

Chapter 7: The Vitamins



**PowerPoint Lectures for
Nutrition: Concepts and Controversies, eleventh edition
Frances Sizer and Ellie Whitney**

Lectures by Judy Kaufman, Ph.D.

Introduction

- ◆ Vitamins were discovered at the beginning of the twentieth century.
 - ◆ **Definition:** An essential, noncaloric, organic nutrient needed in tiny amounts in the diet.
-

Introduction

- ◆ The role of vitamins is to help make possible the processes by which other nutrients are digested, absorbed, and metabolized or built into body structures.
 - ◆ The only disease a vitamin can cure is the one caused by a **deficiency** of that vitamin.
-

Definition and Classification of Vitamins

TABLE 7-1 Vitamin Names^a

Fat-Soluble Vitamins

Vitamin A

Vitamin D

Vitamin E

Vitamin K

Water-Soluble Vitamins

B vitamins

Thiamin (B₁)

Riboflavin (B₂)

Niacin (B₃)

Folate

Vitamin B₁₂

Vitamin B₆

Biotin

Pantothenic acid

Vitamin C

^aVitamin names established by the International Union of Nutritional Sciences Committee on Nomenclature. Other names are listed in Tables 7-5 and 7-6 (pp. 252, 254).

Definition and Classification of Vitamins

Vitamins fall into 2 classes, fat soluble and water soluble



Vitamin Precursors

- ◆ Some vitamins exist as **precursors**, or **provitamins**

Fat-Soluble and Water-Soluble Vitamins

TABLE 7-2 Characteristics of the Fat-Soluble and Water-Soluble Vitamins

While each of the vitamins have unique functions and features, a few generalizations about the fat-soluble and water-soluble vitamins can aid understanding.

	FAT-SOLUBLE VITAMINS: VITAMINS A, D, E, AND K	WATER-SOLUBLE VITAMINS: B VITAMINS AND VITAMIN C
Absorption	Absorbed like fats, first into the lymph, then the blood.	Absorbed directly into the blood.
Transport and Storage	Must travel with protein carriers in watery body fluids; stored in the liver or fatty tissues.	Travel freely in watery fluids; most are not stored in the body.
Excretion	Not readily excreted; tend to build up in the tissues.	Readily excreted in the urine.
Toxicity	Toxicities are likely from supplements, but occur rarely from food.	Toxicities are unlikely but possible with high doses from supplements.
Requirements	Needed in periodic doses (perhaps weeks or even months) because the body can draw on its stores.	Needed in frequent doses (perhaps 1 to 3 days) because the body does not store most of them to any extent.

The Fat-Soluble Vitamins

- ◆ A, D, E, K
 - Found in fats and oils of foods
 - Require bile for absorption
 - Stored in liver and fatty tissues until needed
 - Not needed in the diet daily
 - Can reach toxic levels if too much is consumed
 - Deficiencies can occur when people eat diets that are extraordinarily low in fat
-

Vitamin A

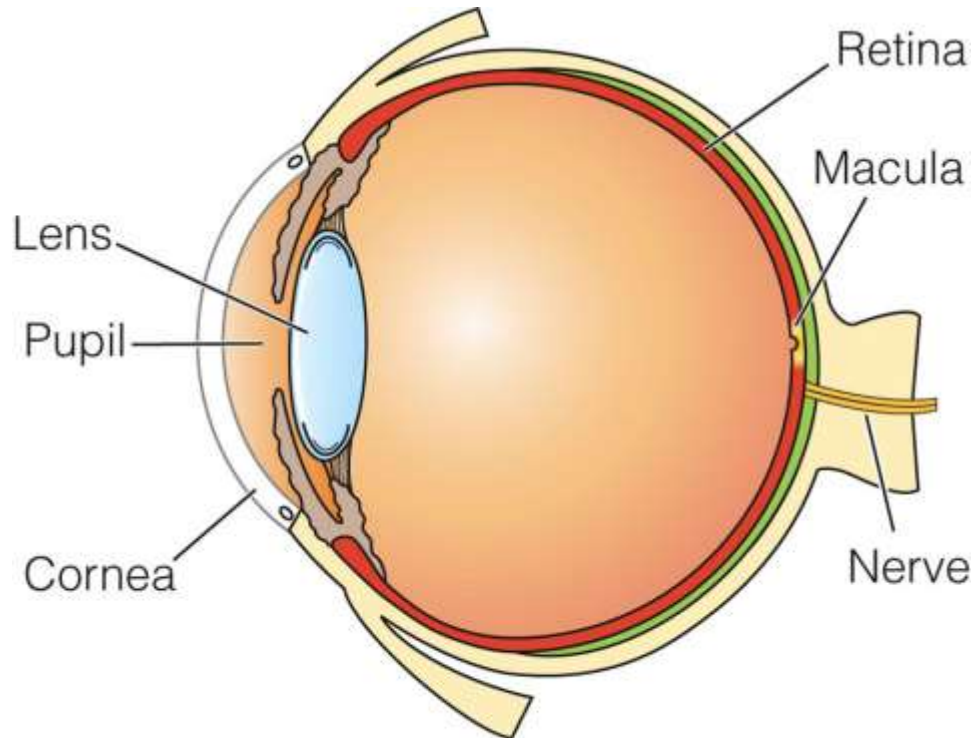
- ◆ Beta-carotene – plant-derived precursor
 - ◆ Retinol – active form stored in the liver
 - Converted by cells into its other two active forms, retinal and retinoic acid, as needed
-

◆ Vitamin A plays a role in

- Gene expression
 - Vision
 - Maintenance of body linings and skin
 - Immune defenses
 - Growth of bones and of the body
 - Normal development of cells
 - Reproduction
-

- ◆ Vitamin A exerts influence on body functions through its regulation of genes.
 - ◆ Hundreds of genes are regulated by the retinoic acid form of vitamin A.
-

- ◆ Vitamin A plays two roles:
 - Process of light perception at the retina
 - Maintenance of a healthy cornea



An eye (sectioned).

- ❖ Vitamin A is part of the **rhodopsin** molecule, a pigment within the cells of the retina.
 - ❖ When light falls on the eye, it bleaches rhodopsin, which breaks off the vitamin A, initiating a signal that conveys the sensation of sight to the optic center of the brain.
-

Eyesight

- ◆ The vitamin then reunites with the pigment, but a little vitamin A is destroyed each time this reaction takes place, and fresh vitamin A must replenish the supply.
- ◆ If the vitamin A supply runs low, **night blindness** can result – a lag before the eye can see again after a flash of bright light at night.



In dim light, you can make out the details in this room.



A flash of bright light momentarily blinds you as the pigment in the retina is bleached.



You quickly recover and can see the details again in a few seconds.



With inadequate vitamin A, you do not recover but remain blind for many seconds; this is night blindness.

- ❖ A more serious deficiency of vitamin A occurs when the protein **keratin** accumulates and clouds the eye's outer vitamin A-dependent part, the cornea.
 - ❖ **Keratinization** of the cornea can lead to **xerosis** (drying) and then progress to thickening and permanent blindness, **xerophthalmia**.
 - ❖ 500,000 of the world's vitamin A-deprived children become blind each year due to **xerophthalmia**.
-

- ❖ Vitamin A is needed by all epithelial tissue which includes the protective linings of the lungs, intestines, vagina, urinary tract, and bladder.
 - ❖ If vitamin A is deficient, cells fail to make mucus and secrete keratin, the same protein found in hair and nails.
 - ❖ **Keratinization** makes the tissues dry, hard and cracked which makes they are more susceptible to infection.
-

◆ The skin in vitamin A deficiency



- ◆ Vitamin A has a reputation as an “anti-infective” vitamin.
 - ◆ Body’s defenses depend on an adequate supply.
-

- ❖ Vitamin A assists in growth of bone (and teeth).
 - ❖ In children, failure to grow is one of the first signs of poor vitamin A status.
-


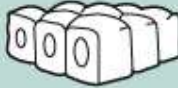

- ◆ Between 3 and 10 million of the world's children suffer from a severe vitamin A deficiency including
 - Xerophthalmia
 - Diarrhea
 - Appetite loss
 - Reduced food intake
 - ◆ 275 million more children have impaired immunity, leaving them open to infections
-

- ◆ Can occur when excess vitamin A is taken as supplements or fortified foods
 - ◆ Chronic use of vitamin supplements providing three to four times the recommended dose for pregnancy has caused birth defects
-

Vitamin A Toxicity

- With the exception of liver, it is not easy to ingest toxic amounts of vitamin A.
 - 1 oz of beef liver contains 3 times the DRI.

Vitamin A intake,
μg/day

Deficient 0–500		Normal 500–3,000		Toxic 3,000 and over	
Effects on cells	Health consequences	Effects on cells	Health consequences	Effects on cells	Health consequences
Decreased cell division and deficient development 	Night blindness Keratinization Xerophthalmia Impaired immunity Reproductive and growth abnormalities Exhaustion Death	Normal cell division and development 	Normal body functioning	Overstimulated cell division 	Skin rashes Hair loss Hemorrhages Bone abnormalities Birth defects Fractures Liver failure Death

Vitamin A from highly fortified foods and other rich sources can add up. The UL for Vitamin A is 3,000 μg per day.

High-potency vitamin pill	3,000 μg
Calf's liver, 1 oz. cooked	2,300 μg
Regular multivitamin pill	1,500 μg
Vitamin gumball, 1	1,500 μg
Chicken liver, 1 oz cooked	1,400 μg
"Complete" liquid supplement	
drink, 1 serving	350–1,500 μg
Instant breakfast	
drink, 1 serving	600–700 μg
"Diet" low-carbohydrate	
drink, 1 serving	500–700 μg
Cereal breakfast bar, 1	350–400 μg
"Energy" candy bar, 1	350 μg
Milk, 1 c	150 μg
Vitamin-fortified cereal,	
1 serving	150 μg
Margarine, 1 tsp	55 μg

- ❖ Vitamin A is not needed every day. Why?
 - ❖ DRI for man is 900 micrograms
 - ❖ DRI for woman is 700 micrograms
 - ❖ Tolerable Upper Intake Level is 3,000 micrograms
-

- ◆ Beta-carotene is found in vegetables and fruits
 - Orange or muddy green colored
 - ◆ Active vitamin A is found in foods of animal origin
 - Liver, fish oil, milk, fortified cereals, eggs, butter
-

Food Sources of Vitamin A

SNAPSHOT 7-1

VITAMIN A AND BETA-CAROTENE

DRI RECOMMENDED INTAKES:

Men: 900 µg/day^a

Women: 700 µg/day^a

TOLERABLE UPPER INTAKE LEVEL:

Adults: 3,000 µg vitamin A/day

CHIEF FUNCTIONS:

Vision; maintenance of cornea, epithelial cells, mucous membranes, skin; bone and tooth growth; regulation of gene expression; reproduction; immunity

DEFICIENCY:

Night blindness, corneal drying (xerosis), and blindness (xerophthalmia); impaired bone growth and easily decayed teeth; keratin lumps on the skin; impaired immunity

TOXICITY:

Vitamin A: Increased activity of bone-dismantling cells causing reduced bone density and pain; liver abnormalities; birth defects

Beta-carotene: Harmless yellowing of skin

*These foods provide 10 percent or more of the vitamin A Daily Value in a serving. For a 2,000-calorie diet, the DV is 900 µg/day.

^aVitamin A recommendations are expressed in retinol activity equivalents (RAE).

^bThis food contains preformed vitamin A.

^cThis food contains the vitamin A precursor, beta-carotene.

GOOD SOURCES*

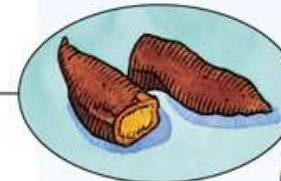
FORTIFIED MILK^b
1 c = 150 µg



CARROTS^c (cooked)
1/2 c = 671 µg



SWEET POTATO^c
(baked)
1/2 c = 961 µg



SPINACH^c (cooked)
1/2 c = 472 µg



BEEF LIVER^b (cooked)
3 oz = 6,582 µg



BOK CHOY^c (cooked)
1/2 c = 180 µg



APRICOTS^c
3 apricots = 100 µg

Colorful foods are often rich in vitamins



- ◆ In plants, vitamin A only exists in its precursor form.
 - ◆ Beta-carotene, the most abundant of these **carotenoid** precursors, has the highest vitamin A activity.
 - 12 micrograms of beta carotene from food supplies the equivalent of 1 microgram of retinol in the body.
-

- Beta-carotene from food is not converted to retinol efficiently enough to cause vitamin A toxicity. Excess beta-carotene is stored the fat under the skin, imparting a yellow cast.
- Do you think this is harmful?



Answer: NO

- ◆ Yes, eating carrots and other rich sources of beta-carotene promotes good vision.
 - Dark green vegetables
 - Spinach, broccoli, collard greens
 - Orange fruits and vegetables
 - Carrots, sweet potatoes, pumpkins, mango, cantaloupe, apricots
-

- ❖ People with low intakes of beta-carotene have a high incidence of **macular degeneration**.
 - ❖ Beta-carotene is an antioxidant along with vitamin E, vitamin C, selenium, and many phytochemicals.
-

Vitamin D

- ◆ Can be self-synthesized with the help of sunlight.
 - ◆ Whether made with the help of sunlight or obtained from food, vitamin D undergoes chemical transformations in the liver and kidneys to activate it.
-

Vitamin D

- ◆ The sunshine Vitamin: D



- ◆ Vitamin D functions as a hormone to:
 - Regulate blood calcium and phosphorus levels, thereby maintaining bone integrity
 - To replenish blood calcium, vitamin D acts at three body locations to raise blood calcium levels:
 - Skeleton
 - Digestive tract
 - Kidneys
-

- ❖ Vitamin D stimulates maturation of cells, including immune cells that defend against disease
 - ❖ Vitamin D acts on genes, affecting how cells grow, multiply, and specialize
 - Deficiencies may include
 - High blood pressure
 - Some common cancers
 - Rheumatoid arthritis
 - Multiple sclerosis
 - Psoriasis
-

Too Little Vitamin D – A Danger to Bones



Rickets leads to bowed legs to unmineralized bone and also beaded ribs as calcium is deposited on the ribs, rather than in the ribs.

