

Chapter 5: Vitamins

Vitamins

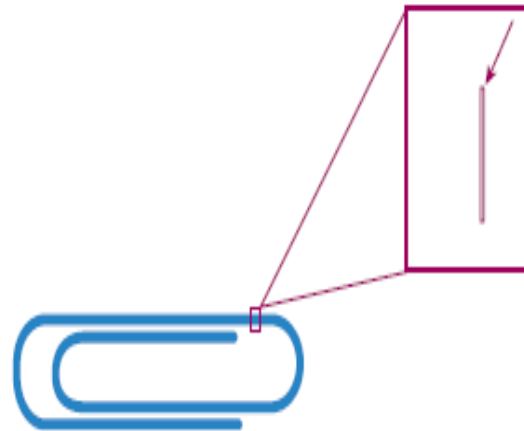
1. Do not provide energy.
but are needed for the metabolism of energy
2. Are needed in microgram or milligram quantities, not gram quantities → “micronutrients”



1 large paperclip weighs approximately 1 *gram*
RDA for protein for adult female who weighs 127 pounds is 46 g



If you divide 1 large paperclip into 1000 equal portions, each piece weighs 1 *milligram*
RDA for thiamin for adult female is 1.1 mg



If you divide a 1 mg piece into 1000 equal portions, each piece weighs 1 *microgram*
RDA for vitamin B₁₂ for adult female is 2.4 μ g

FIGURE 5.1 Representative sizes of 1 g, 1 mg, and 1 mcg.

Vitamins Are Chemically Defined

- the body cannot distinguish between natural vitamins extracted from food and synthetic vitamins produced in a laboratory.
- However, the **absorption rates** of natural and synthetic vitamins sometimes differ because of different **chemical forms** of the same vitamin
 - (e.g., synthetic folic acid is better absorbed than natural folate in foods)
- or because the synthetic vitamins are “free,” not “bound” to other components in food
 - (e.g., synthetic vitamin B12 is not bound to small peptides as natural vitamin B12 is).

Vitamins Are Susceptible to Destruction

- vitamins in food are susceptible to destruction and subsequent loss of function
 - **thiamin** is heat sensitive and is easily destroyed by high temperatures and long cooking times
 - **Riboflavin** is resistant to heat, acid, and oxidation but is quickly destroyed by light.
 - riboflavin-rich milk is sold in opaque, not transparent, containers
 - **Vitamin C** is destroyed by heat, air, and alkalis

Vitamins

- **Some Vitamins Are Coenzymes**
 - E.g : B vitamins
- **Some Vitamins Are Antioxidants**
 - The major antioxidants are vitamin C, vitamin E, and betacarotene.
 - Each has a slightly different role, so one cannot completely substitute for another.
- **Some Vitamins Are Used As Food Additives**
 - vitamin C is added to frozen fish to help prevent rancidity and to luncheon meats to stabilize the red color
 - Vitamin E helps retard rancidity in vegetable oils,
 - betacarotene adds color to margarine
- **Vitamins As Drugs**
 - Large doses of niacin are used to lower cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides
 - retinoic acid, a form of vitamin A: is used as a topical treatment for acne vulgaris and orally for acute promyelocytic leukemia.

Classifications based on solubility

Water soluble

- Vitamin c
- B vitamins :
 - Thiamin
 - Riboflavin
 - Niacin
 - Folate
 - B6, B12
 - Biotin
 - Pantothenic acid

Fat soluble

DEKA

TABLE 5.1

Group Characteristics of Fat-Soluble and Water-Soluble Vitamins

Characteristic	Fat-Soluble Vitamins	Water-Soluble Vitamins
Sources	The fat and oil portion of foods	The watery portion of foods
Absorption	With fat encased in chylomicrons that enter the lymphatic system before circulating in the bloodstream	Directly into the bloodstream
Transportation through the blood	Attach to protein carriers because fat is not soluble in watery blood	Move freely through the watery environment of blood and within cells
Fat when consumed in excess of need	Are stored—primarily in the liver and adipose tissue	Are excreted in the urine, although some tissues may hold limited amounts of certain vitamins
Safety of consuming high intakes through supplements	Can be toxic. This applies primarily to vitamins A and D; large doses of vitamins E and K are considered relatively nontoxic	Are generally considered nontoxic, although side effects can occur from consuming very large doses of vitamin B ₆ over a prolonged period
Frequency of intake	Generally do not have to be consumed daily because the body can retrieve them from storage as needed	Must be consumed daily because there is no reserve in storage

