# Vitamins

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Compared to protein, carbohydrate, and fat, the science behind vitamins is relatively new. It began in 1906 when Christian Eijkman showed that diseases such as beriberi were due to the absence of certain nutrients in the diet rather than a bacterium, a theory that was rampant during turn of the century. Initially, scientists thought these important micronutrients were amines and therefore called them "vitamine" but changed the name to vitamin when it was discovered that not all vitamins are amino acids. In general, vitamins fit the following criteria: they are organic compounds found in animals and plants that are required for normal physiological function. Our body is able to make limited amounts of certain vitamins, but the majority of vitamins are obtained exclusively through food sources. It is important to eat a variety food since different vitamins are found in different foods.

Also, unlike macronutrients - protein, carbohydrate, and fat - vitamins contribute no calories and are needed in much smaller quantities.

The 14 vitamins defined today are classified into 2 groups, fat soluble and water soluble. Vitamins A, D, E, and K fall in the first category, while vitamin C and B vitamins, including biotin, pantothenic acid, and choline are water soluble vitamins.

## Water Soluble Vitamins

Water soluble B vitamins have many similar functions in the body. They are critical in releasing energy from macronutrients. Thanks to fortification of grains and bread products in the US, deficiency of B vitamins are no longer the serious public health issue it once was. Beriberi, a disease of thiamin deficiency, and pellagra, a disease of niacin deficiency, are very rare. However, alcoholics are one group vulnerable to suboptimum levels of water soluble vitamins due to their poor dietary habits. It is important to meet daily needs for these vitamins since any excess of these vitamins are excreted rather than stored in the body. And typically, multiple deficiencies will be evident since food sources for these vitamins are often the same. Clinical symptoms of mild deficiencies can be quickly reversed by eating a nutrient-rich diet.

### Thiamin

Thiamin is also known as vitamin B1, since it was the first B vitamin to be discovered. Beriberi is a disease of thiamin deficiency.

Functions

Thiamin is required for normal function of all body cells, especially nerves. It plays a critical part in releasing acetylcholine, the nerve chemical that regulates memory. Like other B vitamins, thiamin is involved in numerous body processes that break down macronutrients for energy.

Nutrient Interactions

High alcohol and tea consumption decreases thiamin absorption. Thiamin is sensitive to heat. Foods high in thiamin are also good sources of other B vitamins, especially, riboflavin, niacin, vitamin B6, biotin, and pantothenic acid.

### Riboflavin

Riboflavin is important for normal growth and development, the production and regulations of certain hormones, and the formation of red blood cells. Riboflavin helps activate vitamin B6 and converts tryptophan to niacin.

Nutrient Interactions

Riboflavin is heat stable but light sensitive. Riboflavin enhances the role of iron in treating anemia.

### Niacin

Like vitamins D and K, the body can make niacin from the amino acid tryptophan. Niacin deficiency causes pellagra with 4 classic symptoms; dermatitis, diarrhea, dementia, and death.

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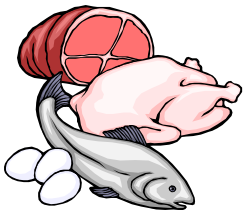
Functions

Niacin is known to be involved in more than 50 body processes and also in detoxifications of several drugs and chemicals. Niacin can also decrease blood cholesterol levels.



Nutrient Interactions

Therapeutic doses of niacin are used to treat heart disease, cancer, diabetes, and epilepsy.

## Vitamin B6

Pyridoxine, pyridoxamine, and pyridoxal are 3 compounds that make up vitamin B6.

Functions

Primary role of B6 is synthesis of amino acids and protein. This vitamin is involved in the manufacture of protein-related compounds such as hormone, hemoglobin, nerve chemicals, and many enzymes. It also plays a critical role in regulating mental processes and mood.

Nutrient Interactions

Therapeutic doses of vitamin B6 are sometimes used to treat carpal tunnel, premenstrual symptoms, and cancer. Along with other B vitamins, B6 can lower homocysteine levels, which has been associated with heart disease risk. Toxicity is possible with large doses of B6 supplements.

## Vitamin B12

Vitamin B12 is a group of cobalamin-containing compounds. Vitamin B12 is an interesting water soluble vitamin in that it is stored in the liver, kidney and other tissues and deficiency is only manfested upon years of inadequate intake. The elderly are at risk of B12 deficiency due to decreased absorption resulting from low levels of intrinsic factor, found in gastric juice. Synthetic form of vitamin B12 is cyanocobalamin.

Functions

Along with its role in breaking down macronutrients, this vitamin plays a critical role in myelin sheath and neurotransmitter formation. It is also thought that low levels of vitamin B12 may contribute to Alzheimer's disease, pernicious anemia, and diabetes.

Nutrient Interaction

High folate intake can mask anemia associated with B12 deficiency. Optimum levels of calcium and vitamin B6 facilitate vitamin B12 absorption.

