

MICRONUTRIENTS

Water soluble vitamins

Water soluble vitamins	Source	Biological function	Deficiency	Interactions, comments
Thiamine (vitamin B1)	Pork, poultry Peas, nuts, dried beans, soybeans Whole grain cereals, lentils, legumes, rice Yeast	Helps the breakdown and release of energy from food. Nervous system function Heart function	Beriberi – heart failure, nerve damage and muscle weakness Wernicke-Korsakov syndrome – temporary or permanent damage to the brain function, particularly memory	Deficiency occurs in people with a poor dietary intake, especially when their body has increased requirements e.g. emergency bowel surgery. Also associated with chronic alcohol dependence, Crohn's disease, eating disorders Dialysis, certain water tablets e.g. frusemide and excess tea and coffee also reduce levels
Riboflavin (vitamin B2)	Milk and dairy products Eggs Red meat Salmon, tuna Almonds, spinach	Breakdown of fat, protein, and carbohydrate	Involved in processing nutrients, deficiency can lead to other nutrients and anaemia	Increased risk of deficiency in pregnancy and with vegan diet
Niacin (vitamin B3)	Meat, fish, eggs Dairy products Nuts	Release of energy from food Skin and nervous system	Pellegra. Skin rash or discolouration, red tongue Vomiting, constipation, diarrhoea Fatigue, memory loss	Increased risk of deficiency with chronic alcohol dependence, eating disorders and gut malabsorption disease e.g. Crohn's disease
Pantothenic acid (vitamin B5)	Chicken, beef, eggs Many vegetables, including tomato, broccoli, legumes. Whole grains	Release of energy from food Making blood cells	Vague symptoms, may include headache, fatigue, irritability, impaired muscle coordination, bowel function disturbance	
Pyridoxine (Vitamin B6)	Poultry, pork, sirloin steak	Protein metabolism Essential for	Skin rashes (dermatitis) Cracked and sore	Deficiency commonly goes along with deficiency of other B vitamins, such as folic

	Halibut Bananas, avocados, baked potato with skin, raw red pepper, prunes, lentils	the liver to break down fat and glycogen to make glucose. Helps the immune system. Nervous system function	lips Sore glossy tongue Anaemia, fatigue, and tiredness Depression Seizures Neuropathy – tingling and numbness	acid and B12. Deficiency is more likely in people who are obese, chronic alcohol dependent, pregnant, have coeliac or inflammatory bowel disease, or bariatric surgery, autoimmune or kidney disease
Biotin (vitamin B7)	Made by the gut bacteria. Food sources include – yeast, soybeans, eggs, peanut butter, mushrooms	Fatty acid and glucose metabolism	Hair loss Rashes, mouth sores, dry skin Nausea and vomiting Depression, lethargy	Deficiency is rare but can occur with very restricted diets
Folate (Vitamin B9)	Green vegetables, beans, legumes, whole grains Lesser amounts in fruit	Essential for all cell replication	Megaloblastic anaemia Spina bifida	
Vitamin B12	Meat, fish Milk, dairy products Eggs	Making red blood cells Release of energy from food Needed for folate use	Anaemia Nerve and spinal cord damage Impaired mental function	Deficiency may occur due to impaired absorption from the stomach e.g. pernicious anaemia, or lack of intake from vegan diet
Ascorbic acid (vitamin C)	Fruit and vegetables, especially – Raw red and yellow peppers Guava, blackcurrants, kiwi fruit, lychee, lemon, orange, strawberry Broccoli	Vital for a range of metabolic function Protein metabolism Collagen synthesis Nervous system function	Scurvy, impaired wound healing Fluid swelling Fatigue, depression Poor immunity	Low vitamin C levels have been seen with central obesity, but it's not clear whether this is a cause or effect. Commoner in people with poor diet, chronic alcohol dependent, smokers

Fat soluble vitamins

Deficiency of fat-soluble vitamins is associated with fat malabsorption e.g. cystic fibrosis, chronic pancreatitis, coeliac disease, cholestatic liver disease, Crohn's disease.