Vitamin A : Functions

1. The formation of visual purple (Rhodopsin), which **enables the eye to adapt to dim light**
2. Normal growth and development of bones and teeth
3. The formation and maintenance of **mucosal epithelium** to maintain healthy functioning of skin and membranes, hair, gums, and various glands
4. Important role in immune function

Vitamin A : Sources

- **Retinol (from animal sources)**
 - Liver, milk, butter, cheese, cream, egg yolk, fortified milk, margarine, and ready to- eat cereals
- **Beta-Carotene (from plant sources)**
 - Spinach, kale , mango, broccoli, carrots, peaches, pumpkin, red peppers, sweet potatoes, winter squash, watermelon, apricots, cantaloupe

Vitamin A : Deficiency

- Slow recovery of vision after flashes of bright light at night
- Bone growth ceases
- Skin becomes dry, scaly, rough, and cracked
- Decreased saliva secretion ,difficulty chewing, swallowing → anorexia

Vitamin A : Deficiency

- Decreased mucous secretion of the stomach and intestines → impaired digestion and absorption
- Impaired immune system functioning → increased susceptibility to infections

Vitamin A : Toxicity

- Headaches, vomiting, double vision
- hair loss, bone abnormalities
- liver damage
- Can cause birth defects during pregnancy

Vitamin D : Functions

- Maintains serum calcium concentrations by:
 1. Stimulating GI absorption
 2. Stimulating the release of calcium from the bones
 3. Stimulating calcium absorption from the kidneys