## Folic Acid

Functions

Folic acid plays a critical role in regulating cell division and the transfer of inherited traits from one cell to another. Beginning in 1999, all grain products are fortified with folic acid to protect unborn babies against neural tube defects. Also, it is involved in production of neurotransmitters, such as serotonin, that regulate appetite, sleep, and mood.

Nutrient Interactions

Vitamin B12, niacin, and vitamin C are needed to help convert folic acid to its biologically active form. Excess folic acid levels may mask B12 deficiency.

## Biotin (Vitamin B7)

Like vitamin K, some biotin is produced by bacteria in the intestine. Biotin has many similar functions as other B vitamins.

Nutrient interaction

Chronic use of antibiotics will interfere with biotin production and increase risk of biotin deficiency.

## Pantothenic Acid

This vitamin is named after the Greek word panto, meaning "everywhere." It's found in both plants and animal products.

Functions

Pantothenic acid is essential for production of coenzyme A, an important catalyst in the breakdown of fats, carbohydrates, and protein for energy. Coenzyme A also functions in the synthesis of fats, cholesterol, bile, vitamin D, red blood cells, and some hormones, and neurotransmitters.

Nutrient Interactions

Pantothenic acid is necessary for vitamin D production. Biotin lessens the symptoms of a pantothenic acid deficiency.

## Choline

Choline is the latest nutrient to be added as an essential nutrient by the Institute of Medicine. Choline plays an important role in brain development in the young and memory retention in the old. Choline deficiency has been shown to increase the risk of liver damage.

## Vitamin C

Humans are one of few species that cannot produce vitamin C (ascorbic acid). Prior to its discovery, scurvy, a disease of vitamin C deficiency, claimed the lives of many crew members on long ocean voyages.

Functions

Vitamin C plays an important role in the formation and maintenance of collagen, "cement" that holds all cells together. Vitamin C promotes the healing of wounds. Vitamin C is also a powerful antioxidant that works with vitamin E to fight oxidative stressors that damage cells and can cause cancer and other chronic diseases.

Nutrient Interaction

Vitamin C enhances iron absorption.

# Fat Soluble Vitamins

## Vitamin A

In 1913 the first vitamin, vitamin A, was isolated from the retina. Vitamin A is a family of compounds that includes retinal, retinol, retinoic acid, and carotenoids. Retinal and retinol are found in foods of animal origin and can be used directly by the body. Carotenoids, pro-vitamin form of vitamin A, of which beta carotene is the most active, is found in plants. Pro-vitamin is converted into vitamin A through enzymatic process. Vitamin A deficiency continues to be a leading cause of blindness in developing countries, but here in the States, toxicity is more of a problem when people consume supplements with large doses of vitamin A.

Functions

Vitamin A plays an essential role in helping eyes work properly, especially with night vision. It also promotes the growth and health of cells and tissues throughout the body including bones and soft tissues. Vitamin A is involved in immune system. Carotenoids act as antioxidants and protect against certain cancers and diseases associated with aging, such as heart disease.

Nutrient Interactions

Vitamin A's function is enhanced by adequate intake of zinc and optimum blood levels of vitamin E. Medications that interfere with dietary fat absorption will also decrease vitamin A absorption.

## Vitamin D

Vitamin D is also known as "sunshine" vitamin since our body uses ultraviolet sun light to produce vitamin D. Ten minutes of sun exposure per day is thought to be adequate. However, dietary sources of vitamin D continue to be important for people that don't get enough sun and for the elderly, who have a diminished ability to make vitamin D. Rickets, a disease of malformed bones, is nearly eliminated in children due to fortified milk, but osteomalacia, another bone disease that occurs in the elderly with low vitamin D intake, continues to be a problem.

Functions

The primary function of vitamin D is for homeostasis of calcium and phosphorus in the body. Vitamin D ensures bones and teeth are strong as well as making sure that nerves and muscles work properly by regulating calcium levels in the blood. It is also thought that vitamin D is involved in insulin production, the immune system, and in treating skin disorders.

Nutrient Interactions

Pantothenic acid is needed for vitamin D synthesis.

## Vitamin E

Vitamin E is a powerful antioxidant that protects our body by neutralizing cell damage. It was first named tocopherol, which in Greek means childbirth and to bear, after it was shown to prevent fetal death. Of the various tocopherals and tocotrienols classified as vitamin E, α-tocopheral is the most abundant and biologically active.

Functions

Due to its ability to neutralize free radicals that are produced in the body or from the environment, studies indicate that vitamin E can protect against heart disease, cancer, Alzheimer's disease and other chronic diseases.

Nutrient Interactions

It works with other antioxidants to protect against premature aging. Vitamin E might be needed to make B12 work properly. Vitamin E might mask symptoms of zinc deficiency. Large doses of vitamin E can interfere with coagulation property of vitamin K.

## Vitamin K

Vitamin K is actually a group of compounds derived from naphthoquinone. In the gut, intestinal bacteria can synthesized vitamin K. Limited amounts of vitamin K are stored in the body.

