

Water-soluble vitamins are found in foods such as whole grain cereals, leafy green vegetables, fruits, and legumes. Vitamin B₁₂ is present only in meat and dairy foods. These vitamins are not stored to any great extent in the body and must be replenished regularly. When taken in excess, these vitamins are excreted by the body in the urine. Table 8-2 lists the water-soluble vitamins, food sources, functions, and signs of deficiency. The water-soluble vitamins are:

- Folic acid
- Nicotinic acid (niacin) and nicotinamide (niacinamide)
- Vitamin B₁ (thiamine hydrochloride)
- Vitamin B₂ (riboflavin)
- Vitamin B₆ (pyridoxine hydrochloride)
- Vitamin B₁₂
- Vitamin C (ascorbic acid)

water-soluble vitamin A vitamin that can be dissolved in water.

Fun Facts

Vitamins are lost during food processing because they are easily destroyed by light, air, heat, and water. Vitamin loss can be avoided by eating foods that are fresh and by properly preparing foods to minimize the loss. For example, use as little water as possible to prepare vegetables; keep the pan covered and heat them for only a short period of time.

Minerals

Minerals are inorganic substances that participate in many biochemical and physiological processes necessary for proper growth, development, and health. If the body requires more than 100 milligrams of an inorganic substance each day, it is labeled a *mineral*. If the body requires less than 100 milligrams a day, the substance needed is considered a trace element.

Many minerals are essential parts of enzymes. They also participate in regulating many physiological functions. These include:

- Transporting oxygen to each of the body's 60 trillion cells
- Providing the stimulus for muscles to contract
- Guaranteeing normal function of the central nervous system

Minerals are required for the growth, maintenance, repair, and health of tissues and bones. Some, such as selenium, do this by forming antioxidant enzymes.

mineral An inorganic substance that participates in many biochemical and physiological processes required for the growth, maintenance, repair, and health of tissues and bones.

Fun Facts

The elements oxygen, carbon, nitrogen, and hydrogen make up 96% of body weight. All remaining elements are minerals that make up only 4% of body weight.

Table 8-2 Water-Soluble Vitamins

NAME	FOOD SOURCES	FUNCTIONS	DEFICIENCY/TOXICITY
Thiamin (vitamin B ₁)	Animal Lean pork Beef Liver Eggs Fish Plant Whole and enriched grains Legumes Brewer's yeast	Metabolism of carbohydrates and some amino acids Maintains normal appetite and functioning of nervous system	Deficiency* Gastrointestinal tract, nervous system, and cardiovascular system problems Beriberi Toxicity None
Riboflavin (vitamin B ₂)	Animal Liver, kidney, heart Milk Cheese Plant Green, leafy vegetables Cereals Enriched bread	Aids release of energy from food Health of the mouth tissue Healthy eyes	Deficiency Cheilosis Eye sensitivity Dermatitis Glossitis Photophobia Toxicity None
Niacin (nicotinic acid)	Animal Milk Eggs Fish Poultry Plant Enriched breads and cereals	Energy metabolism Healthy skin and nervous and digestive systems	Deficiency Pellagra-dermatitis, dementia, diarrhea Toxicity Vasodilation of blood vessels
Pyridoxine (vitamin B ₆)	Animal Pork Fish Poultry Liver, kidney Milk Eggs Plant Whole-grain cereals Legumes	Conversion of tryptophan to niacin Release of glucose from glycogen Protein metabolism and synthesis of nonessential amino acids	Deficiency Cheilosis Glossitis Dermatitis Confusion Depression Irritability Toxicity Depression Nerve damage

(continues)

Table 8-2 Water-Soluble Vitamins (continued)

NAME	FOOD SOURCES	FUNCTIONS	DEFICIENCY/TOXICITY
Vitamin B ₁₂ (cobalamin)	Animal Seafood Poultry Liver, kidney Muscle meats Eggs Milk Cheese Plant None	Synthesis of red blood cells Maintenance of myelin sheaths Treatment of pernicious anemia Folate metabolism	Deficiency Degeneration of myelin sheaths Pernicious anemia Sore mouth and tongue Anorexia Neurological disorders Toxicity None
Folate (folic acid)	Animal Liver Plant Leafy green vegetables Spinach Legumes Seeds Broccoli Cereal fortified with folate Fruit	Synthesis of RBCs Synthesis of DNA	Deficiency Anemia Glossitis Neural tube defects such as anencephaly and spina bifida Toxicity Could mask a B ₁₂ deficiency
Biotin	Animal Milk Liver and kidney Egg yolks Plant Legumes Brewer's yeast Soy flour Cereals Fruit	Coenzyme in carbohydrate and amino acid metabolism Niacin synthesis from tryptophan	Deficiency Dermatitis Nausea Anorexia Depression Hair loss Toxicity None
Pantothenic acid	Animal Eggs Liver Salmon Poultry Plant Mushrooms Cauliflower Peanuts Brewer's yeast	Metabolism of carbohydrates, lipids, and proteins Synthesis of fatty acids, cholesterol, steroid hormones	Deficiency Rare: burning feet syndrome; vomiting; fatigue Toxicity None

(continues)

Table 8-2 Water-Soluble Vitamins (continued)

NAME	FOOD SOURCES	FUNCTIONS	DEFICIENCY/TOXICITY
Vitamin C (ascorbic acid)	Animal None Plants All citrus fruits Broccoli Melons Strawberries Tomatoes Brussels sprouts Potatoes Cabbage Green peppers	Prevention of scurvy Formation of collagen Healing of wounds Release of stress hormones Absorption of iron Antioxidant Resistance to infection	Deficiency Scurvy Muscle cramps Ulcerated gums Tendency to bruise easily Toxicity Raised uric acid level Hemolytic anemia Kidney stones Rebound scurvy

KEY CONCEPT

Vitamins are essential to helping the body use the energy taken in as food. Minerals are necessary to repair and maintain tissue and bone.

Most minerals are widely distributed in foods (Table 8-3). Of all essential minerals, only a few may be deficient in a typical diet. Even so, there are exceptions. Iron deficiency is common in infants, children, and pregnant women. Zinc and copper deficiencies occur fairly frequently as well. Severe mineral deficiency is unusual in the Western world.

Table 8-3 Minerals

MAJOR MINERALS			
NAME	FOOD SOURCES	FUNCTIONS	DEFICIENCY/TOXICITY
Calcium (Ca ⁺⁺)	Milk, cheese Sardines Salmon Some dark green, leafy vegetables	Development of bones and teeth Transmission of nerve impulses Blood clotting Normal heart action Normal muscle activity	Deficiency Osteoporosis Osteomalacia Rickets Tetany Retarded growth Poor tooth and bone formation

(continues)