Vitamin D : Sources

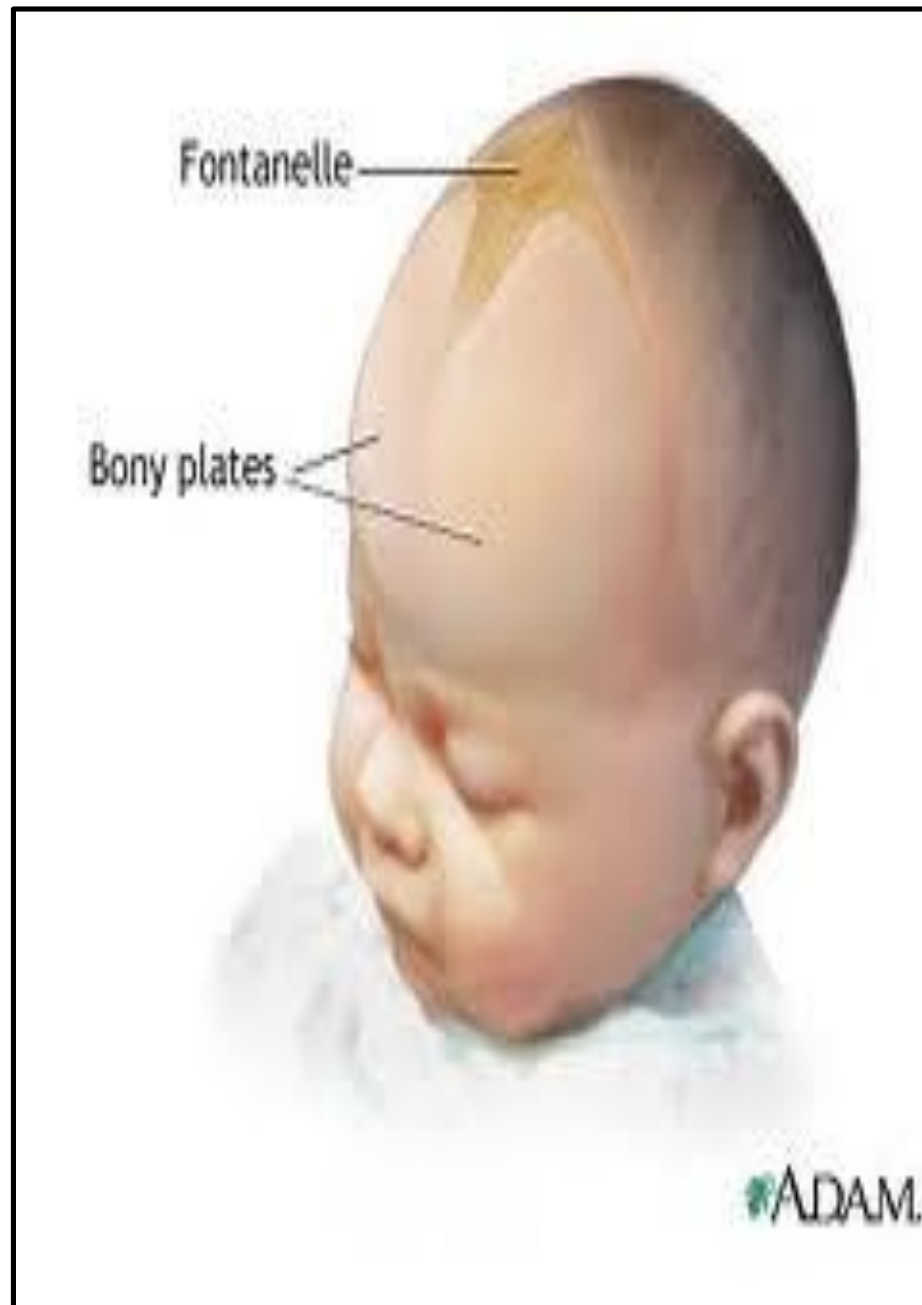
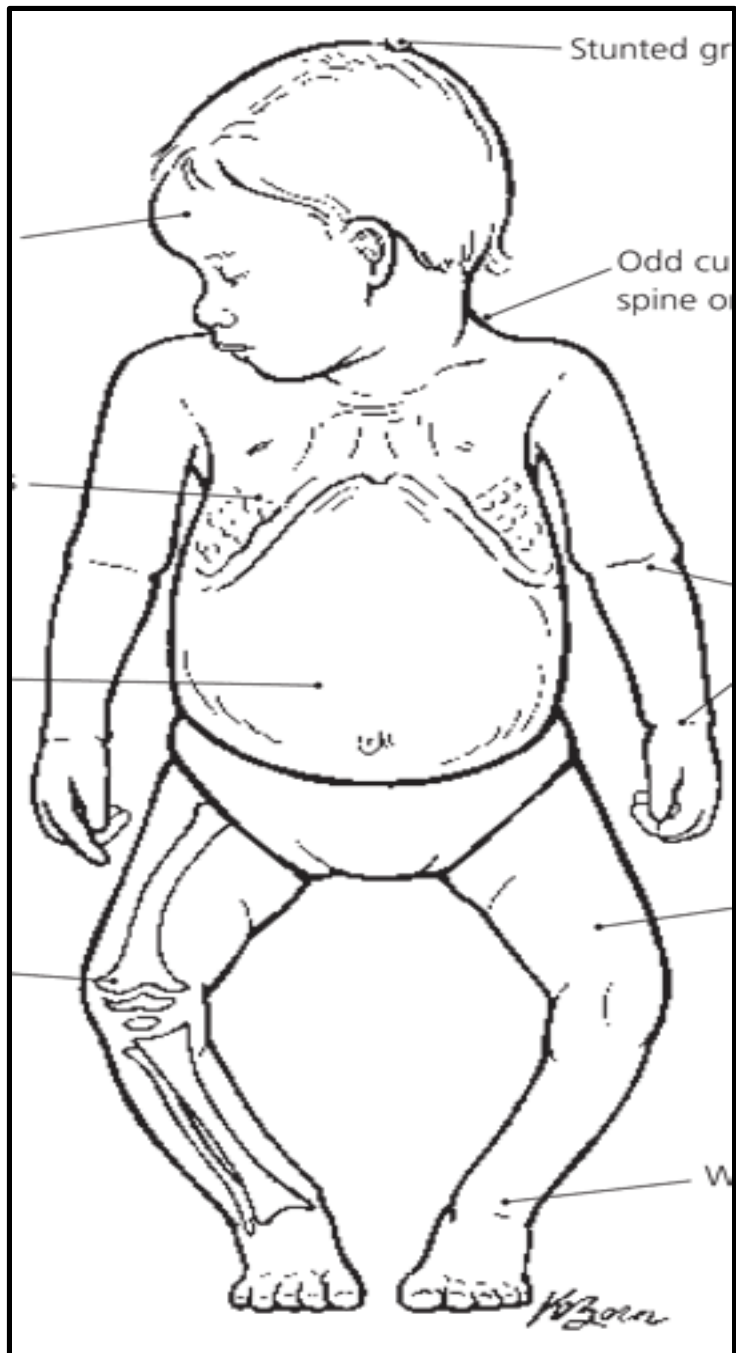
- Sunlight on the skin
- Cod liver oil, oysters , most fish
- egg yolks
- fortified milk
- some ready-to-eat cereals
- Margarine
- Sun dried grass !! As source for animals