Functions

Vitamin K is essential in the production of prothrombin, a protein essential for blood coagulation; therefore, vitamin K is critical in regulating normal blood clotting. It also is involved in bone and kidney metabolism.

Nutrient Interactions

Chronic use of antibiotics can destroy the bacteria that produce vitamin K. Blood thinning medications can counter the effects of vitamin K.

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# Dietary Reference Intakes

| | 9-13 y.o. | | 14-18 y.o. | | 19-50 y.o. | | 50-70 y.o. | | >70 y.o. | | Preg-nant | Lacta-tion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | M | F | M | F | M | F | M | F | | |
| Vitamin A (µg/d) | 600 | 600 | 900 | 700 | 900 | 700 | 900 | 700 | 900 | 700 | 770 | 1300 |
| Vitamin D (µg/d) | 5* | 5* | 5* | 5* | 5* | 5* | 10* | 10* | 15* | 15* | 5* | 5* |
| Vitamin E (µg/d) | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 19 |
| Vitamin K (µg/d) | 60* | 60* | 75* | 75* | 120* | 90* | 120* | 90* | 120* | 90* | 90* | 90* |
| Thiamin or B1 (mg/d) | 0.9 | 0.9 | 1.2 | 1.0 | 1.2 | 1.1 | 1.2 | 1.1 | 1.2 | 1.1 | 1.4 | 1.4 |
| Riboflavin or B2 (mg/d) | 0.9 | 0.9 | 1.3 | 1.0 | 1.3 | 1.1 | 1.3 | 1.1 | 1.3 | 1.1 | 1.4 | 1.6 |
| Niacin (mg/d) | 12 | 12 | 16 | 14 | 16 | 14 | 16 | 14 | 16 | 14 | 18 | 17 |
| Vitamin B6 (mg/d) | 1.0 | 1.0 | 1.3 | 1.2 | 1.3 | 1.3 | 1.7 | 1.5 | 1.7 | 1.5 | 1.9 | 2.0 |
| Vitamin B12 (µg/d) | 1.8 | 1.8 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.6 | 2.8 |
| Folic Acid (µg/d) | 300 | 300 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 600 | 500 |
| Biotin (µg/d) | 20* | 20* | 25* | 25* | 30* | 30* | 30* | 30* | 30* | 30* | 30* | 35* |
| Pantothenic Acid (mg/d) | 4* | 4* | 5* | 5* | 5* | 5* | 5* | 5* | 5* | 5* | 6* | 7* |
| Vitamin C (mg/d) | 45 | 45 | 75 | 65 | 90 | 75 | 90 | 75 | 90 | 75 | 85 | 120 |
| Choline (mg/d) | 375* | 375* | 550* | 400* | 550* | 425* | 550* | 425* | 550* | 425* | 450* | 550* |

Asterisk (*) indicates adequate intake.

# Food Sources of Essential Vitamins

| | |
|---|---|
| Vitamin A | 3.5 oz. braised liver (10,602 µg); ½ cup cooked sweet potatoes (959 µg); 2/3 cup cooked spinach (494 µg); large egg (84 µg) |
| Vitamin D | Cup of fortified milk (2.5 µg); large egg (0.6 µg); tsp of margarine (0.5 µg); fortified breakfast cereals |
| Vitamin E | Ounce dried sunflower seeds (14 mg); ¼ cup wheat germ (4 mg), table spoon of safflower oil (5 mg) |
| Vitamin K | ½ cup raw chopped turnip greens (182 µg); 3.5 oz. raw beef liver (104 µg); large egg yolk (25 µg); seaweed |
| Thiamin | Pork, wheat germ, organ meats, greens, peanuts, orange |
| Riboflavin | Same as thiamin |
| Niacin | 3 oz. chicken (11 mg); 3 oz. tuna (5 mg); 2 tbsp peanut butter (4 mg); fortified grains and cereals |
| Vitamin B6 | Medium banana (0.66 mg); 3 oz. salmon (0.55 mg); 4 oz. sweet potato (0.27 mg) |
| Vitamin B12 | 3.5 oz. beef liver (71 µg); 6 medium oysters (16 µg); ½ cup tempeh (0.7 µg); large egg (0.5 µg). Fermented vegetables are the only vegetable sources of vitamin B12. |
| Folic Acid | Serving of fortified breakfast cereal (100-400 µg); ½ cup cooked spinach (131 µg); 1 cup orange juice (109 µg) |
| Biotin | Large egg (10 µg); Good sources are yeast, soy beans, egg yolks, peanut butter and mushrooms. |
| Pantothenic Acid | Medium avocado (1.7 mg); cup of milk (0.8 mg); Large egg (0.6mg) |
| Vitamin C | Cup cooked broccoli (116 mg); cup orange juice (97 mg); cup strawberries (84 mg) |
| Choline | Large egg (280 mg); cup of milk; peanuts; liver |