- ◆ In adults, the poor mineralization of bone results in **osteomalacia**.
 - Brittle, soft, and deformed bones
-

- ◆ Vitamin D is the most potentially toxic of all vitamins
 - ◆ More likely if supplements are taken
 - Toxic to bones, kidneys, brain, nerves, heart, and arteries
-

- ◆ When ultraviolet light from the sun shines on a cholesterol compound in human skin, the compound is transformed into a vitamin D precursor and is absorbed directly into the blood.
 - ◆ Over the next day, the liver and kidneys finish converting the precursor to active vitamin D.
 - ◆ Sunlight presents no risk of vitamin D toxicity; sun breaks down excess vitamin D in the skin.
-

- ❖ At the end of winter, many otherwise healthy northern U.S. adults, even those drinking milk fortified with vitamin D, may test low for blood vitamin D.
 - ❖ Dark-skinned people need up to three hours of direct sun for several days to make enough vitamin D.
 - ❖ Light-skinned people need much less time – 10 or 15 minutes.
-

Intake Recommendations and Food Sources

- ◆ 5 micrograms/day for adults 19 to 50 years
- ◆ UL 50 micrograms/day (2,000 IU on supplement labels)

SNAPSHOT 7-2
VITAMIN D

DRI RECOMMENDED INTAKES:
Adults: 5 µg/day (19–50 yr)
10 µg/day (51–70 yr)
15 µg/day (>70 yr)

TOLERABLE UPPER INTAKE LEVEL:
Adults: 50 µg/day

CHIEF FUNCTIONS:
Mineralization of bones and teeth (raises blood calcium and phosphorus by increasing absorption from digestive tract, withdrawing calcium from bones, stimulating retention by kidneys)

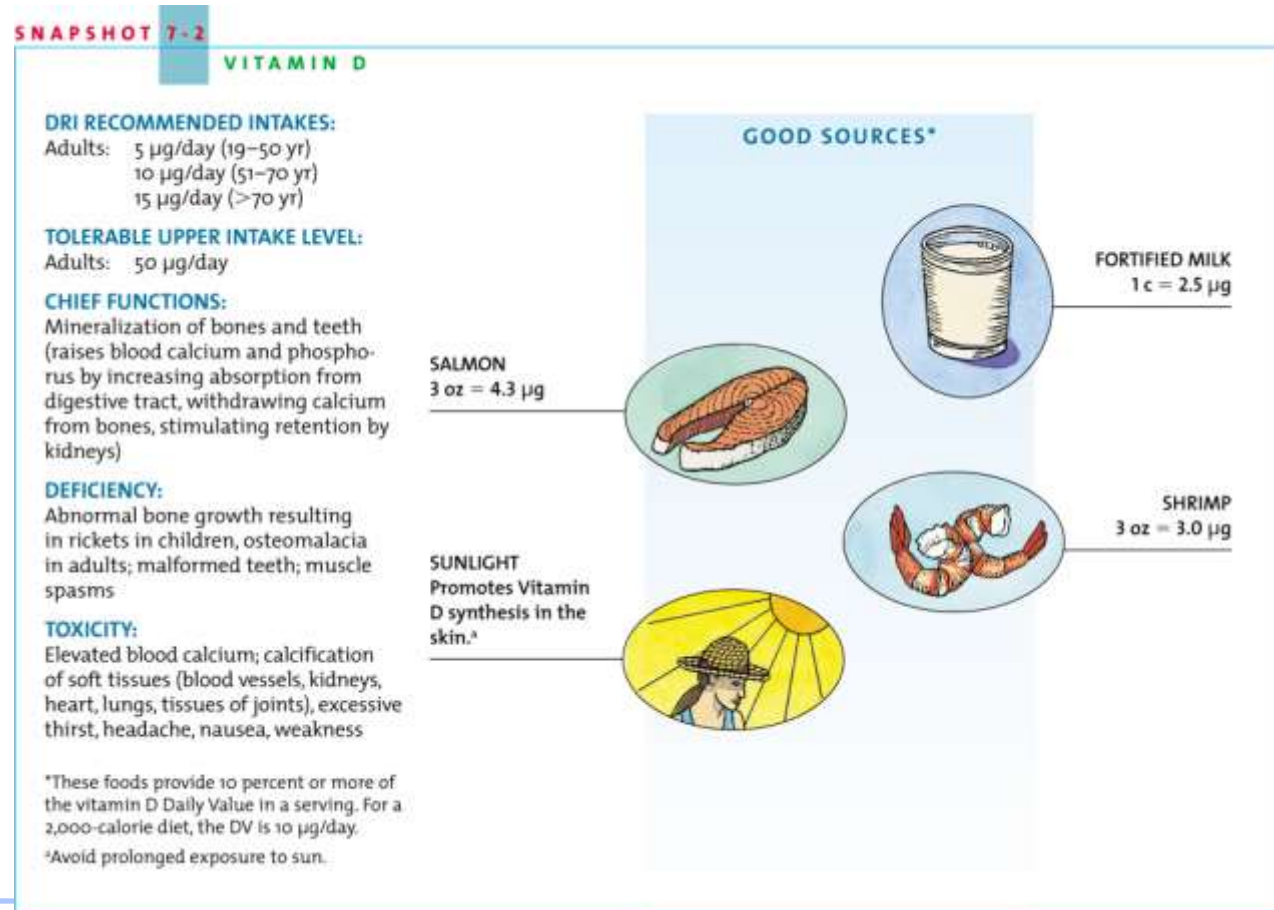
DEFICIENCY:
Abnormal bone growth resulting in rickets in children, osteomalacia in adults; malformed teeth; muscle spasms

TOXICITY:
Elevated blood calcium; calcification of soft tissues (blood vessels, kidneys, heart, lungs, tissues of joints), excessive thirst, headache, nausea, weakness

GOOD SOURCES*

- SALMON**
3 oz = 4.3 µg
- FORTIFIED MILK**
1 c = 2.5 µg
- SHRIMP**
3 oz = 3.0 µg
- SUNLIGHT**
Promotes Vitamin D synthesis in the skin.^a

*These foods provide 10 percent or more of the vitamin D Daily Value in a serving. For a 2,000-calorie diet, the DV is 10 µg/day.
^aAvoid prolonged exposure to sun.

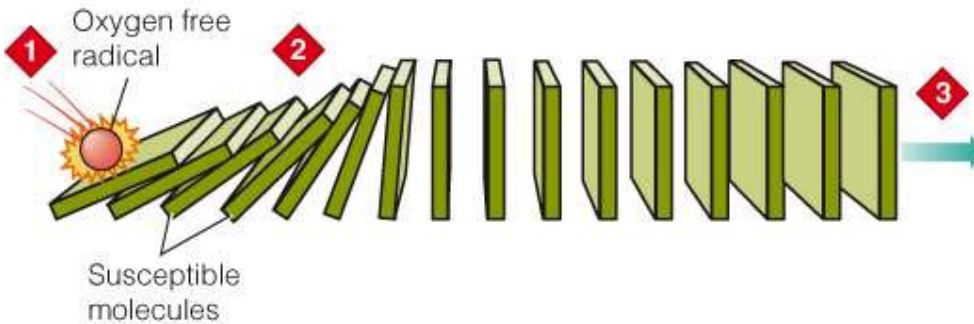
The infographic is titled "SNAPSHOT 7-2 VITAMIN D". It lists DRI recommended intakes, tolerable upper intake level, chief functions, deficiency, and toxicity. It also features a "GOOD SOURCES*" section with four items: Salmon (3 oz = 4.3 µg), Fortified Milk (1 c = 2.5 µg), Shrimp (3 oz = 3.0 µg), and Sunlight (Promotes Vitamin D synthesis in the skin). Each source is accompanied by a small illustration: a salmon fillet, a glass of milk, a shrimp, and a person wearing a hat under a sun. A footnote at the bottom explains that these sources provide 10% or more of the Daily Value and advises against prolonged sun exposure.

◆ Vitamin E, a.k.a. tocopherol

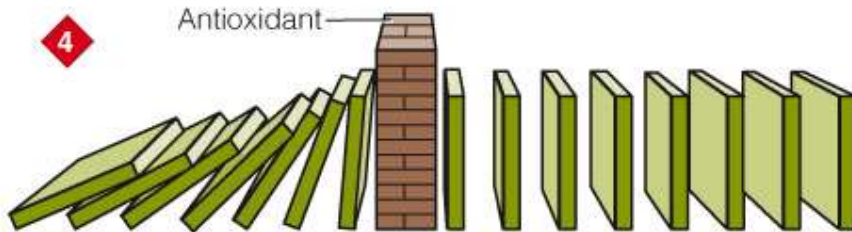
- ◆ Vitamin E is an antioxidant.
 - ◆ Oxidative damage occurs when highly unstable molecules known as **free radicals**, formed normally during cell metabolism, run amok and disrupt cellular structures.
-

The Extraordinary Bodyguard

Free radicals cause chain reactions that damage cellular structures.



Antioxidants quench free radicals and protect cellular structures.



- 1** A chemically reactive oxygen free radical attacks fatty acid, DNA, protein, or cholesterol molecules, which form other free radicals in turn.
- 2** This initiates a rapid, destructive chain reaction.
- 3** The result is disabling injury to lipids of cell membranes and cellular proteins, damage to DNA, or oxidation of cholesterol. These changes may initiate steps leading to diseases such as heart disease, cancer, macular degeneration, and others.
- 4** Antioxidants, such as vitamin E, stop the chain reaction by changing the nature of the free radical.

- ◆ Deficiencies are almost never seen in healthy humans.
 - ◆ A classic vitamin E deficiency occurs in premature babies born before the transfer of the vitamin from mother to the infant, which takes place in the last weeks of pregnancy.
 - Infant's RBC lyse and infant becomes anemic
-

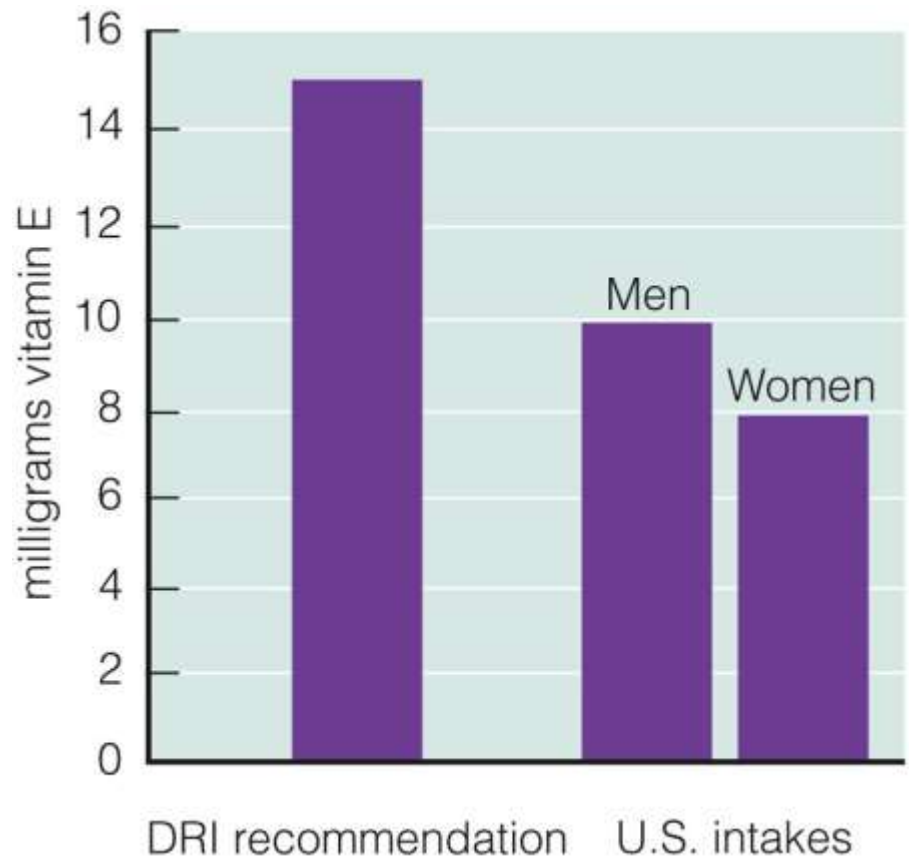
- ◆ Heart disease and cancer may arise in part through tissue oxidation and inflammation.
 - ◆ People with low blood vitamin E concentrations die more often from these and other causes than do people with higher blood levels.
-

Toxicity of Vitamin E

- ❖ No adverse effects arise from consuming foods that naturally provide vitamin E.
 - ❖ Vitamin E supplements appear safe at lower doses.
 - ❖ An increase in brain hemorrhages, a form of stroke, among smokers taking just 50 mg of vitamin E per day has also been noted.
 - ❖ Supplements may also increase the effects of anticoagulant medication.
-

Vitamin E Requirements

- ◆ 15 milligrams a day for adults
- ◆ On average, U.S. intakes of vitamin E fall substantially below the recommendation.



Food Sources of Vitamin E

SNAPSHOT 7-3

VITAMIN E

DRI RECOMMENDED INTAKE:

Adults: 15 mg/day

TOLERABLE UPPER INTAKE LEVEL:

Adults: 1,000 mg/day

CHIEF FUNCTIONS:

Antioxidant (protects cell membranes, regulates oxidation reactions, protects polyunsaturated fatty acids)

DEFICIENCY:

Red blood cell breakage, nerve damage

TOXICITY:

Augments the effects of anticlotting medication

*These foods provide 10 percent or more of the vitamin E Daily Value in a serving. For a 2,000-calorie diet, the DV is 30 IU or 20 mg/day.

GOOD SOURCES*

SAFFLOWER OIL (cooked)
1 tbs = 4.7 mg



WHEAT GERM
1 oz = 6.0 mg



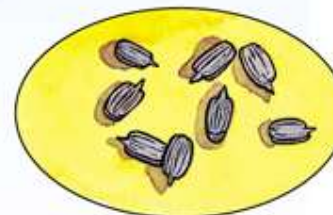
MAYONNAISE
(safflower oil)
1 tbs = 3.0 mg



CANOLA OIL
1 tbs = 2.4 mg



SUNFLOWER SEEDS
(shelled)
2 tbs = 9.0 mg



- ❖ Raw vegetable oils contain substantial vitamin E, but high temperatures destroy it



- ◆ Have you ever thought about how remarkable it is that blood can clot?
 - ◆ What would happen if it didn't?
-

- ◆ Main function of vitamin K is to help synthesize proteins that help blood clot.
 - ◆ Also necessary for the synthesis of key bone proteins.
-

- ❖ Vitamin K can be made by intestinal bacteria.
- ❖ Newborns are given a dose of vitamin K at birth.