Factors that impair vitamin D synthesis

- Dense clouds
- Heavy smog
- Clothing
- Window glass
- Sunscreen
- Dark skin

Vitamin D : Deficiency

- Rickets (in infants and children) : Retarded bone growth
- Osteomalacia (in adults)
- Delayed closing of the fontanel → rapid enlargement of the head
- Decreased serum calcium and/or phosphorus
- Increased secretion of parathyroid hormone
- Involuntary muscle twitching and spasms



Vitamin D : Toxicity

- Kidney stones
- irreversible kidney damage
- muscle and bone weakness
- excessive bleeding
- loss of appetite
- Headache
- Excessive thirst
- Calcification of soft tissues (blood vessels, kidneys, heart, lungs)
- Death

Vitamin E : Functions

- Acts as an **antioxidant** to protect vitamin A and PUFA from being destroyed
- Protects cell membranes

Vitamin E : Sources

- Vegetable oils, margarine, salad dressing
- other foods made with vegetable oil
- Nuts, seeds, wheat germ
- Dark green vegetables
- whole grains
- fortified cereals

Vitamin E : Deficiency

- Increased RBC hemolysis
- In infants, anemia, edema, and skin lesions

Vitamin E : Toxicity

- Relatively nontoxic
- High doses enhance action of anticoagulant medications

Vitamin K : Functions

- Synthesis of blood clotting proteins and a bone protein that regulates blood calcium

Vitamin K : Sources

- Bacterial synthesis
 - Brussels sprouts, broccoli, cauliflower, Swiss chard, spinach
 - loose-leaf lettuce, carrot
 - Green beans, asparagus
 - Eggs
-
- Single dose of vitamin K is given at birth . why ???

Vitamin K

- **Deficiency**
 - Hemorrhaging
 - Antibiotics kill the intestinal bacteria that synthesize vitamin K.
- **Toxicity**
 - No symptoms have been observed

Water soluble vitamins

Vitamin B1 (Thiamin) : Functions

- Coenzyme in energy metabolism
- Promotes normal appetite and nervous system functioning

Vitamin B1 (Thimain) : Sources

- Whole grain and enriched breads and cereals
- Liver
- nuts, wheat germ
- Pork
- Dried peas and beans

Vitamin B1 (Thimain) : Deficiency

- Beriberi
- Fatigue
- Peripheral paralysis
- Muscle weakness and wasting
- Anorexia, weight loss
- Edema
- Enlarged heart
- Sudden death from heart failure

Vitamin B2 (Riboflavin) : Functions

- Coenzyme in energy metabolism
- Aids in the conversion of tryptophan into niacin

Vitamin B2 (Riboflavin) : Sources

- Milk and other dairy products
- whole grain and enriched breads and cereals
- Liver
- Eggs
- meat
- spinach

Vitamin B2 (Riboflavin) : Deficiency

- Dermatitis
- Cheilosis
- Glossitis
- Photophobia
- Reddening of the cornea

Vitamin B3 (Niacin) : Functions

- Coenzyme in energy metabolism
- Promotes normal nervous system functioning

Vitamin B3 (Niacin) : Sources

- All protein foods
- whole grain and enriched breads and cereals

Vitamin B3 (Niacin) : Deficiency

- **Pellagra: 4 D's**

1. Dermatitis and glossitis
2. Diarrhea
3. Dementia, irritability, mental confusion
4. Death, if untreated

Vitamin B6 : Functions

- Coenzyme in amino acid and fatty acid metabolism
- **Helps convert tryptophan to niacin**
- Helps produce insulin, hemoglobin, myelin sheaths, and antibodies

