

Table 31-2 Characteristics of Vitamin Deficiencies

VITAMIN	PURPOSE	DEFICIENCY	COMMENTS	SOURCE
WATER SOLUBLE				
Thiamine (B ₁)	Coenzyme in ketoacid decarboxylation (e.g., pyruvate → acetyl-CoA transketolase reaction)	<i>Beriberi</i> : polyneuropathy, calf tenderness, heart failure, edema, ophthalmoplegia	Inborn errors of lactate metabolism; boiling milk destroys B ₁	Liver, meat, milk, cereals, nuts, legumes
Riboflavin (B ₂)	FAD coenzyme in oxidation-reduction reactions	Anorexia, mucositis, anemia, cheilosis, nasolabial seborrhea	Photosensitizer	Milk, cheese, liver, meat, eggs, whole grains, green leafy vegetables
Niacin (B ₃)	NAD coenzyme in oxidation-reduction reactions	<i>Pellagra</i> : photosensitivity, dermatitis, dementia, diarrhea, death	Tryptophan is a precursor	Meat, fish, liver, whole grains, green leafy vegetables
Pyridoxine (B ₆)	Cofactor in amino acid metabolism	Seizures, hyperacusis, microcytic anemia, nasolabial seborrhea, neuropathy	Dependency state: deficiency secondary to drugs	Meat, liver, whole grains, peanuts, soybeans
Pantothenic acid	CoA in Krebs cycle	None reported		Meat, vegetables
Biotin	Cofactor in carboxylase reactions of amino acids	Alopecia, dermatitis, hypotonia, death	Bowel resection, inborn error of metabolism,* and ingestion of raw eggs	Yeast, meats; made by intestinal flora
B ₁₂	Coenzyme for 5-methyltetrahydrofolate formation; DNA synthesis	Megaloblastic anemia, peripheral neuropathy, posterior lateral spinal column disease, vitiligo	Vegans; fish tapeworm; short gut syndrome; transcobalamin or intrinsic factor deficiencies	Meat, fish, cheese, eggs
Folate	DNA synthesis	Megaloblastic anemia; neural tube defects	Goat milk deficient; drug antagonists; heat inactivates	Liver, greens, vegetables, cereals, cheese
Ascorbic acid (C)	Reducing agent; collagen metabolism	<i>Scurvy</i> : irritability, purpura, bleeding gums, periosteal hemorrhage, aching bones	May improve tyrosine metabolism in preterm infants	Citrus fruits, green vegetables; cooking destroys it
FAT SOLUBLE				
A	Epithelial cell integrity; vision	Night blindness, xerophthalmia, Bitot spots, follicular hyperkeratosis; immune defects	Common with protein-calorie malnutrition; malabsorption	Liver, milk, eggs, green and yellow vegetables, fruits
D	Maintain serum calcium, phosphorus levels	<i>Rickets</i> : reduced bone mineralization	Prohormone of 25- and 1,25-vitamin D	Fortified milk, cheese, liver; sunlight
E	Antioxidant	Hemolysis in preterm infants; areflexia, ataxia, ophthalmoplegia	May benefit patients with G6PD deficiency	Seeds, vegetables, germ oils, grains
K	Post-translation carboxylation of clotting factors II, VII, IX, X and proteins C, S	Prolonged prothrombin time; hemorrhage; elevated protein induced in vitamin K absence (PIVKA)	Malabsorption; breastfed infants	Liver, green vegetables; made by intestinal flora

CoA, Coenzyme A; FAD, flavin adenine dinucleotide; G6PD, glucose-6-phosphate dehydrogenase; NAD, nicotinamide adenine dinucleotide.

*Biotinidase deficiency.

Vitamin B₆

Vitamin B₆ refers to three naturally occurring pyridines: pyridoxine (pyridoxol), pyridoxal, and pyridoxamine. The phosphates of the latter two pyridines are metabolically and functionally related and are converted in the liver to the coenzyme form, pyridoxal phosphate. The metabolic functions of vitamin B₆ include interconversion reactions of amino acids, conversion of tryptophan to niacin and serotonin, metabolic reactions in the brain, carbohydrate metabolism, immune development, and the biosynthesis of heme and prostaglandins. The pyridoxal and pyridoxamine forms of the vitamin are destroyed by heat; heat treatment was responsible for vitamin B₆ deficiency and seizures in infants fed improperly processed formulas. Goat's milk is deficient in vitamin B₆.

Dietary deprivation or malabsorption of vitamin B₆ in children results in hypochromic microcytic anemia, vomiting,

diarrhea, failure to thrive, listlessness, hyperirritability, and seizures. Children receiving isoniazid or penicillamine may require additional vitamin B₆ because the drug binds to the vitamin. Vitamin B₆ is unusual as a water-soluble vitamin in that very large doses (≥500 mg/day) have been associated with a sensory neuropathy.

Folate



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