Sources of Vitamin K

SNAPSHOT 7-4

VITAMIN K

DRI RECOMMENDED INTAKES:

Men: 120 $\mu\text{g}/\text{day}$

Women: 90 $\mu\text{g}/\text{day}$

CHIEF FUNCTIONS:

Synthesis of blood-clotting proteins and bone proteins

DEFICIENCY:

Hemorrhage; abnormal bone formation

TOXICITY:

Opposes the effects of anti-clotting medication

*These foods provide 10 percent or more of the vitamin K Daily Value in a serving. For a 2,000-calorie diet, the DV is 80 $\mu\text{g}/\text{day}$.

Data from Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine, *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (Washington, D.C.: National Academy Press, 2001), p.185.

GOOD SOURCES*

CABBAGE (steamed)
 $\frac{1}{2}$ c = 102 μg



SPINACH (steamed)
 $\frac{1}{2}$ c = 360 μg



SOYBEANS (dry roasted)
 $\frac{1}{2}$ C = 20 μg



CAULIFLOWER (steamed)
 $\frac{1}{2}$ c = 20 μg



CANOLA OIL
1 tbs = 19 μg



SALAD GREENS
1 c = 60 μg

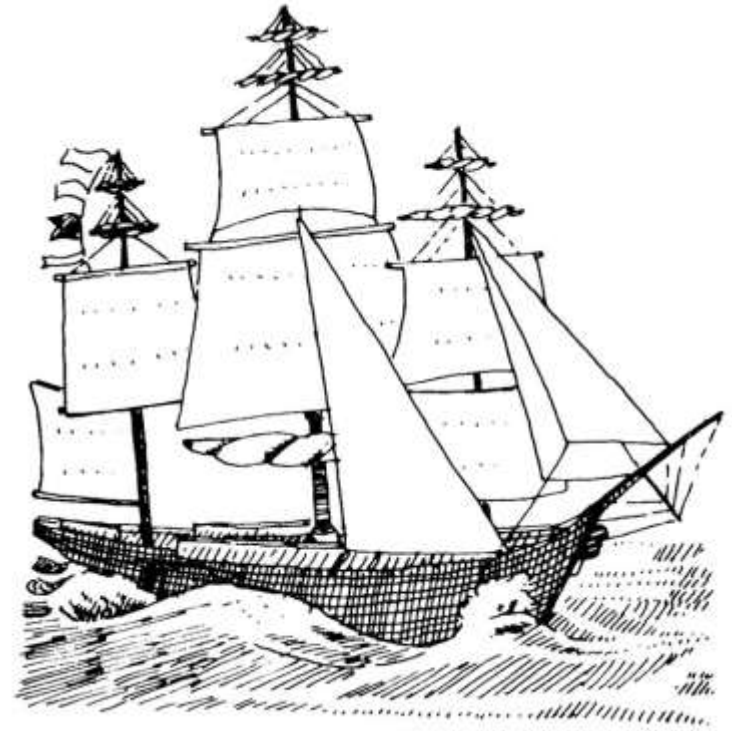
- ❖ Toxicity is rare and there is no Tolerable Upper Intake Level.
 - ❖ Toxicity causes jaundice and may occur if supplements of a synthetic version are given too enthusiastically.
-

The Water-Soluble Vitamins

◆ Vitamin C and the B vitamins

- Cooking and washing cut foods with water can leach these vitamins out of the food.
 - Absorbed easily and excreted easily in urine.
 - Foods never deliver a toxic dose of them but large doses concentrated in some vitamin supplements can reach toxic levels.
 - “The most expensive urine in town”
-

◆ More than 200 years ago, any man who joined the crew of a seagoing ship knew he might contract scurvy, which would end up killing as many as 2/3 of the crew.



Long voyages without fresh fruits and veggies spelled death by scurvy for the crew

◆ The first nutrition experiment was done nearly 250 years ago to find a cure for scurvy:

– 4 Experimental Groups

1. Vinegar

2. Sulfuric acid

3. Seawater

4. Lemons

Which group do you think was cured?

Answer: group 4

- ◆ Those receiving the citrus fruits were cured
 - ◆ It took 50 years for the British navy to make use of the information and require all its ships to provide lime juice to every sailor daily
 - ◆ Nicknamed them "limeys"
 - ◆ The name given to the vitamin that the fruit provided, ascorbic acid, literally means "no scurvy acid"
 - ◆ Today called vitamin C
-

◆ Functions of vitamin C

- Assists enzymes involved in the formation and maintenance of **collagen**
 - Acts as an antioxidant, especially protecting the immune system cells from free radicals generated during their assault on invaders
-

◆ Most scurvy symptoms are due to collagen breakdown

- Loss of appetite
 - Growth cessation
 - Tenderness to touch
 - Bleeding gums
 - Swollen ankles and wrists
 - Anemia
 - Red spots on skin
 - Weakness
 - Loose teeth
-

Deficiency Symptoms



- ◆ Do you think vitamin C relieves colds?
 - a. Yes
 - b. No
 - c. I have no opinion
-

- ◆ More than 30 years ago, Linus Pauling, a Nobel Prize Winner, became a vocal supporter of vitamin C supplements.
 - ◆ The scientific community all but discounts his claims because research fails to support Pauling's theories.
-

- ❖ One review of the literature did reveal a modest benefit – a difference in duration of less than one day per cold in favor of those taking a daily dose of at least 1 gram of vitamin C.
 - ❖ The effect may be greater in children than in adults (adults may need doses near the UL of 2 grams a day).
-

- ◆ In drug-like doses, vitamin C may act like a weak antihistamine.



Can vitamin C ease the suffering of a person with a cold?

◆ Possible adverse effects of taking 2 grams a day:

- Alteration of the insulin response to carbohydrate
 - Interference with blood clotting medications
 - Kidney stones
 - Gout
 - Digestive upsets
-

Is Vitamin C Hazardous to Health?

SNAPSHOT 7-5

VITAMIN C

DRI RECOMMENDED INTAKES:

Men: 90 mg/day
Women: 75 mg/day
Smokers: +35 mg/day

TOLERABLE UPPER INTAKE LEVEL:

Adults: 2,000 mg/day

CHIEF FUNCTIONS:

Collagen synthesis (strengthens blood vessel walls, forms scar tissue, provides matrix for bone growth), antioxidant, restores vitamin E to active form, supports immune system, boosts iron absorption

DEFICIENCY:

Scurvy, with pinpoint hemorrhages, fatigue, bleeding gums, bruises; bone fragility, joint pain; poor wound healing, frequent infections

TOXICITY:

Nausea, abdominal cramps, diarrhea; rashes; interference with medical tests and drug therapies; in susceptible people, aggravation of gout or kidney stones.

*These foods provide 10 percent or more of the vitamin C Daily Value in a serving. For a 2,000-calorie diet, the DV is 60 mg/day.

GOOD SOURCES*

SWEET RED PEPPER
(raw) $\frac{1}{2}$ C = 142 mg



BRUSSELS SPROUTS
(cooked)
 $\frac{1}{2}$ c = 48 mg



GRAPEFRUIT
 $\frac{1}{2}$ grapefruit
= 36 mg



SWEET POTATO
 $\frac{1}{2}$ c = 20 mg



ORANGE JUICE
 $\frac{1}{2}$ c = 62 mg



GREEN PEPPERS (raw)
 $\frac{1}{2}$ c = 60 mg



BROCCOLI (cooked)
 $\frac{1}{2}$ c = 51 mg



STRAWBERRIES
 $\frac{1}{2}$ c = 43 mg



BOK CHOY (cooked)
 $\frac{1}{2}$ c = 22 mg

The Need for Vitamin C

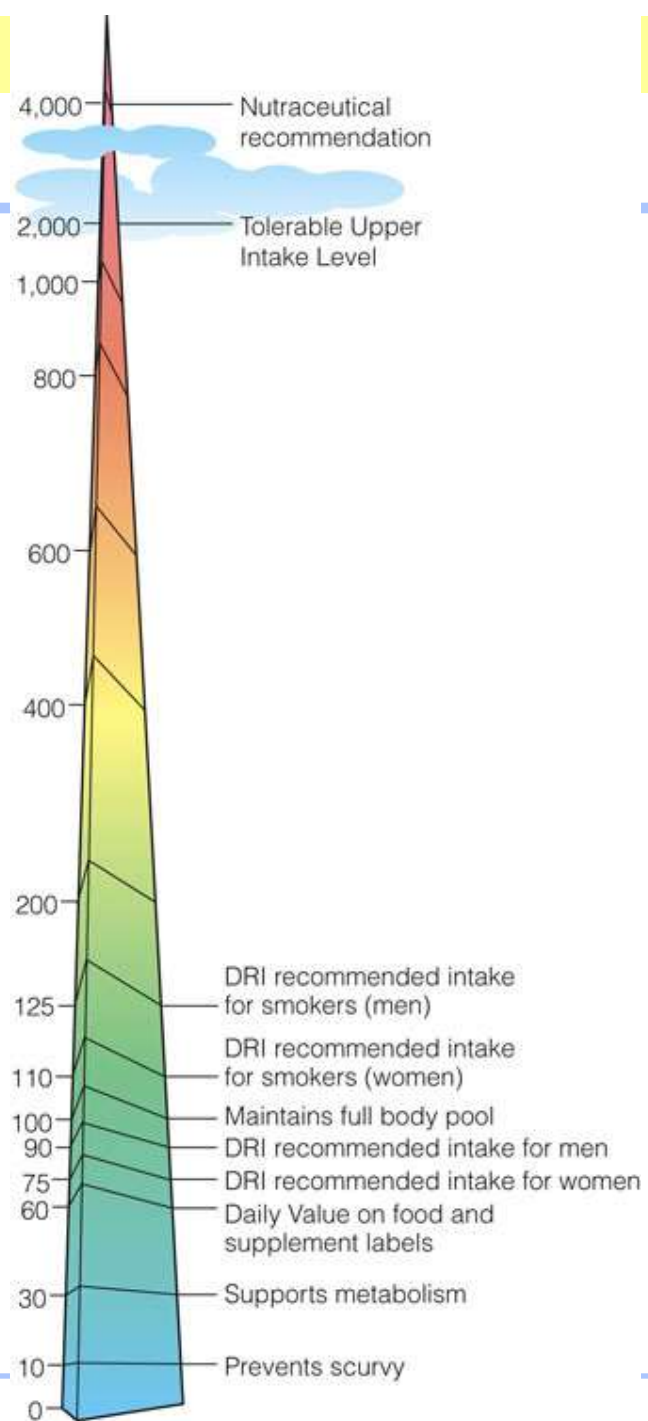


TABLE 7-4 Minimizing Nutrient Losses

Each of these tactics saves a small percentage of the vitamins in foods, but repeated each day this can add up to significant amounts in a year's time.

Prevent enzymatic destruction:

- Refrigerate most fruits, vegetables, and juices to slow breakdown of vitamins.

Protect from light and air:

- Store milk and enriched grain products in opaque containers to protect riboflavin.
- Store cut fruits and vegetables in the refrigerator in airtight wrappers; reseal opened juice containers before refrigerating.

Prevent heat destruction or losses in water:

- Wash intact fruits and vegetables before cutting or peeling to prevent vitamin losses during washing.
- Cook fruits and vegetables in a microwave oven, or quickly stir fry, or steam them over a small amount of water to preserve heat-sensitive vitamins and to prevent vitamin loss in cooking water. Recapture dissolved vitamins by using cooking water for soups, stews, or gravies.
- Avoid high temperatures and long cooking times.

DRI RECOMMENDED INTAKES:

Men: 90 mg/day
 Women: 75 mg/day
 Smokers: +35 mg/day

TOLERABLE UPPER INTAKE LEVEL:

Adults: 2,000 mg/day

CHIEF FUNCTIONS:

Collagen synthesis (strengthens blood vessel walls, forms scar tissue, provides matrix for bone growth), antioxidant, restores vitamin E to active form, supports immune system, boosts iron absorption

DEFICIENCY:

Scurvy, with pinpoint hemorrhages, fatigue, bleeding gums, bruises; bone fragility, joint pain; poor wound healing, frequent infections

TOXICITY:

Nausea, abdominal cramps, diarrhea; rashes; interference with medical tests and drug therapies; in susceptible people, aggravation of gout or kidney stones.

*These foods provide 10 percent or more of the vitamin C Daily Value in a serving. For a 2,000-calorie diet, the DV is 60 mg/day.

GOOD SOURCES*

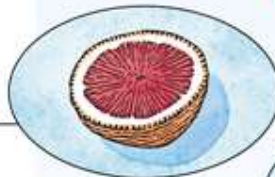
SWEET RED PEPPER
 (raw) $\frac{1}{2}$ C = 142 mg



BRUSSELS SPROUTS
 (cooked)
 $\frac{1}{2}$ c = 48 mg



GRAPEFRUIT
 $\frac{1}{2}$ grapefruit
 = 36 mg



SWEET POTATO
 $\frac{1}{2}$ c = 20 mg



ORANGE JUICE
 $\frac{1}{2}$ c = 62 mg

GREEN PEPPERS (raw)
 $\frac{1}{2}$ c = 60 mg



BROCCOLI (cooked)
 $\frac{1}{2}$ c = 51 mg



STRAWBERRIES
 $\frac{1}{2}$ c = 43 mg



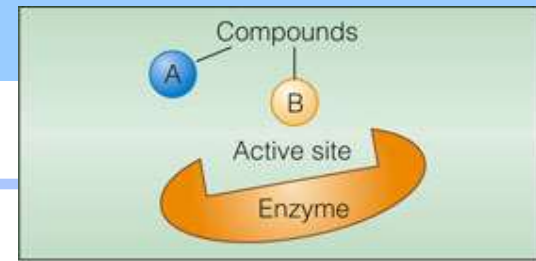
BOK CHOY (cooked)
 $\frac{1}{2}$ c = 22 mg



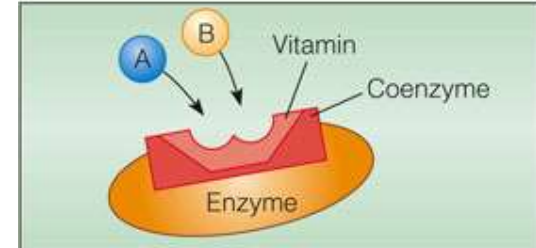
The B Vitamins in UNISON

◆ B vitamins function as part of **coenzymes**

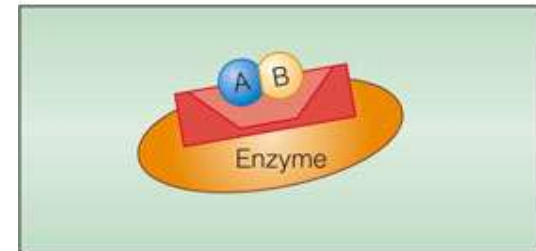
- coenzymes help enzymes do their jobs



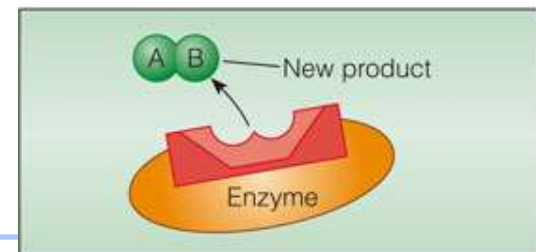
Without the coenzyme, compounds A and B don't respond to the enzyme.



