Table 4–2. SOURCES, FUNCTIONS, AND EFFECTS OF VITAMINS

NUTRIENT	PRINCIPAL SOURCES	FUNCTIONS	EFFECTS OF DEFICIENCY AND TOXICITY
Folate (folic acid)	Fresh green leafy vegetables, fruits, organ meats (eg, liver), enriched cereals and breads	Maturation of RBCs Synthesis of purines, pyrimidines, and methionine Development of fetal nervous system	**Deficiency:** Megaloblastic anemia, neural tube birth defects, mental confusion
Niacin (nicotinic acid, nicotinamide)	Liver, red meat, fish, poultry, legumes, whole-grain or enriched cereals and breads	Oxidation-reduction reactions Carbohydrate and cell metabolism	**Deficiency:** Pellagra (dermatitis, glossitis, GI and CNS dysfunction) **Toxicity:** Flushing
Riboflavin (vitamin B_2)	Milk, cheese, liver, meat, eggs, enriched cereal products	Many aspects of carbohydrate and protein metabolism Integrity of mucous membranes	**Deficiency:** Cheilosis, angular stomatitis, corneal vascularization
Thiamin (vitamin B_1)	Whole grains, meat (especially pork and liver), enriched cereal products, nuts, legumes, potatoes	Carbohydrate, fat, amino acid, glucose, and alcohol metabolism Central and peripheral nerve cell function Myocardial function	**Deficiency:** Beriberi (peripheral neuropathy, heart failure), Wernicke-Korsakoff syndrome
Vitamin A (retinol)	As preformed vitamin: fish liver oils, liver, egg yolks, butter, vitamin A–fortified dairy products As provitamin carotenoids: dark green and yellow vegetables, carrots, yellow and orange fruits	Formation of rhodopsin (a photoreceptor pigment in the retina) Integrity of epithelia Lysosome stability Glycoprotein synthesis	**Deficiency:** Night blindness, perifollicular hyperkeratosis, xerophthalmia, keratomalacia, increased morbidity and mortality in young children **Toxicity:** Headache, peeling of skin, hepatosplenomegaly, bone thickening, intracranial hypertension, papilledema
Vitamin B_6 group (pyridoxine, pyridoxal, pyridoxamine)	Organ meats (eg, liver) whole-grain cereals, fish, legumes	Many aspects of nitrogen metabolism (eg, transaminations, porphyrin and heme synthesis, tryptophan conversion to niacin) Nucleic acid biosynthesis Fatty acid, lipid, and amino acid metabolism	**Deficiency:** Seizures, anemia, neuropathies, seborrheic dermatitis **Toxicity:** Peripheral neuropathy
Vitamin B_{12} (cobalamins)	Meats (especially beef, pork, and organ meats [eg, liver]), poultry, eggs, fortified cereals, milk and milk products	Maturation of RBCs, neural function, DNA synthesis, myelin synthesis and repair	**Deficiency:** Megaloblastic anemia, neurologic deficits (confusion, paresthesias, ataxia)

Table continues on the following page.

Table 4–2. SOURCES, FUNCTIONS, AND EFFECTS OF VITAMINS (*Continued*)

NUTRIENT	PRINCIPAL SOURCES	FUNCTIONS	EFFECTS OF DEFICIENCY AND TOXICITY
Vitamin C (ascorbic acid)	Citrus fruits, tomatoes, potatoes, broccoli, strawberries, sweet peppers	Collagen formation Bone and blood vessel health Carnitine, hormone, and amino acid formation Wound healing	**Deficiency:** Scurvy (hemorrhages, loose teeth, gingivitis, bone defects)
Vitamin D (cholecalciferol, ergocalciferol)	Direct ultraviolet B irradiation of the skin (main source), fortified dairy products (main dietary source), fish liver oils, fatty fish, liver	Ca and phosphate absorption Mineralization and repair of bone Tubular reabsorption of Ca Insulin and thyroid function, improvement of immune function, reduction of autoimmune disease	**Deficiency:** Rickets (sometimes with tetany), osteomalacia **Toxicity:** Hypercalcemia, anorexia, renal failure, metastatic calcifications
Vitamin E group (α-tocopherol, other tocopherols)	Vegetable oils, nuts, legumes	Intracellular antioxidant Scavenger of free radicals in biologic membranes	**Deficiency:** RBC hemolysis, neurologic deficits **Toxicity:** Tendency to bleed
Vitamin K group (phylloquinone, menaquinones)	Green leafy vegetables (especially collards, spinach, and salad greens), soy beans, vegetable oils Bacteria in the GI tract after neonatal period	Formation of prothrombin, other coagulation factors, and bone proteins	**Deficiency:** Bleeding due to deficiency of prothrombin and other factors, osteopenia