Vitamin B6 : Sources

- Meats, fish, poultry
- fruits, green leafy vegetables
- whole grains
- Nuts
- dried peas and beans

Vitamin B6 : Deficiency

- Dermatitis
- Cheilosis
- Glossitis
- Convulsions
- anemia

Folate : Functions

- Coenzyme in DNA synthesis
 - Therefore vital for new cell synthesis and the transmission of inherited characteristics

Folate : Sources

- Liver
- okra, spinach, asparagus
- dried peas and beans, seeds, orange
- juice; breads, cereals

Folate : Deficiency

- Glossitis
- Diarrhea
- Macrocytic anemia
- Depression
- Mental confusion
- fainting, fatigue

Vitamin B 12 : Functions

- Coenzyme in the synthesis of new cells
- **Activates folate**
- Maintains nerve cells
- Helps metabolize some fatty acids and amino acids

Vitamin B 12 : Sources

- Animal products:
 - Meat, fish, poultry, shellfish, milk, dairy products, eggs
- Some fortified foods

Vitamin B 12 : deficiency

- GI changes: glossitis, anorexia, indigestion, recurring diarrhea or constipation, and weight loss
- Macrocytic anemia
- Neurologic changes: paresthesia of the hands and feet
- Poor memory
- irritability
- depression
- hallucinations

Vitamin C : Functions

- Collagen synthesis
- Antioxidant
- Promotes iron absorption
- Involved in the metabolism of certain amino acids
- Thyroxin synthesis
- Immune system functioning

Vitamin C : Sources

- Citrus fruits and juices
- red and green peppers
- Broccoli, cauliflower,
- Brussels sprouts, cantaloupe,
- Kiwifruit
- Mustard greens
- Strawberries
- Tomatoes

Vitamin C : Deficiency

- Bleeding gums
- Scurvy
- Delayed wound healing: reopening of old wounds
- Softening of the bones → malformations, pain, easy fractures
- Soft, loose teeth
- Anemia
- Increased susceptibility to infection
- Hysteria and depression

Vitamin C : Toxicity

- Diarrhea
- Mild GI upset

Multivitamin / multi-mineral supplements

- **Can Supplements Be Used As Insurance Against Poor Food Choices?**
- While there is little scientific evidence to suggest that vitamin supplements can benefit the average person, there is also **little evidence of harm from low-dose multivitamin or multivitamin and mineral supplements.**
- Because vitamins **work best together** and in balanced proportions, a multivitamin that provides no more than 100% of the Daily Value (DV) is usually better than single-vitamin supplements that tend to provide doses much greater than the RDA.
- Remember that pills are not a substitute for healthy food: “supplement” means “add to,” not “replace.”



Other groups who may benefit from a multivitamin supplement include

- Dieters who consume less than 1200 calories. Even with optimal food choices, it may not be possible to consume adequate amounts of all nutrients on a low-calorie diet.
- Vegans, who eat no animal products, need supplemental B₁₂ because it is found naturally only in animal products. They may also need vitamin D if sunlight exposure is inadequate because the only plant sources of vitamin D are some fortified margarines and some fortified cereals.
- Finicky eaters and people who eliminate one or more food groups from their typical diet. For instance, someone who cannot tolerate citrus juices because of gastric reflux may not consistently obtain adequate vitamin C without the use of a vitamin supplement.
- The elderly, who may have an inadequate food intake related to a limited food budget, impaired chewing and swallowing, social isolation, physical limitations that make shopping

or cooking difficult, or a decreased sense of taste leading to poor appetite. In addition, their vitamin requirements may be elevated as a result of chronic disease or as a side effect of certain medications. Low-dose multivitamin and mineral supplements can help meet recommended intake levels in the elderly (ADA, 2005).

- Alcoholics, because alcohol alters vitamin intake, absorption, metabolism, and excretion. The nutrients most profoundly affected are thiamin, riboflavin, niacin, folic acid, and pantothenic acid.

KEY RECOMMENDATIONS FOR SPECIFIC POPULATION GROUPS

- *People over age 50. Consume vitamin B₁₂ in its crystalline form (i.e., fortified foods or supplements).*

Men and women over age 50 are urged to consume most of their RDA for vitamin B₁₂ via fortified cereals or supplements because they may not adequately absorb adequate B₁₂ from protein-bound food sources.