With the coenzyme in place, compounds A and B are attracted to the active site on the enzyme, and they react.

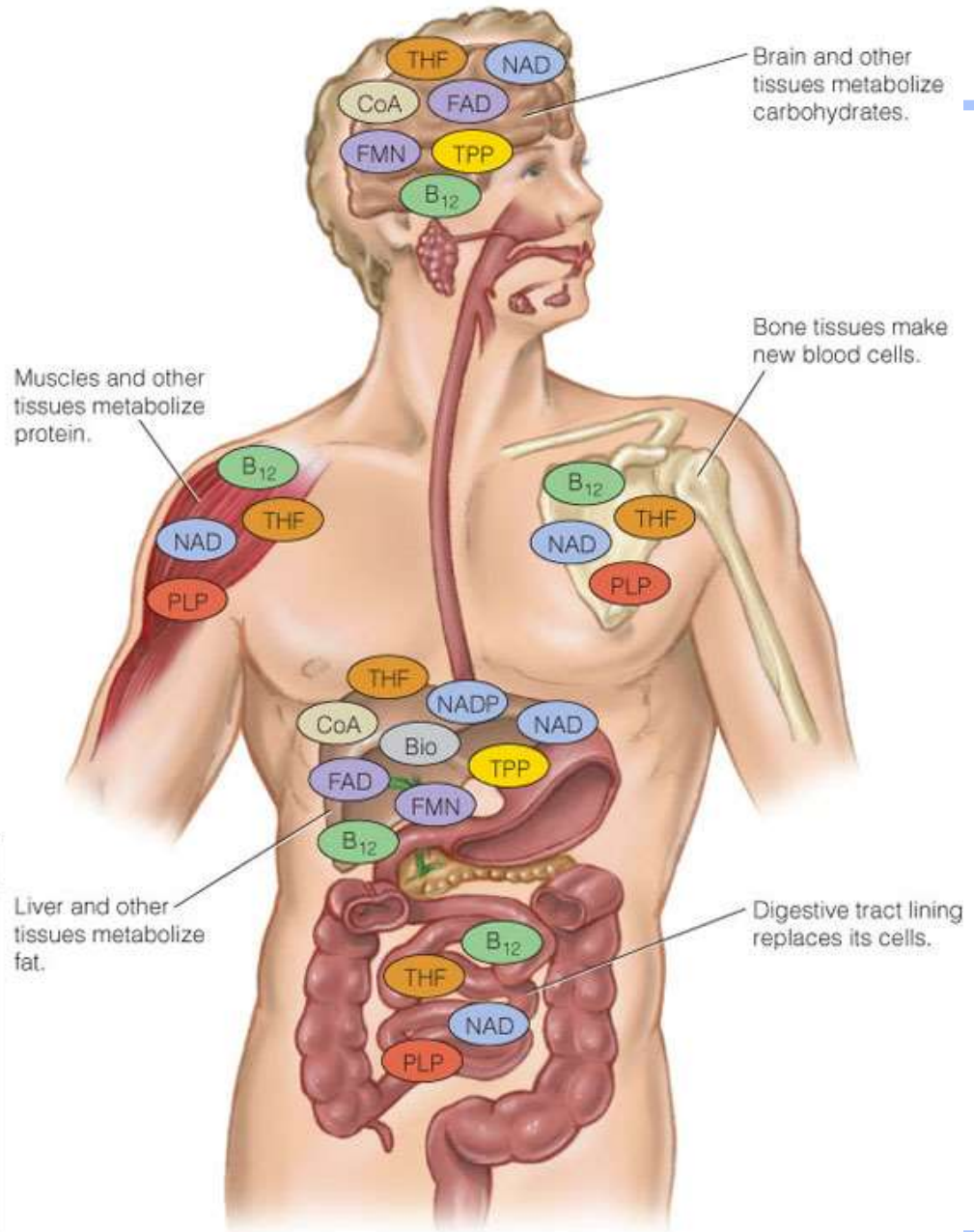


The reaction is completed with the formation of a new product. In this case the product is AB.



The product AB is released.

B Vitamin Roles in Metabolism



Key:

Coenzyme	Vitamin
TPP	= thiamin
FAD, FMN	= riboflavin
NAD, NADP	= niacin
PLP	= vitamin B ₆
THF	= folate
CoA	= pantothenic acid
Bio	= biotin
B ₁₂	= vitamin B ₁₂

- ◆ Thiamin, riboflavin, niacin, pantothenic acid, and biotin – participate in the release of energy from the energy nutrients
 - ◆ Folate and vitamin B₁₂ help cells multiply
 - ◆ Vitamin B₆ helps the body use amino acids to synthesize proteins
-

◆ In a B vitamin deficiency, every cell is affected.

– Symptoms include

- Nausea
 - Severe exhaustion
 - Irritability
 - Depression
 - Forgetfulness
 - Loss of appetite and weight
 - Impairment of immune response
 - Abnormal heart action
 - Skin problems
 - Swollen red tongue
 - Teary, red eyes
 - Pain in muscles
-

◆ Thiamin

- Plays a critical role in the energy metabolism of all cells.
 - Occupies a site on nerve cell membranes.
 - Nerve processes and their responding muscles depend heavily on thiamin.
-

◆ Beriberi

- First observed in East Asia, where rice provided 80 to 90 percent of the total calories most people consumed.
 - Polished rice became widespread, and beriberi became epidemic.
-

Thiamin Deficiency



- ◆ In developed countries today, alcohol abuse often leads to a severe form of thiamin deficiency, Wernicke-Korsakoff syndrome.
 - Alcohol impairs thiamin absorption
 - Symptoms
 - Apathy, irritability, mental confusion, memory loss, jerky movement, staggering gait
-

Food Sources and Recommended Intakes

SNAPSHOT 7-6

THIAMIN

DRI RECOMMENDED INTAKES:

Men: 1.2 mg/day

Women: 1.1 mg/day

CHIEF FUNCTIONS:

Part of coenzyme active in energy metabolism

DEFICIENCY:^a

Beriberi with possible edema or muscle wasting; enlarged heart, heart failure, muscular weakness, pain, apathy, poor short-term memory, confusion, irritability, difficulty walking, paralysis, anorexia, weight loss

TOXICITY:

None reported

*These foods provide 10 percent or more of the thiamin Daily Value in a serving. For a 2,000-calorie diet, the DV is 1.5 mg/day.

^aSevere thiamin deficiency is often related to heavy alcohol consumption.

GOOD SOURCES*

ENRICHED PASTA
 $\frac{1}{2}$ c = 0.15 mg



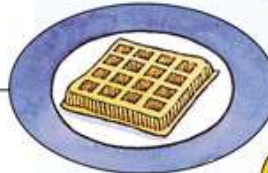
PORK CHOP
3 oz = 0.56 mg



GREEN PEAS (cooked)
 $\frac{1}{2}$ = 0.23 mg



WAFFLE
1 waffle = 0.25 mg



WHOLE WHEAT BAGEL
 $\frac{1}{2}$ bagel = 0.19 mg



ENRICHED CEREAL
(ready-to-eat)
 $\frac{3}{4}$ c = 0.38 mg



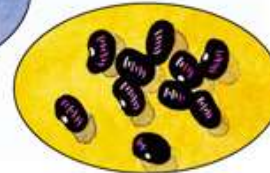
SUNFLOWER SEEDS
2 tbs = 0.41 mg



BAKED POTATO
1 whole potato
= 0.22 mg



BLACK BEANS
(cooked)
 $\frac{1}{2}$ C = 0.21 mg



- ◆ Riboflavin plays a role in energy metabolism
 - ◆ When thiamin is deficient, riboflavin usually is also
-

Riboflavin

SNAPSHOT 7-7

RIBOFLAVIN

DRI RECOMMENDED INTAKES:

Men: 1.2 mg/day
Women: 1.1 mg/day

CHIEF FUNCTIONS:

Part of coenzyme active in energy metabolism

DEFICIENCY:

Cracks and redness at corners of mouth; painful, smooth, purplish red tongue; sore throat; inflamed eyes and eyelids, sensitivity to light; skin rashes

TOXICITY:

None reported

*These foods provide 10 percent or more of the riboflavin Daily Value in a serving. For a 2,000-calorie diet, the DV is 1.7 mg/day.

GOOD SOURCES*

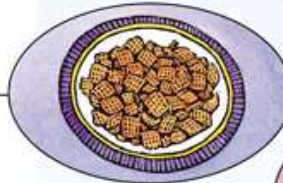
BEEF LIVER (cooked)
3 oz = 2.9 mg



COTTAGE CHEESE
1 c = 0.38 mg



ENRICHED CEREAL
(ready-to-eat)
 $\frac{3}{4}$ c = 0.43 mg



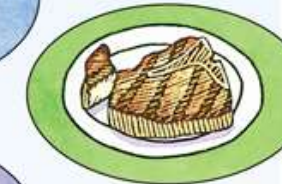
SPINACH (cooked)
 $\frac{1}{2}$ c = 0.21 mg



MILK
1 c = 0.45 mg



YOGURT (plain)
1 c = 0.60 mg



PORK CHOP
(lean only)
3 oz = 0.23 mg



MUSHROOMS
(cooked)
 $\frac{1}{2}$ c = 0.23 mg

- ❖ Participates in energy metabolism of every cell.
 - ❖ Deficiency disease is **pellagra**, which appeared in Europe in the 1700s when corn from the New World became a staple food.
 - ❖ In the early 1900s in the U.S., pellagra was affecting hundreds of thousands in the South and Midwest.
-

- ❖ Pellagra is still common in parts of Africa and Asia.
 - ❖ Pellagra still occurs in the U.S. among poorly nourished people, especially those with alcohol addiction.
-

◆ Pellagra symptoms: 4 "D's"

- Diarrhea
- Dermatitis
- Dementia
- Death



- ◆ The key nutrient that prevents pellagra is niacin
 - ◆ Or, consuming adequate tryptophan which can be converted to niacin in the body
 - ◆ The amount of niacin in a diet is stated in terms of **niacin equivalents (NE)**, a measure that takes available tryptophan into account
-

Niacin Sources

SNAPSHOT 7-8

NIACIN

DRI RECOMMENDED INTAKES:

Men: 16 mg/day^a

Women: 14 mg/day

TOLERABLE UPPER INTAKE LEVEL:

Adults: 35 mg/day

CHIEF FUNCTIONS:

Part of coenzymes needed in energy metabolism

DEFICIENCY:

Pellagra, characterized by flaky skin rash (dermatitis) where exposed to sunlight; mental depression, apathy, fatigue, loss of memory, headache; diarrhea, abdominal pain, vomiting; swollen, smooth, bright red or black tongue

TOXICITY:

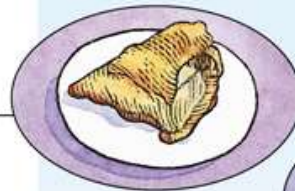
Painful flush, hives, and rash ("niacin flush"); excessive sweating; blurred vision; liver damage, impaired glucose tolerance

^aNiacin DRI Recommended Intakes are expressed in niacin equivalents (NE); the Tolerable Upper Intake Level refers to preformed niacin.

*These foods provide 10 percent or more of the niacin Daily Value in a serving. For a 2,000-calorie diet, the DV is 20 mg/day. The DV values are for preformed niacin, not niacin equivalents.

