vitamin B12 Cobalamin.

Vitamin B3 niacin. folate/folic acid.

Vitamin B12 (Cobalamin)

Properties	
Water soluble Insoluble in fat Destroyed by strong acids, alkalis and light Heat stable, but some loss during cooking	
Food sources	Other sources
Offal Eggs Milk Meat Cheese Fish	As vitamin B12 is only found in animal sources, vegans are strongly advised to take supplements or to consume fortified foods, e.g., soya milk.
Functions	Effects of deficiency
Aids the metabolism of fatty acids to release energy.	Tiredness and irritability due to a lack of energy.
Aids the metabolism of folate/folic acid.	Increased risk of neural tube defects in the foetus.
Maintains the myelin sheath, which speeds up nerve impulses.	Delayed nerve impulses, leading to cognitive impairment, e.g., memory loss or slow mental response.
Aids formation of red blood cells.	Pernicious anaemia, due to low levels of red blood cells that are needed to transport oxygen.
Recommended Daily Allowance (RDA)/ Reference Intake (RI)	
Group	RDA/RI
Children Adolescents and adults Pregnant women Lactating women	0.7-1 µg 1.4 µg 1.6 µg 1.9 µg

Folate/folic acid

Forms	
Folate: a natural form found in food.	Folic acid: a synthetic form used to make supplements.
Properties	
Water soluble Insoluble in fat Heat stable, but some loss during cooking	

Destroyed by alkalis, oxygen and light Unaffected by acids	
Food sources	Other sources
Leafy green vegetables Wheat germ Wholemeal bread Offal Fortified breakfast cereals	In pregnancy, women are advised to take daily folic acid supplements (400 µg) for 12 weeks prior to conception and 12 weeks after.
Functions	Effects of deficiency
Needed during pregnancy to form the brain of a foetus and to close the end of its spinal cord.	Neural tube defects (NTD) in the foetus. For example: spina bifida occurs when the base of the spine fails to close, causing paralysis of the lower limbs. Anencephaly occurs when the top of the spine fails to close, and the brain, skull and scalp do not develop. A baby with this condition is not likely to survive.
Works with vitamin B12 (cobalamin) to form red blood cells.	Mild cases of deficiency will lead to feelings of tiredness or fatigue due to a lack of red blood cells. In severe cases anaemia may occur.
Maintains the immune system by helping the white blood cells to fight illness and infection.	Increased susceptibility to illness and infection such as colds and flu.
Recommended Daily Allowance (RDA)/ Reference Intake (RI)	
Group	RDA/RI
Children Adolescents and adults Pregnant women Lactating women	100-200 µg 300 µg 500 µg 400 µg

Vitamin B1 (thiamine)

Properties	
Water soluble Insoluble in fat Destroyed by high temperatures, alkalis and light 70% loss during milling	
Food sources	Other sources
Wholegrain cereals Fortified breakfast cereals Eggs	A small amount is synthesised by bacteria in the large intestine.

Meat Milk Offal	
Functions	Effects of deficiency
Aids the metabolism of carbohydrates and fats to release energy.	Tiredness and irritability due to a lack of energy.
Aids the correct functioning and maintenance of nerves.	Severe deficiency can result in beri beri, a serious nerve disease that causes muscular pain, paralysis and death.
Aids growth and development of children.	Stunted or delayed growth in children, leaving them smaller in height than the average for their age.

Vitamin B2 (riboflavin)

Properties	
Water soluble Insoluble in fat Unstable at high temperatures Destroyed by alkalis Sensitive to light	
Sources	
Fortified breakfast cereals Meat Offal Milk Eggs Yeast extract, e.g., marmite	
Functions	Effects of deficiency
Aids the metabolism of carbohydrates, proteins and fats to release energy.	Tiredness and irritability due to a lack of energy.
Maintains healthy mucous membranes of the body, e.g., eyes and mouth.	A swollen, red tongue; sore, cracked lips; dry eyes.
Aids growth and development of children.	Stunted or delayed growth in children, leaving them smaller in height than the average for their age.

Vitamin B3 (niacin)

Properties	
Water soluble Insoluble in fat Stable to acids and alkalis	

80-90% loss during milling Heat stable	
Food sources	Other sources
Fortified breakfast cereals Bread Nuts Meat and offal	Produced in the intestine from the amino acid tryptophan.
Functions	Effects of deficiency
Aids the metabolism of carbohydrates to release energy.	Tiredness and irritability due to a lack of energy.
Helps maintain healthy skin.	Pellagra, a severe deficiency disease. Symptoms include dermatitis, diarrhoea, depression, dementia and it can eventually lead to death.
Supports healthy nerve activity.	Delayed nerve impulses leading to cognitive impairment, e.g., memory loss or disorientation.

Vitamin B6 (pyrodoxine)

Properties	
Water soluble Insoluble in fat Heat stable, but some loss during cooking Destroyed by oxygen, alkalis and light	
Sources	
Meat Fish Green vegetables Nuts Bananas Offal	
Functions	Effects of deficiency
Aids the metabolism of carbohydrates, proteins and fats to release energy.	Tiredness and irritability due to a lack of energy.
Relieves symptoms of pre-menstrual tension (PMT) and nausea in early pregnancy.	PMT symptoms, including mood swings, irritability, depression, anxiety and bloating. Nausea during pregnancy.
Supports healthy nerve activity.	Delayed nerve impulses leading to cognitive impairment, e.g., memory loss or disorientation.
Prevents pyridoxine-dependent epilepsy in babies.	Convulsions and seizures in young babies.