



Vitamins

A vitamin is an organic compound and an essential nutrient that an organism requires in limited amounts. Vitamins are classified by both **biological** and **chemical** activity, and not their structure. Each vitamin name (the word vitamin followed by a letter of the alphabet) refers to a number of vitamer compounds that all show the same biological activity. For example, vitamin A refers to the compounds retinal, retinol, and four known carotenoids.

Vitamins have diverse biochemical functions. Some, such as vitamin D, have hormone-like functions as regulators of mineral metabolism, or regulators of cell and tissue growth and differentiation (such as some forms of vitamin A). Others function as antioxidants (e.g., vitamin E and vitamin C). The largest number of vitamins, the B complex vitamins, function as enzyme cofactors (coenzymes).

Classification of vitamins

Vitamins are classified as either **water-soluble** or **fat-soluble**. In humans there are 13 vitamins: 4 fat-soluble (A, D, E, and K) and 9 water-soluble (8 B vitamins and vitamin C). Water-soluble vitamins dissolve easily in water and excreted from the body within urine, because they are not as readily stored, more consistent intake is important. Fat-soluble vitamins are absorbed through the intestinal tract with the help of lipids (fats). Because they are more likely to accumulate in the body, they are more likely to lead to hypervitaminosis than are water-soluble vitamins.

Vitamin A

Vitamin A includes retinol, retinal, and four carotenoids including beta carotene. It is important for growth and development, for the maintenance of the immune system and **good vision**.

Vitamin A can be found in two principal forms in foods:

- Retinol, the form of vitamin A absorbed when eating animal food sources.
- The carotenes and the xanthophyll, function as provitamin A in herbivores and omnivore animals, which possess the enzyme cleaves carotene in the intestinal mucosa and converts it to retinol.



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Primary vitamin A deficiency occurs among children and adults who do not consume an adequate intake of provitamin A carotenoids from fruits and vegetables or preformed vitamin A from animal and dairy products. **Secondary vitamin A deficiency** is associated with chronic malabsorption of lipids.

Due to the unique function of retinal as a visual chromophore, one of the earliest and specific manifestations of vitamin A deficiency is **impaired vision**, particularly in reduced light – **night blindness**.

Keratomalacia is an eye disorder that results from vitamin A deficiency. Vitamin A is required to maintain specialized epithelia. A lack of vitamin A leads to replacement of the normal epithelium by an inappropriate keratinized stratified squamous epithelium.

Excessive vitamin A consumption can lead to nausea, irritability, anorexia (reduced appetite), vomiting, blurry vision, headaches, hair loss, muscle and abdominal pain and weakness, and altered mental status.

Vitamin A is found in many foods, including: Liver, orange, ripe yellow fruits, leafy vegetables, carrots, squash, spinach, fish, milk.

Vitamin B

Vitamins B are a class of water-soluble vitamins that play important roles in cell metabolism. In general, dietary supplements containing all eight are referred to as a vitamin B complex (Table 6.1).

Table (6.1): List of vitamins B

B number	Name	B number	Name
Vitamin B ₁	Thiamine	Vitamin B ₆	Pyridoxine
Vitamin B ₂	Riboflavin	Vitamin B ₇	Biotin
Vitamin B ₃	Niacin	Vitamin B ₉	Folic acid
Vitamin B ₅	Pantothenic acid	Vitamin B ₁₂	Cobalamins

Several named vitamin deficiency diseases may result from the lack of sufficient vitamins B. Deficiency of Vitamin B₉ results in an anemia, deficiency in pregnant women can lead to birth defects.



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Because water-soluble vitamins B are eliminated in the urine, taking large doses of certain vitamins B usually only produces transient side-effects. General side effects may include nausea and insomnia.

Good sources for vitamins B include beans, whole grains, potatoes, bananas, chili peppers, and nutritional yeast.

Vitamin C

Vitamin C, also known as **ascorbic acid**. The disease **scurvy** is prevented and treated with vitamin C-containing foods or dietary supplements.

Vitamin C is an essential nutrient involved in the repair of tissue, required for the functioning of several enzymes and is important for immune system function. It also functions as an antioxidant.

Symptoms reported for large dose include nausea, abdominal cramps and diarrhea. Vitamin C is a water-soluble vitamin, with dietary excesses not absorbed, and excesses in the blood rapidly excreted in the urine, so it exhibits remarkably low acute toxicity.

Foods containing vitamin C include citrus fruits, broccoli, Brussels sprouts, raw bell peppers, and strawberries.

Vitamin D

Vitamin D is a group of fat-soluble steroids responsible for increasing intestinal absorption of calcium, magnesium, and phosphate, and multiple other biological effects. In humans, the most important compounds in this group are vitamin D₃ (cholecalciferol) and vitamin D₂ (ergocalciferol). Only a few foods contain vitamin D. The major natural source of the vitamin is synthesis of cholecalciferol in the skin from cholesterol through a chemical reaction that is dependent on sun exposure.

Vitamin D from the diet or skin synthesis is biologically inactive; enzymatic conversion (hydroxylation) in the liver and kidney is required for activation. Vitamin D has a significant role in calcium homeostasis and metabolism.

A diet deficient in vitamin D in conjunction with inadequate sun exposure causes osteomalacia (or rickets when it occurs in children), which is a softening of the bones.



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Vitamin D overdose causes hypercalcemia. If hypercalcemia is not treated, it results in excess deposits of calcium in soft tissues and organs such as the kidneys, liver, and heart, resulting in pain and organ damage. The main symptoms of vitamin D overdose which are those of hypercalcemia including anorexia, nausea, and vomiting.

Although vitamin D is not present naturally in most foods, it is commonly added in manufactured foods. Dairy milk, fish, eggs, liver, mushrooms, and edible beverages made from soy, almond, and rice are good sources for vitamin D.

Vitamin E

Vitamin E refers to a group of compounds that include both tocopherols and tocotrienols.

Vitamin E deficiency causes sterility in males, miscarriage in females, mild hemolytic anemia in newborn infants.

Consumption of tocopherol as a dietary supplement in amounts in excess of 300 mg/day may lead to interactions with drugs.

Many fruits and vegetables, nuts and seeds are sources for vitamin E.

Vitamin K

Vitamin K is a group of structurally similar, fat-soluble vitamins that the human body requires for blood coagulation and which the body also needs for controlling binding of calcium in bones and other tissues.

Without vitamin K, blood coagulation is seriously impaired, and uncontrolled bleeding occurs. Deficiency of vitamin K may weaken bones.

Overdose of vitamin K increases coagulation in patients taking warfarin.

Leafy green vegetables such as spinach, egg yolks, and liver are sources for vitamin K.



Hormones

A hormone is molecules produced by glands in multicellular organisms that are transported by the circulatory system to regulate physiology and behavior. Hormones have diverse chemical structures, mainly of 3 classes: **eicosanoids**, **steroids**, and **amino acid/protein derivatives** (amines, peptides, and proteins).

Hormones are used to communicate between organs and tissues for physiological regulation and behavioral activities, such as digestion, metabolism, respiration, tissue function, sensory perception, sleep, excretion, lactation, stress, growth and development, movement, reproduction, and mood.

Chemical classes

Vertebrate hormones fall into three main chemical classes:

- **Amino acid derived:** include melatonin and thyroxine.
- **Eicosanoids:** hormones derive from lipids such as arachidonic acid, lipoxins and prostaglandins.
- **Steroid:** hormones derived from cholesterol. Examples of steroid hormones include the sex hormones estradiol and testosterone as well as the stress hormone cortisol.

Plant hormones include abscisic acid, auxin, cytokinin, ethylene, and gibberellin.