- *Women of childbearing age who may become pregnant. Eat foods high in heme-iron and/or consume iron-rich plant foods or iron-fortified foods with an enhancer of iron absorption, such as vitamin C-rich foods.*

Vitamin C enhances the absorption of iron from plant sources.

- *Women of childbearing age who may become pregnant and those in the first trimester of pregnancy. Consume adequate synthetic folic acid daily (from fortified foods or supplements) in addition to food forms of folate from a varied diet.*

Women capable of becoming pregnant are urged to obtain 400 micrograms of folic acid through supplements or fortified food in addition to natural folate obtained through a normal mixed diet. Notice the word “or.” Women who consume folic acid–fortified cereal do not need a supplement; in fact, they may be at risk for an excessive folic acid intake if they consume both. Although fortified cereals only provide 400 micrograms of folic acid per serving, actual portion sizes eaten are usually much bigger.

- *Older adults, people with dark skin, and people exposed to insufficient ultraviolet band radiation (i.e., sunlight). Consume extra vitamin D from vitamin D–fortified foods and/or supplements.*

“Extra” is not defined.

Source: United States Department of Health and Human Services, United States Department of Agriculture. (2005). *Dietary Guidelines for Americans* (7th ed.). Available at www.cnpp.usda.gov/dietaryguidelines.htm

Phytochemicals

Phytochemicals

- **Phytochemicals** : plant (“phyto” in Greek) chemicals
- a broad class of nonnutritive compounds that plants produce to protect themselves against viruses, bacteria, and fungi.
- Though not essential for life, are thought to promote health.

Lycopene

- Potent antioxidant that may reduce the risk of prostate cancer and heart diseases
- **Sources** : Red fruits and vegetables, such as tomatoes, tomato products, red grapefruit, red peppers, watermelon

Limonene

- Boosts levels of body enzymes that may destroy carcinogens
- Sources : Oranges, grapefruit, tangerines, lemons, and limes

Polyphenols (catechins)

- May help to prevent DNA damage by neutralizing free radicals
- Onion, apple, tea, red wine, grapes, grape juice, strawberries, green tea

Allyl sulfides

- Boost levels of naturally occurring enzymes that may help to maintain healthy immune system
- Garlic, onions, leeks, chives

TABLE 5.4 Possible Effects and Sources of Selected Phytochemicals

Phytochemical (Name or Class)	Possible Effects	Sources
Lycopene	Potent antioxidant that may reduce the risk of prostate cancer and heart disease	Red fruits and vegetables, such as tomatoes, tomato products, red grapefruit, red peppers, watermelon
Allyl sulfides	Boost levels of naturally occurring enzymes that may help to maintain healthy immune system	Garlic, onions, leeks, chives
Isoflavones (genistein and daidzein)	Antiestrogen activity, which may decrease the risk of estrogen-dependent cancers; may inhibit the formation of blood vessels that enable tumors to grow	Soybeans, soy flour, soy milk, tofu, other legumes
Ellagic acid	May reduce the risk of certain cancers and decrease cholesterol levels	Red grapes, strawberries, raspberries, blueberries, kiwifruit, currants
Limonene	Boosts levels of body enzymes that may destroy carcinogens	Oranges, grapefruit, tangerines, lemons, and limes
Polyphenols (catechins)	May help to prevent DNA damage by neutralizing free radicals	Onion, apple, tea, red wine, grapes, grape juice, strawberries, green tea, wine
Lignans	Act as a phytoestrogen; may reduce the risk of certain kinds of cancer	Flaxseed, whole grains
Phytic acid	May inhibit oxidative reactions in the colon that produce harmful free radicals	Whole wheat
Lutein	Acts as an antioxidant; may reduce the risk of heart disease, age-related eye diseases, and cancer	Kale, spinach, collard greens, kiwifruit, broccoli, Brussels sprouts, Swiss chard, romaine
Zeaxanthin	May help prevent macular degeneration and certain types of cancer	Corn, spinach, winter squash
Resveratrol	May reduce the risk of heart disease, cancer, and stroke	Red grapes, red grape juice, red wine