Fat soluble vitamins	Source	Biological function	Deficiency	Interactions, comments
Vitamin A (retinol) and carotenoids	Liver, dairy products Yellow, red and green (leafy) vegetables, such as spinach, carrots, sweet potatoes, and red peppers Yellow fruit, such as mango, papaya, and apricots	Function of the immune system Night vision Health of the skin and body linings e.g. nose and mouth	Xerophthalmia (drying out of the tear ducts of the eyes, if prolonged this can lead to corneal damage and impair vision) Impaired immunity (immunosuppression) Diarrhoea	Absorption is reduced in people with fat malabsorption
Cholecalciferol (vitamin D)	Oily fish – salmon, sardines, herring, mackerel Red meat Liver Egg yolks	Regulates calcium and phosphate. Promotes bone formation. Immune system function	Rickets in children Bone weakness in adults Decreased muscle strength. Poor immunity and wound healing Fatigue, poor sleep	Sun exposure allows the skin to make vitamin D. Deficiency is very common in the UK, as there is inadequate sun exposure in the winter, and for many people all year round
Tocopherol (vitamin E)	Vegetable oils Nuts, seeds, whole grains	Maintain cell membranes	Nerve damage, Ataxia (difficulty with coordination of walking) Muscle weakness Red blood cell breakdown Impaired vision Poor immunity	Vitamin E is fat soluble, which means it needs to be absorbed with fat. People at risk of deficiency include those with fat malabsorption, e.g. chronic pancreatitis, cystic fibrosis, Crohn's disease, short bowel syndrome
Vitamin K	Green leafy vegetables Vegetable oils Cereal grains	Blood clotting Wound healing	Prolonged blood clotting	Warfarin is given to reduce blood clotting by creating vitamin K deficiency

Minerals and Trace Elements

Minerals and Trace Elements	Source	Biological function	Deficiency	Interactions, comments
Calcium	Dairy products, tofu, sardines,	Muscle contraction,	Bone weakness (rickets in	Absorption is reduced in vitamin D

	green leafy vegetables	including heart and blood vessels. Nerve conduction Blood clotting Bones and teeth	children, osteoporosis in adults) Impaired blood clotting Impaired heart function	deficiency. Some foods (spinach, rhubarb, soy) reduce calcium absorption.
Iodine	Sea fish Shellfish Fortified salt Seaweed (depends on location it comes from)	Essential for thyroid function	Those of an underactive thyroid - Fatigue, weakness, weight gain, dry skin, hair loss Goitre (enlarge thyroid gland in neck)	Common deficiency worldwide, and particularly with vegan diet Caution with using seaweed for replacement as may cause toxicity
Iron	Red meat Beans, peas, broccoli, nuts and seeds, green leafy vegetables	Red blood cells	Iron deficiency anaemia – fatigue, breathlessness, lethargy	Iron in meat is more readily absorbed than the iron in plants
Magnesium	Leafy green vegetables, grains, legumes, some fish, nuts, seeds, chocolate	Many metabolic functions throughout the body	Muscle weakness, tremors, or cramp Cardiac rhythm disturbance Altered mental function. Seizures Abnormal absorption or vitamin D	Some diuretics (water tablets) such as Bendroflumethiazide cause magnesium to be lost in the urine
Phosphorus (phosphate)	Fish, poultry, meat, and dairy products Nuts, seeds, whole grains (less easily absorbed)	Essential for release of energy in cells throughout the body Necessary for cell replication Transports nutrients into cell Bone and teeth strength	Bone weakness and pain Muscle weakness, stiff joints Anxiety, fatigue Breathing problems and heart failure	May be caused by vitamin D deficiency, as this helps with absorption. Other causes – poor intake from diet, malnutrition, particularly in people with chronic alcohol excess and eating disorders. May occur when recovering from diabetic ketoacidosis, or starvation from any cause (refeeding syndrome)

Potassium	Fruits – especially bananas, citrus fruits, raisins Beans, nuts, grains Vegetables – potato with skin	Essential for the electrical activity in muscle cells, particularly the heart	Heart rhythm abnormalities, cardiac arrest Muscle weakness	May be lost in bowel disorders causing vomiting or diarrhoea, or from the kidneys with water tablets
Selenium	Fish, shellfish Content in grain and vegetables depends on the soil content	Supports the action of vitamin E and thyroid function	Cardiomyopathy Weak hair and nails Nausea and vomiting Neuropathy (nerve damage)	
Sodium	Salt	Fluid and acid regulation Electrical activity of nerves	Weakness, fatigue, confusion, seizures	Inadequate intake is rare. Sodium loss may occur from sweat due to exercise in hot weather, from vomiting or diarrhoea
Zinc	Shellfish Red meats Legumes, nuts	Many enzyme systems, including immune function	May contribute to fatty liver disease. Impaired immune function, wound healing, sense of smell and taste	Dietary deficiency is common as the daily requirement is high

Phytonutrients (plant pigment chemicals):

Sources: Skin of brightly coloured fruit and vegetables e.g. citrus fruits, berries, grapes, peaches, tomatoes, red cabbage, onion, peppers, beans, sage. Soy, dark chocolate, green tea, red wine

Biological functions: Reduce risk of vitamin C deficiency. May improve cardiovascular health, reduce blood pressure, and reduce cancer risk.

Deficiency: increased risk of scurvy