GOOD SOURCES*

CHICKEN BREAST
3 oz = 8.9 mg



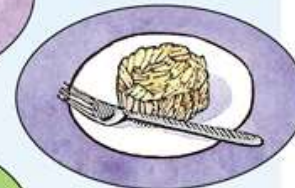
PORK CHOP
3 oz = 3.9 mg



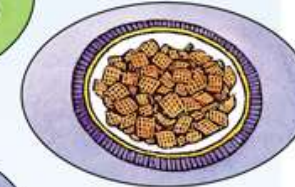
BAKED POTATO
1 whole potato
= 3.3 mg



TUNA (in water)
3 oz = 11.3 mg



ENRICHED CEREAL
(ready-to-eat)
³/₄ c = 5.0 mg



MUSHROOMS (cooked)
¹/₂ c = 3.5 mg



- ◆ Supplements may be taken as a treatment to lower blood lipids associated with cardiovascular disease.
 - ◆ Symptoms of toxicity
 - Life-threatening drop in blood pressure
 - Liver injury
 - Peptic ulcers
 - Vision loss
 - Niacin flush
-

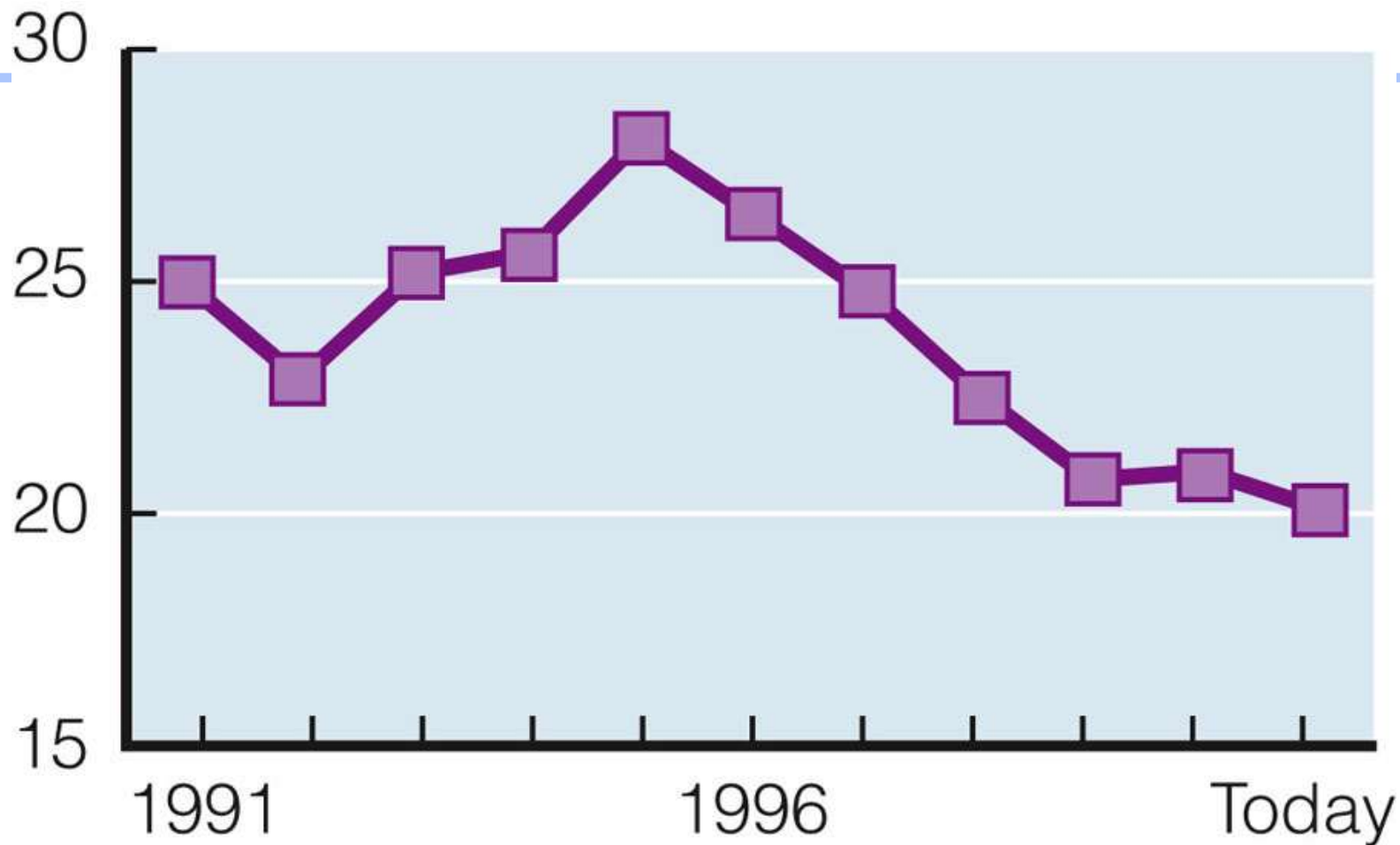
- ◆ Folate helps synthesize DNA and so is important for making new cells

- ❖ Deficiency of folate causes anemia, diminished immunity, and abnormal digestive function.
 - ❖ Deficiencies are related to increased risk of cervical cancer (in women infected with HPV), breast cancer (in women who drink alcohol) and pancreatic cancer (in men who smoke).
-

- ◆ Adequate intakes of folate during pregnancy can reduce a woman's chances of having a child with a **neural tube defect (NTD)**.
 - ◆ NTD arise in the first days or weeks of pregnancy, long before most women suspect they are pregnant.
-

- ◆ In the late 1990s the FDA ordered fortification of all enriched grain products with an absorbable synthetic form of folate, *folic acid*.
 - ◆ Since fortification began, the U.S. incidence of NTD dropped by 25 percent.
-

Folate and Birth Defects



Key:



Rate per 100,000

- ◆ Tolerable Upper Intake Level for folate is 1,000 micrograms a day for adults
 - ◆ A concern about fortifying the nation's food supply with folic acid is folate's ability to mask deficiencies of vitamin B₁₂
-

Sources of Folate and Recommendations

SNAPSHOT 7-9

FOLATE

DRI RECOMMENDED INTAKE:

Adults: 400 $\mu\text{g}/\text{day}$ ^a

TOLERABLE UPPER INTAKE LEVEL:

Adults: 1,000 $\mu\text{g}/\text{day}$

CHIEF FUNCTIONS:

Part of a coenzyme needed for new cell synthesis

DEFICIENCY:

Anemia, smooth, red tongue; depression, mental confusion, weakness, fatigue, irritability, headache; a low intake increases the risk of neural tube birth defects

TOXICITY:

Masks vitamin B₁₂-deficiency symptoms

*These foods provide 10 percent or more of the folate Daily Value in a serving. For a 2,000-calorie diet, the DV is 400 $\mu\text{g}/\text{day}$.

^aFolate recommendations are expressed in dietary folate equivalents (DFE). Note that for natural folate sources, 1 μg = 1 DFE; for enrichment sources, 1 μg = 1.7 DFE.

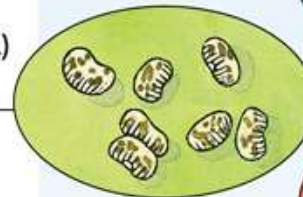
^bSome highly enriched cereals may provide 400 or more micrograms in a serving.

GOOD SOURCES*

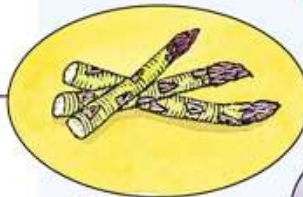
BEEF LIVER (cooked)
3 oz = 221 μg



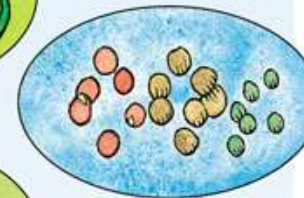
PINTO BEANS (cooked)
1/2 c = 146 μg



ASPARAGUS
1/2 c = 131 μg



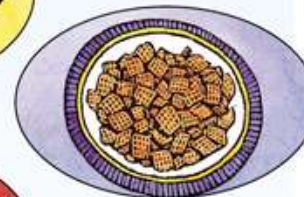
AVOCADO
1/2 c = 45 μg



LENTILS (cooked)
1/2 c = 179 μg



SPINACH (raw)
1 c = 58 μg



ENRICHED CEREAL
(ready-to-eat)^b
3/4 c = 82 μg



BEETS
1/2 c = 68 μg

- ❖ Vitamin B₁₂ and folate are closely related: each depends on the other for activation.
 - ❖ Main roles: helps maintain nerves and is a part of coenzymes needed in new blood cell synthesis.
-

- ❖ Symptoms of deficiency of either folate or vitamin B₁₂ include the presence of immature red blood cells.
- ❖ Administering extra folate often clears up this blood condition but allows the B₁₂ deficiency to continue.
- ❖ Vitamin B₁₂'s other functions then become compromised, and the results can be devastating: damaged nerves, creeping paralysis, and general muscle and nerve malfunctioning.

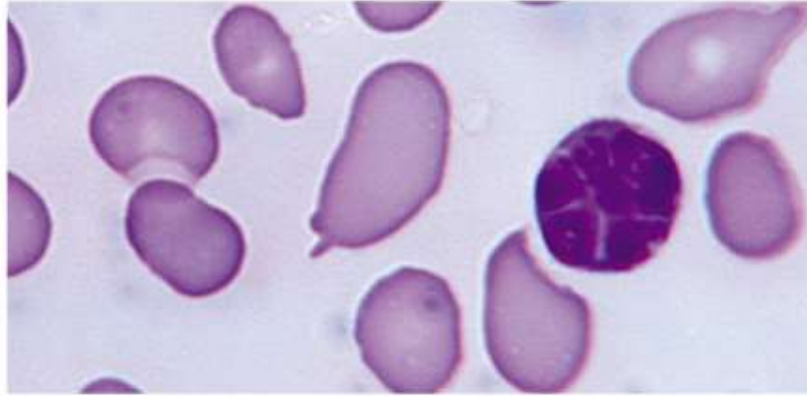
- ◆ Intrinsic factor is a compound made by the stomach needed for the absorption of B₁₂.
 - ◆ A few people have an inherited defect in the gene for intrinsic factor, which makes B₁₂ absorption poor.
-

- ❖ Vitamin B₁₂ must be injected to bypass the defective absorptive system.
 - ❖ This anemia of the vitamin B₁₂ deficiency caused by a lack of intrinsic factor is known as **pernicious anemia**.
-

Vitamin B₁₂

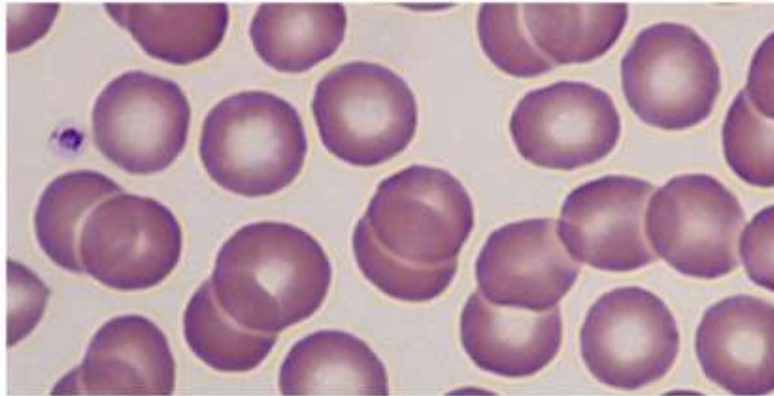
The anemia of folate deficiency is indistinguishable from that of vitamin B₁₂ deficiency.

Carolina Biological/Visuals
Unlimited



Blood cells of pernicious anemia. The cells are larger than normal and irregular in shape.

Ed Reschke/Peter Arnold, Inc.



Normal blood cells. The size, shape, and color of these red blood cells show that they are normal.

Vitamin B₁₂

SNAPSHOT 7-10

VITAMIN B₁₂

DRI RECOMMENDED INTAKE:

Adults: 2.4 µg/day

CHIEF FUNCTIONS:

Part of coenzymes needed in new cell synthesis; helps to maintain nerve cells

DEFICIENCY:

Pernicious anemia;^a anemia (large-cell type);^b smooth tongue; tingling or numbness; fatigue, memory loss, disorientation, degeneration of nerves progressing to paralysis

TOXICITY:

None reported

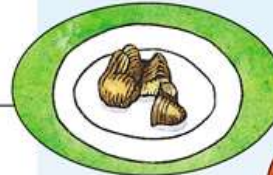
*These foods provide 10 percent or more of the vitamin B₁₂ Daily Value in a serving. For a 2,000-calorie diet, the DV is 6 µg/day.

^aThe name *pernicious anemia* refers to the vitamin B₁₂ deficiency caused by a lack of stomach intrinsic factor, but not to anemia from inadequate dietary intake.

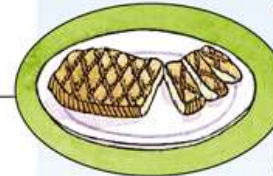
^bLarge cell-type anemia is known as either *macrocytic* or *megaloblastic anemia*.

GOOD SOURCES*

CHICKEN LIVER
3 oz = 14.0 µg



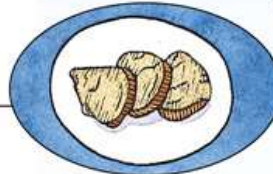
SIRLOIN STEAK
3 oz = 2.0 µg



COTTAGE CHEESE
1 c = 2.0 µg



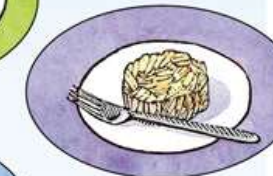
PORK ROAST (lean)
3oz = 1.0 µg



SARDINES
3 oz = 7.5 µg



TUNA (in water)
3 oz = 3.0 µg



SWISS CHEESE
1 1/2 oz = 1.5 µg



Who is at particular risk of a B₁₂ deficiency?

Answer: vegans

- ◆ Vitamin B₆ participates in more than 100 reactions in body tissues.
 - Needed to convert one amino acid to another amino acid that is lacking
 - Aids in conversion of tryptophan to niacin
 - Plays important roles in the synthesis of hemoglobin and neurotransmitters
 - Assists in releasing glucose from glycogen
 - Has roles in immune function and steroid hormone activity
 - Critical to fetal nervous system development
-

Vitamin B₆



Vitamin B₆

SNAPSHOT 7-11

VITAMIN B₆

DRI RECOMMENDED INTAKE:

Adults (19–50 yr): 1.3 mg/day

TOLERABLE UPPER INTAKE LEVEL:

Adults: 100 mg/day

CHIEF FUNCTIONS:

Part of a coenzyme needed in amino acid and fatty acid metabolism; helps to convert tryptophan to niacin and to serotonin; helps to make hemoglobin for red blood cells

DEFICIENCY:

Anemia, depression, confusion, abnormal brain wave pattern, convulsions; greasy, scaly dermatitis

TOXICITY:

Depression, fatigue, impaired memory, irritability, headaches, nerve damage causing numbness and muscle weakness progressing to an inability to walk and convulsions; skin lesions

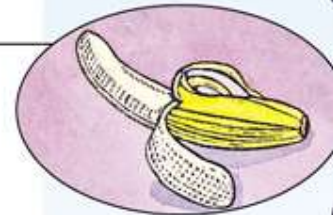
*These foods provide 10 percent or more of the vitamin B₆ Daily Value in a serving. For a 2,000-calorie diet, the DV is 2 mg/day.

GOOD SOURCES*

BEEF LIVER (cooked)
3 oz = 0.87 mg



BANANA
1 whole banana
= 0.66 mg



SWEET POTATO
(cooked)
1/2 c = 0.29 mg



BAKED POTATO
1 whole potato
= 0.70 mg



CHICKEN BREAST
3 oz = 0.35 mg



SPINACH (cooked)
1/2 c = 0.22 mg

- ◆ People with an inherited rare disorder that raises the blood level of the amino acid homocysteine almost invariably suffer from a severe form of cardiovascular disease.
 - ◆ CVD sufferers without the inherited disorder also sometimes accumulate homocysteine in the blood.
-

- ◆ When healthy men with elevated homocysteine are given supplements of folate, vitamin B₆, and vitamin B₁₂, their homocysteine values drop significantly.
 - ◆ However, a drop in CVD has not emerged so far from controlled studies.
-

- ◆ Biotin and pantothenic acid are also important in energy metabolism.
 - ◆ Both vitamins are readily available in foods.
-

- ◆ Many substances that people claim are B vitamins are not.
 - Choline – important in fetal development
 - Common in foods
 - Carnitine, inositol, and lipoic acid – nonvitamins because they are nonessential
 - Common in foods
-

Conclusion

TABLE 7-5 The Fat-Soluble Vitamins—Functions, Deficiencies, and Toxicities

VITAMIN A

OTHER NAMES

Retinol, retinal, retinoic acid; main precursor is beta-carotene

CHIEF FUNCTIONS IN THE BODY

Vision; health of cornea, epithelial cells, mucous membranes, skin; bone and tooth growth; regulation of gene expression; reproduction; immunity

Beta-carotene: antioxidant

DEFICIENCY DISEASE NAME

Hypovitaminosis A

SIGNIFICANT SOURCES

Retinol: fortified milk, cheese, cream, butter, fortified margarine, eggs, liver

Beta-carotene: spinach and other dark, leafy greens; broccoli; deep orange fruits (apricots, cantaloupe) and vegetables (winter squash, carrots, sweet potatoes, pumpkin)

DEFICIENCY SYMPTOMS

TOXICITY SYMPTOMS

Blood/Circulatory System

Anemia (small cell type)^a

Red blood cell breakage, cessation of menstruation, nosebleeds

Bones/Teeth

Cessation of bone growth, painful joints; impaired enamel formation, cracks in teeth, tendency toward tooth decay

Bone pain; growth retardation; increased pressure inside skull; headaches; possible bone mineral loss

Digestive System

Diarrhea, changes in intestinal and other body linings

Abdominal pain, nausea, vomiting, diarrhea, weight loss

Immune System

Frequent infections

Overreactivity

Nervous/Muscular System

Night blindness (retinal)
Mental depression

Blurred vision, muscle weakness, fatigue, irritability, loss of appetite

Skin and Cornea

Keratinization, corneal degeneration leading to blindness,^a rashes

Dry skin, rashes, loss of hair; cracking and bleeding lips, brittle nails; hair loss

Other

Kidney stones, impaired growth

Liver enlargement and liver damage; birth defects

^aCorneal degeneration progresses from *keratinization* (hardening) to *xerosis* (drying) to *xerophthalmia* (thickening, opacity, and irreversible blindness).

TABLE 7-5 The Fat-Soluble Vitamins—Functions, Deficiencies, and Toxicities (continued)

VITAMIN D

OTHER NAMES

Calciferol, cholecalciferol, dihydroxy vitamin D; precursor is cholesterol

CHIEF FUNCTIONS IN THE BODY

Mineralization of bones (raises blood calcium and phosphorus via absorption from digestive tract and by withdrawing calcium from bones and stimulating retention by kidneys)

DEFICIENCY DISEASE NAME

Rickets, osteomalacia

SIGNIFICANT SOURCES

Self-synthesis with sunlight; fortified milk or margarine, liver, sardines, salmon, shrimp

Blood/Circulatory System

Bones/Teeth

Nervous System

Other

DEFICIENCY SYMPTOMS

Abnormal growth, misshapen bones (bowing of legs), soft bones, joint pain, malformed teeth

Muscle spasms

TOXICITY SYMPTOMS

Raised blood calcium; calcification of blood vessels and heart tissues

Calcification of tooth soft tissues; thinning of tooth enamel

Excessive thirst, headaches, irritability, loss of appetite, weakness, nausea

Kidney stones; calcification of soft tissues (kidneys, lungs, joints); mental and physical retardation of offspring

VITAMIN E

OTHER NAMES

Alpha-tocopherol, tocopherol

CHIEF FUNCTIONS IN THE BODY

Antioxidant (quenching of free radicals), stabilization of cell membranes, support of immune function, protection of polyunsaturated fatty acids; normal nerve development

DEFICIENCY DISEASE NAME

(No name)

SIGNIFICANT SOURCES

Polyunsaturated plant oils (margarine, salad dressings, shortenings), green and leafy vegetables, wheat germ, whole-grain products, nuts, seeds

Blood/Circulatory System

DEFICIENCY SYMPTOMS

Red blood cell breakage, anemia

TOXICITY SYMPTOMS

Augments the effects of anticlotting medication

Digestive System

Nerve degeneration, weakness, difficulty walking, leg cramps

General discomfort, nausea

Eyes

Blurred vision

Nervous/Muscular System

Fatigue

VITAMIN K

OTHER NAMES

Phylloquinone, naphthoquinone

CHIEF FUNCTIONS IN THE BODY

Synthesis of blood-clotting proteins and proteins important in bone mineralization

DEFICIENCY DISEASE NAME

(No name)

SIGNIFICANT SOURCES

Bacterial synthesis in the digestive tract; green leafy vegetables, cabbage-type vegetables, soybeans, vegetable oils.

Blood/Circulatory System

Bones

DEFICIENCY SYMPTOMS

Hemorrhage

Poor skeletal mineralization

TOXICITY SYMPTOMS

Interference with anticlotting medication

Conclusion

TABLE 7-6 The Water-Soluble Vitamins—Functions, Deficiencies, and Toxicities

VITAMIN C

OTHER NAMES

Ascorbic acid

CHIEF FUNCTIONS IN THE BODY

Collagen synthesis (strengthens blood vessel walls, forms scar tissue, matrix for bone growth), antioxidant, restores vitamin E to active form, hormone synthesis, supports immune cell functions, helps in absorption of iron

DEFICIENCY DISEASE NAME

Scurvy

SIGNIFICANT SOURCES

Citrus fruits, cabbage-type vegetables, dark green vegetables, cantaloupe, strawberries, peppers, lettuce, tomatoes, potatoes, papayas, mangoes

DEFICIENCY SYMPTOMS

TOXICITY SYMPTOMS

Digestive System

Nausea, abdominal cramps, diarrhea, excessive urination

Immune System

Immune suppression, frequent infections

Mouth, Gums, Tongue

Bleeding gums, loosened teeth

Nervous/Muscular System

Muscle degeneration and pain, depression, disorientation

Headache, fatigue, insomnia

Skeletal System

Bone fragility, joint pain

Aggravation of gout

Skin

Pinpoint hemorrhages, rough skin, blotchy bruises

Rashes

Other

Failure of wounds to heal

Interference with medical tests; kidney stones in susceptible people

THIAMIN

OTHER NAMES

Vitamin B₁

CHIEF FUNCTIONS IN THE BODY

Part of a coenzyme needed in energy metabolism, supports normal appetite and nervous system function

DEFICIENCY DISEASE NAME

Beriberi (wet and dry)

SIGNIFICANT SOURCES

Occurs in all nutritious foods in moderate amounts; pork, ham, bacon, liver, whole and enriched grains, legumes, seeds

Blood/Circulatory System

DEFICIENCY SYMPTOMS

Edema, enlarged heart, abnormal heart rhythms, heart failure

TOXICITY SYMPTOMS

(No symptoms reported)

Nervous/Muscular System

Degeneration, wasting, weakness, pain, apathy, irritability, difficulty walking, loss of reflexes, mental confusion, paralysis

Other

Anorexia; weight loss

RIBOFLAVIN

OTHER NAMES

Vitamin B₂

CHIEF FUNCTIONS IN THE BODY

Part of a coenzyme needed in energy metabolism, supports normal vision and skin health

DEFICIENCY DISEASE NAME

Ariboflavinosis

SIGNIFICANT SOURCES

Milk, yogurt, cottage cheese, meat, liver, leafy green vegetables, whole-grain or enriched breads and cereals

Mouth, Gums, Tongue

DEFICIENCY SYMPTOMS

Cracks at corners of mouth,^b smooth magenta tongue^c; sore throat

Nervous System and Eyes

Hypersensitivity to light, reddening of cornea

Skin

Skin rash

TOXICITY SYMPTOMS

(No symptoms reported)

^aSmall-cell anemia is termed *microcytic anemia*; large-cell type is *macrocytic* or *megaloblastic anemia*.

^bCracks at the corners of the mouth are termed *cheilosis* (kee-LOH-sis).

^cSmoothness of the tongue is caused by loss of its surface structures and is termed glossitis (gloss-EYE-tis).

TABLE 7-6 The Water-Soluble Vitamins—Functions, Deficiencies, and Toxicities (continued)

NIACIN

OTHER NAMES

Nicotinic acid, nicotinamide, niacinamide, vitamin B₃; precursor is dietary tryptophan

CHIEF FUNCTIONS IN THE BODY

Part of coenzymes needed in energy metabolism

DEFICIENCY DISEASE NAME

Pellagra

SIGNIFICANT SOURCES

Synthesized from the amino acid tryptophan; milk, eggs, meat, poultry, fish, whole-grain and enriched breads and cereals, nuts, and all protein-containing foods

DEFICIENCY SYMPTOMS

TOXICITY SYMPTOMS

Digestive System

Diarrhea; vomiting; abdominal pain

Nausea, vomiting

Mouth, Gums, Tongue

Black or bright red swollen smooth tongue^a

Nervous System

Irritability, loss of appetite, weakness, headache, dizziness, mental confusion progressing to psychosis or delirium

Skin

Flaky skin rash on areas exposed to sun

Painful flush and rash, sweating

Other

Liver damage; impaired glucose tolerance

FOLATE

OTHER NAMES

Folic acid, folacin, pteroylglutamic acid

CHIEF FUNCTIONS IN THE BODY

Part of a coenzyme needed for new cell synthesis

DEFICIENCY DISEASE NAME

(No name)

SIGNIFICANT SOURCES

Asparagus, avocado, leafy green vegetables, beets, legumes, seeds, liver, enriched breads, cereal, pasta, and grains

Blood/Circulatory System

Digestive System

Immune System

Mouth, Gums, Tongue

Nervous System

DEFICIENCY SYMPTOMS

Anemia (large-cell type),^b
elevated homocysteine

Heartburn, diarrhea,
constipation

Suppression, frequent
infections

Smooth red tongue^a
Increased risk of neural tube
birth defects

Depression, mental confusion,
fatigue, irritability, headache

TOXICITY SYMPTOMS

Masks vitamin B₁₂ deficiency

VITAMIN B₁₂

OTHER NAMES

Cyanocobalamin

CHIEF FUNCTIONS IN THE BODY

Part of coenzymes needed in new cell synthesis, helps maintain nerve cells

DEFICIENCY DISEASE NAME

(No name)^c

SIGNIFICANT SOURCES

Animal products (meat, fish, poultry, milk, cheese, eggs)

	DEFICIENCY SYMPTOMS	TOXICITY SYMPTOMS
Blood/Circulatory System	Anemia (large-cell type) ^b	(No toxicity symptoms known)
Mouth, Gums, Tongue	Smooth tongue ^a	
Nervous System	Fatigue, nerve degeneration progressing to paralysis	
Skin	Tingling or numbness	

^aSmoothness of the tongue is caused by loss of its surface structures and is termed *glossitis* (gloss-EYE-tis).

^bSmall-cell anemia is termed *microcytic anemia*; large-cell type is *macrocytic* or *megaloblastic anemia*.

^cThe name *pernicious anemia* refers to the vitamin B₁₂ deficiency caused by lack of intrinsic factor, but not to that caused by inadequate dietary intake.

TABLE 7-6 The Water-Soluble Vitamins—Functions, Deficiencies, and Toxicities (continued)

VITAMIN B₆

OTHER NAMES

Pyridoxine, pyridoxal, pyridoxamine

CHIEF FUNCTIONS IN THE BODY

Part of a coenzyme needed in amino acid and fatty acid metabolism, helps convert tryptophan to niacin and to serotonin, helps make red blood cells

DEFICIENCY DISEASE NAME

(No name)

SIGNIFICANT SOURCES

Meats, fish, poultry, liver, legumes, fruits, potatoes, whole grains, soy products

DEFICIENCY SYMPTOMS

TOXICITY SYMPTOMS

Blood/Circulatory System

Anemia (small-cell type)^a

Bloating

Nervous/Muscular System

Depression, confusion, abnormal brain wave pattern, convulsions

Depression, fatigue, impaired memory, irritability, headaches, numbness, damage to nerves, difficulty walking, loss of reflexes, restlessness, convulsions

Skin

Rashes, greasy, scaly dermatitis

Skin lesions

PANTOTHENIC ACID

OTHER NAMES

(None)

CHIEF FUNCTIONS IN THE BODY

Part of a coenzyme needed in energy metabolism

DEFICIENCY DISEASE NAME

(No name)

SIGNIFICANT SOURCES

Widespread in foods

Digestive System

Nervous/Muscular System

Other

DEFICIENCY SYMPTOMS

Vomiting, intestinal distress

Insomnia, fatigue

Hypoglycemia, increased sensitivity to insulin

TOXICITY SYMPTOMS

Water retention (infrequent)

BIOTIN

OTHER NAMES

(None)

CHIEF FUNCTIONS IN THE BODY

A cofactor for several enzymes needed in energy metabolism, fat synthesis, amino acid metabolism, and glycogen synthesis

DEFICIENCY DISEASE NAME

(No name)

SIGNIFICANT SOURCES

Widespread in foods

Blood/Circulatory System

Digestive System

Nervous/Muscular System

Skin

DEFICIENCY SYMPTOMS

Abnormal heart action

Loss of appetite, nausea

Depression, muscle pain, weakness, fatigue, numbness of extremities

Dry around eyes, nose, and mouth

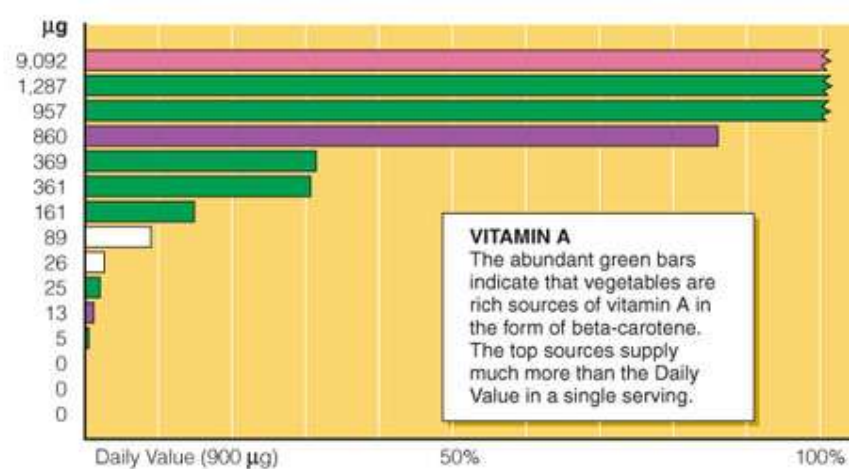
TOXICITY SYMPTOMS

(No toxicity symptoms reported)

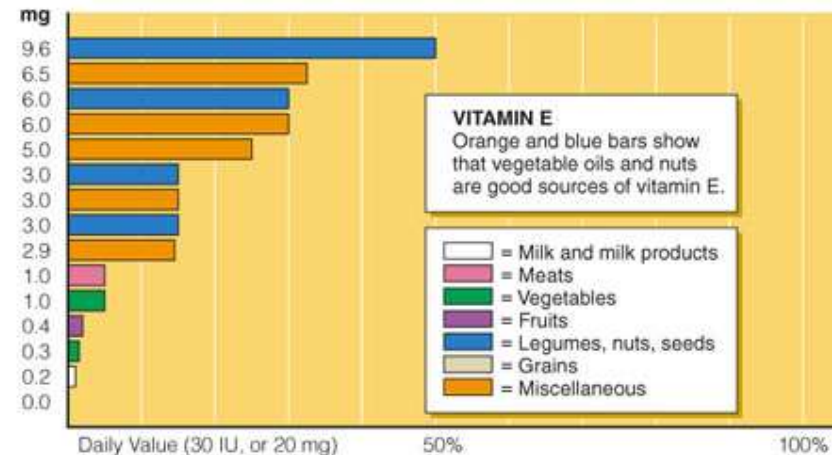
^aSmall-cell anemia is termed *microcytic anemia*; large-cell anemia is *macrocytic* or *megaloblastic anemia*.

Food Feature: Choosing Foods Rich in Vitamins

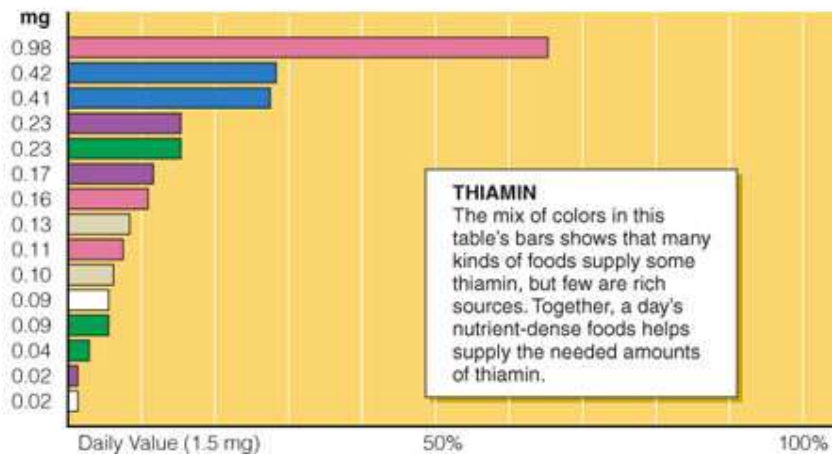
Food	Amount (Energy)	VITAMIN A
Beef liver	3 oz fried (184 cal)	9,092
Sweet potato	1 whole boiled (159 cal)	1,287
Carrots	1/2 c boiled (35 cal)	957
Cantaloupe	1/2 melon (97 cal)	860
Spinach	1/2 c boiled (21 cal)	369
Butternut squash	1/2 c baked (41 cal)	361
Milk, fat-free	1 c (85 cal)	161
Tomatoes	1/2 c boiled (33 cal)	89
Peach	1 fresh medium (42 cal)	26
Orange juice	1 c (fresh)	25
Summer squash	1/2 c boiled (18 cal)	13
Apple	1 fresh medium (81 cal)	5
Sirloin steak	3 oz lean (171 cal)	0
Whole-wheat bread	1 slice (70 cal)	0
Baked potato	1 whole (220 cal)	0



Food	Amount (Energy)	VITAMIN E
Sunflower seeds	2 tbs dry (103 cal)	9.6
Sunflower seed oil	1 tbs (124 cal)	6.5
Wheat germ	1 oz (117 cal)	6.0
Safflower oil	1 tbs (124 cal)	6.0
Cottonseed oil	1 tbs (124 cal)	5.0
Peanuts	1 oz dry roasted (166 cal)	3.0
Corn oil	1 tbs (124 cal)	3.0
Peanut butter	2 tbs (190 cal)	3.0
Canola oil	1 tbs (124 cal)	2.9
Shrimp	3 oz boiled (84 cal)	1.0
Parsley	1/2 c fresh chopped (11 cal)	1.0
Apple	1 fresh medium (81 cal)	0.4
Sweet potato	1 baked (117 cal)	0.3
Cheddar cheese	1 1/2 oz (170 cal)	0.2
Whole-wheat bread	1 slice (70 cal)	0.0

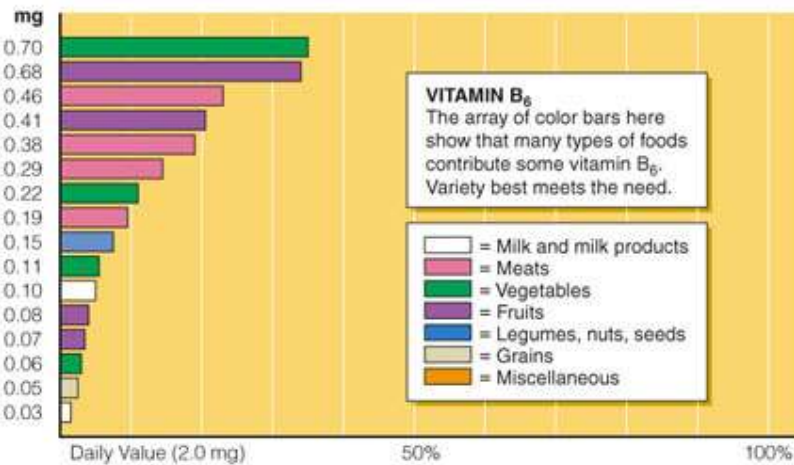


Food	Amount (Energy)	THIAMIN
Pork chop	3 oz broiled (275 cal)	0.98
Black beans	1 c cooked (228 cal)	0.42
Sunflower seeds	2 tbs dry (103 cal)	0.41
Watermelon	1 slice (91 cal)	0.23
Green peas	1/2 c cooked (67 cal)	0.23
Orange juice	3/4 c fresh (84 cal)	0.17
Oysters	5 oysters simmered (125 cal)	0.16
Oatmeal	1/2 c cooked (73 cal)	0.13
Sirloin steak	3 oz lean (171 cal)	0.11
Whole-wheat bread	1 slice (70 cal)	0.10
Milk, fat-free	1 c (85 cal)	0.09
Cabbage	1/2 c cooked (33 cal)	0.09
Summer squash	1/2 c cooked (18 cal)	0.04
Apple	1 fresh medium (81 cal)	0.02
Cheddar cheese	1 1/2 oz (170 cal)	0.02



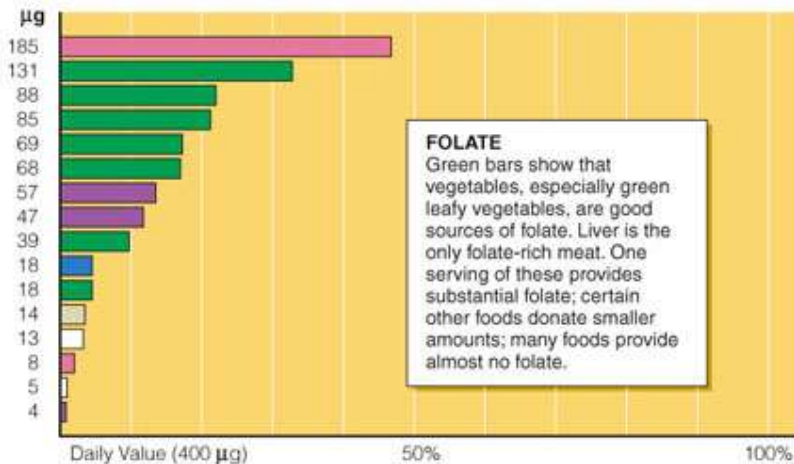
Food
VITAMIN B₆

Food	Amount (Energy)	mg
Baked potato	1 whole (220 cal)	0.70
Banana	1 peeled (109 cal)	0.68
Turkey breast	3 oz (133 cal)	0.46
Watermelon	1 slice (91 cal)	0.41
Sirloin steak	3 oz lean (171 cal)	0.38
Pork roast	3 oz lean (175 cal)	0.29
Spinach	1/2 c cooked (21 cal)	0.22
Salmon	3 oz broiled/baked (183 cal)	0.19
Navy beans	1/2 c cooked (129 cal)	0.15
Broccoli	1/2 c cooked (22 cal)	0.11
Milk, fat-free	1 c (85 cal)	0.10
Orange juice	3/4 c fresh (84 cal)	0.08
Apple	1 fresh medium (81 cal)	0.07
Summer squash	1/2 c boiled (18 cal)	0.06
Whole-wheat bread	1 slice (69 cal)	0.05
Cheddar cheese	1 1/2 oz (170 cal)	0.03



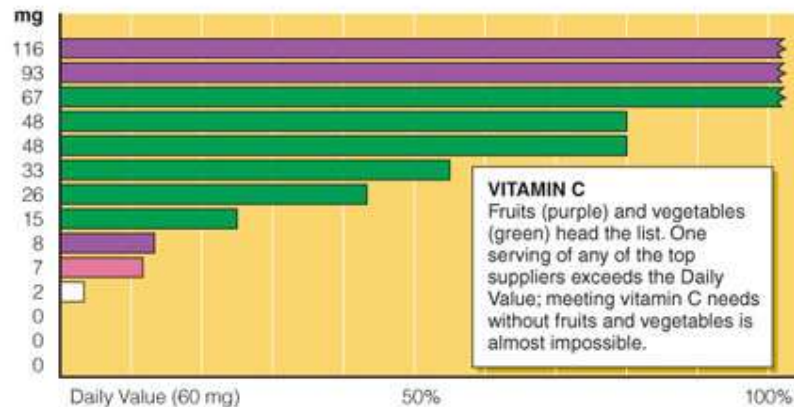
FOLATE

Food	Amount (Energy)	µg
Beef liver	3 oz fried (184 cal)	185
Spinach	1/2 c cooked (21 cal)	131
Asparagus	4 spears cooked (14 cal)	88
Turnip greens	1/2 c cooked (15 cal)	85
Winter squash	1/2 c cooked (48 cal)	69
Beets	1/2 c cooked (37 cal)	68
Orange juice	3/4 c fresh (84 cal)	57
Cantaloupe	1/2 melon (97 cal)	47
Broccoli	1/2 c cooked (22 cal)	39
Lima beans	1/2 c cooked (85 cal)	18
Summer squash	1/2 c cooked (18 cal)	18
Whole-wheat bread ^a	1 slice (70 cal)	14
Milk, fat-free	1 c (85 cal)	13
Sirloin steak	3 oz lean (171 cal)	8
Cheddar cheese	1 1/2 oz (170 cal)	5
Apple	1 fresh medium (81 cal)	4



VITAMIN C

Food	Amount (Energy)	mg
Cantaloupe	1/2 melon (97 cal)	116
Orange juice	3/4 c fresh (84 cal)	93
Green peppers	1/2 c (20 cal)	67
Broccoli	1/2 c cooked (26 cal)	48
Brussels sprouts	1/2 c cooked (30 cal)	48
Tomato juice	3/4 c canned (31 cal)	33
Baked potato	1 whole (220 cal)	26
Cabbage	1/2 c cooked (17 cal)	15
Apple	1 fresh medium (81 cal)	8
Oysters	3 oz (69 cal)	7
Milk, fat-free	1 c (85 cal)	2
Whole-wheat bread	1 slice (69 cal)	0
Sirloin steak	3 oz lean (171 cal)	0
Cheddar cheese	1 oz (170 cal)	0



^aUnenriched.

Food Feature:

Choosing Foods Rich in Vitamins

- ◆ Foods work in harmony to provide most nutrients
 - ◆ A variety of foods works best
-

Controversy: Vitamin Supplements: Do the Benefits Outweigh the Risks?

- ◆ About half of the U.S. population buys nutrient supplements, spending *billions* of dollars each year.
 - ◆ Do you take supplements?
 - a. Yes
 - b. No
-

Controversy: Vitamin Supplements: Do the Benefits Outweigh the Risks?

Which is the best source?



Arguments in Favor of Taking Supplements

TABLE C7-1 Some Valid Reasons for Taking Supplements

THESE PEOPLE MAY NEED SUPPLEMENTS:

- People with nutrient deficiencies.
- Women in their childbearing years (supplemental or enrichment sources of folic acid are recommended to reduce risk of neural tube defects in infants).
- Pregnant or lactating women (they may need iron and folate).
- Newborns (they are routinely given a vitamin K dose).
- Infants (they may need various supplements, see Chapter 13).
- Those who are lactose intolerant (they need calcium to forestall osteoporosis).
- Habitual dieters (they may eat insufficient food).
- Elderly people often benefit from some of the vitamins and minerals in a balanced supplement (they may choose poor diets, have trouble chewing, or absorb or metabolize less efficiently; see Chapter 14).
- Victims of AIDS or other wasting illnesses (they lose nutrients faster than foods can supply them).
- Those addicted to drugs or alcohol (they absorb fewer and excrete more nutrients; nutrients cannot undo damage from drugs or alcohol).
- Those recovering from surgery, burns, injury, or illness (they need extra nutrients to help regenerate tissues).
- Strict vegetarians (they may need vitamin B₁₂, vitamin D, iron, and zinc).
- People taking medications that interfere with the body's use of nutrients.

- ◆ In the U.S. and Canada, adults rarely suffer nutrient deficiencies, but they do still occur.
 - ◆ Luckily, deficiency diseases quickly resolve when a physician identifies them and prescribes therapeutic doses (two to ten times the DRI).
-

- ◆ Nutrient needs increase during certain stages of life and so sometimes nutrient supplementation is needed.
 1. Women who lose a lot of blood and therefore a lot of iron during menstruation each month may need an _____ supplement.
 2. Newborns require a single dose of vitamin _____ at birth.
 3. Women of childbearing age need supplements of _____ to reduce the risk of NTD.

Answers: 1. iron; 2. K; 3. folic acid

- ◆ *Subclinical deficiencies* are more common than classical deficiencies.
 - People who don't eat enough food to deliver the needed amounts of nutrients, such as habitual dieters, otherwise healthy elderly, and vegetarians who omit entire food groups and may not find an appropriate substitute
-

- ◆ Any condition that interferes with a person's appetite, ability to eat, or ability to absorb or use nutrients can easily impair nutrition status.
-

Arguments Against Taking Supplements

- ◆ Unlike foods, supplements can easily cause nutrient imbalances or toxicities.
 - ◆ The higher the dose, the greater the risk of harm.
-

Arguments Against Taking Supplements

TABLE C7-2 Typical Vitamin and Mineral Supplement Values for Adults

NUTRIENT	TOLERABLE UPPER INTAKE LEVELS ^a	DAILY VALUES	TYPICAL MULTIVITAMIN-MINERAL SUPPLEMENT	AVERAGE SINGLE-NUTRIENT SUPPLEMENT
Vitamins				
Vitamin A	3,000 µg (10,000 IU)	5,000 IU	5,000 IU	8,000 to 10,000 IU
Vitamin D	50 µg (2,000 IU)	400 IU	400 IU	400 IU
Vitamin E	1,000 mg (1,500 to 2,200 IU) ^b	30 IU	30 IU	100 to 1,000 IU
Vitamin K	— ^c	80 µg	40 µg	— ^e
Thiamin	— ^c	1.5 mg	1.5 mg	50 mg
Riboflavin	— ^c	1.7 mg	1.7 mg	25 mg
Niacin (as niacinamide)	35 mg ^b	20 mg	20 mg	100 to 500 mg
Vitamin B ₆	100 mg	2 mg	2 mg	100 to 200 mg
Folate	1,000 µg ^b	400 µg	400 µg	400 µg
Vitamin B ₁₂	— ^c	6 µg	6 µg	100 to 1,000 µg
Pantothenic acid	— ^c	10 mg	10 mg	100 to 500 mg
Biotin	— ^c	300 µg	30 µg	300 to 600 µg
Vitamin C	2,000 mg	60 mg	10 mg	500 to 2,000 mg
Choline	3,500 mg	—	10 mg	250 mg
Minerals				
Calcium	2,500 mg	1,000 mg	160 mg	250 to 600 mg
Phosphorus	4,000 mg	1,000 mg	110 mg	— ^e
Magnesium	350 mg ^d	400 mg	100 mg	250 mg
Iron	45 mg	18 mg	18 mg	18 to 30 mg
Zinc	40 mg	15 mg	15 mg	10 to 100 mg
Iodine	1,100 µg	150 µg	150 µg	— ^e
Selenium	400 µg	70 µg	10 µg	50 to 200 µg
Fluoride	10 mg	—	—	— ^e
Copper	10 mg	2 mg	0.5 mg	— ^e
Manganese	11 mg	2 mg	5 mg	— ^e
Chromium	— ^c	120 µg	25 µg	200 to 400 µg
Molybdenum	2,000 µg	75 µg	25 µg	— ^e

- ❖ No one knows for sure how many people in the U.S. suffer from supplement toxicities but in the year 2005, over 125,000 adverse events were reported from vitamins, minerals, essential oils, herbs, and other supplements.
 - ❖ Toxic overdoses are more common in children due to fruit-flavored, chewable vitamins shaped like cartoon characters that young children like to eat in amounts that can cause poisoning.
-

- ❖ Another problem arises when people who are ill use high doses of supplements to cure themselves.
 - ❖ Marketing materials are often misleading and false.
-

- ◆ No one knows exactly how to formulate the “ideal” supplement
 - Should phytochemicals be added? If yes, how much?
 - What nutrients should be added?
-

- ❖ Using supplements may lull people into a false sense of security.
 - ❖ People may think it is not important which foods they choose because the supplement will take care of any discrepancies.
 - ❖ Self-diagnosing a condition and taking a supplement may postpone a diagnosis.
-

- ◆ Nutrients are absorbed best when ingested with food.
 - ◆ Taken in pure, concentrated form, nutrients are likely to interfere with one another's absorption or with the absorption of nutrients from foods eaten with them.
 - Zinc hinders copper and calcium absorption
 - Iron hinders zinc absorption
 - Vitamin C enhances iron absorption
-

Can Supplements Prevent Heart Disease or Cancer?

- ◆ Can taking a supplement prevent these killers?

Marginal Deficiencies, Oxidative Stress, and Chronic Diseases

- ❖ Antioxidant nutrients help to quench **free radicals**, rendering them harmless to cellular structures.
 - ❖ Population studies support the theory that people with high intakes of fruits and vegetables that supply the antioxidant nutrients enjoy better health than people with lower intakes.
-

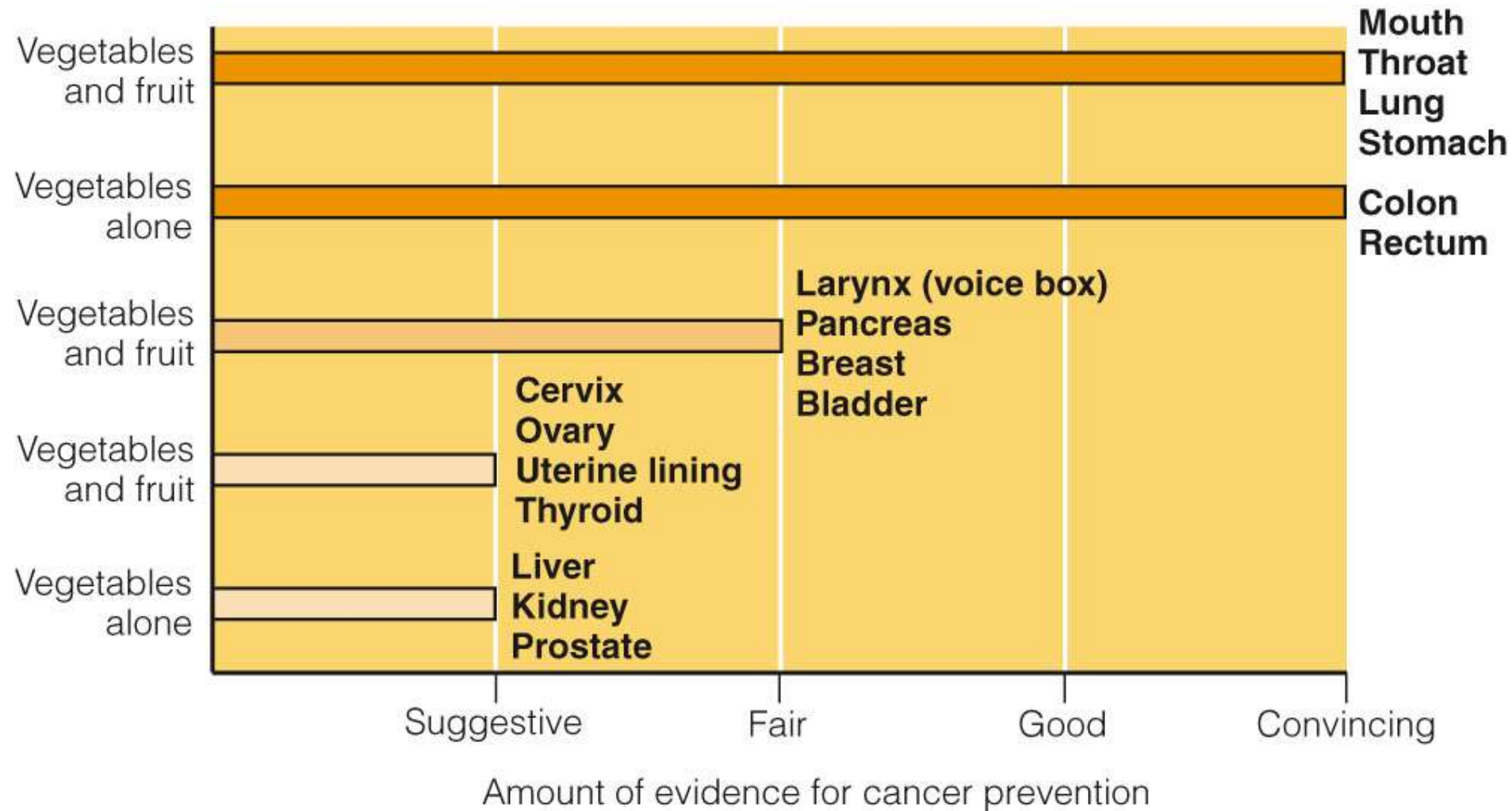
TABLE C7-3 Antioxidant Terms

- **antioxidant nutrients** vitamins and minerals that oppose the effects of oxidants on human physical functions. The antioxidant vitamins are vitamin E, vitamin C, and beta-carotene. The mineral selenium also participates in antioxidant activities.
- **electrons** parts of an atom; negatively charged particles. Stable atoms (and molecules, which are made of atoms) have even numbers of electrons in pairs. An atom or molecule with an unpaired electron is an unstable *free radical*.
- **oxidants** compounds (such as oxygen itself) that oxidize other compounds. Compounds that prevent oxidation are called *antioxidants*, whereas those that promote it are called *prooxidants* (*anti* means “against”; *pro* means “for”).
- **oxidative stress** damage inflicted on living systems by free radicals.
- **subclinical, or marginal, deficiency** a nutrient deficiency that has no outward clinical symptoms. The term is often used to market unneeded nutrient supplements to consumers.

Vitamin E Supplements And Heart Disease: Unconvincing Evidence

- ◆ After years of recording health data, evidence shows that vitamin E supplements offered no protection against heart attack incidence, hospitalization, or death from heart failure.
 - ◆ In fact, an alarming increased risk for death emerged for people taking vitamin E supplements.
-

The Story of Beta-Carotene



- ❖ Similar to the hopeful beginnings of the vitamin E story, beta-carotene showed early promise as a cancer fighter.
 - ❖ Results from controlled clinical human trials reveal no benefit from beta-carotene.
 - ❖ In fact, there was a 38 percent increase in deadly lung cancer among smokers taking beta-carotene compared with placebos.
-

Supplements Must Be Safe, or the Government Would Not Allow Their Sales, Right?

- ◆ Consumers who take supplements without solid research are at least wasting their money, or at worst risking their health.
-

Supplements Must Be Safe, or the Government Would Not Allow Their Sales, Right?

TABLE C7-4 Dietary Supplement Terms

- **aristolochic acid** a Chinese herb ingredient known to attack the kidneys and to cause cancer; U.S. consumers have required kidney transplants and must take lifelong anti-rejection medication after use. Banned by the FDA but available in supplements sold on the Internet.
- **coenzyme Q-10** an enzyme made by cells and important for its role in energy metabolism. With diminished coenzyme Q-10 function, oxidative stress increases, as may occur in aging. Preliminary research suggests that it may be of value for treating certain conditions; toxicity in animals appears to be low. No safe intake levels for human beings have been established.
- **DHEA^a** a hormone secretion of the adrenal gland whose level falls with advancing age. DHEA may protect antioxidant nutrients. Real DHEA is available only by prescription; the herbal DHEA imitator for sale in health-food stores is not active in the body. No safety information exists for either.
- **dietary supplement** a product, other than tobacco, that is added to the diet and contains one of the following ingredients: a vitamin, mineral, herb, botanical (plant extract), amino acid, metabolite, constituent, or extract, or a combination of any of these ingredients.
- **ephedrine** one of a group of compounds with dangerous amphetamine-like stimulant effects; extracted from the herb ma huang and recently banned by the FDA, but still available from Internet sources. The most severe reported side effects of ephedrine include heart attack, stroke, and sudden death.
- **garlic oil** an extract of garlic; may or may not contain the chemicals associated with garlic; claims for health benefits unproved.
- **green pills, fruit pills** pills containing dehydrated, crushed vegetable or fruit matter. An advertisement may claim that each pill equals a pound of fresh produce, but in reality a pill may equal one small forkful—minus nutrient losses incurred in processing.

-
- **kelp tablets** tablets made from dehydrated kelp, a kind of seaweed used by the Japanese as a foodstuff.
 - **ma huang** an evergreen plant that supposedly boosts energy and helps with weight control. Ma huang, also called ephedra, contains ephedrine (see above) and is especially dangerous in combination with kola nut or other caffeine-containing substances.
 - **melatonin** a hormone of the pineal gland believed to help regulate the body's daily rhythms, to reverse the effects of jet lag, and to promote sleep. Claims for life extension or enhancement of sexual prowess are without merit.
 - **nutritional yeast** a preparation of yeast cells, often praised for its high nutrient content. Yeast is a source of B vitamins as are many other foods. Also called brewer's yeast; not the yeast used in baking.
 - **organ and glandular extracts** dried or extracted material from brain, adrenal, pituitary, or other glands or tissues providing few nutrients but posing a theoretical risk of "mad cow disease." See Chapter 12.
 - **SAM-e** an amino acid derivative that may have an antidepressant effect on the brain in some people, but it is not recommended as a substitute for standard antidepressant therapy.
 - thousands of others.

^aDehydroepiandrosterone.

Note: According to legal definitions, all of the substances listed qualify as dietary supplements, even though some appear to have the effects of drugs, not nutrients. Table 11-7 on page 423 describes many more medicinal herbs, including their effects and their hazards.

What Are the Risks of Taking Nutrient Supplements?

- ◆ Supplements may endanger the taker's health in these ways:
 - Vitamin A intakes of about twice the DRI taken over years are associated with osteoporosis and hip fractures
 - Daily supplements of beta-carotene may increase lung cancer in smokers or in people exposed to asbestos
 - High doses of vitamin C taken by women with diabetes may increase their likelihood of dying of CVD
-

Selection of a Multinutrient Supplement

- ◆ If you cannot meet your needs from foods, a supplement containing nutrients only can prevent serious problems.
-

TABLE C7-5 Some Invalid Reasons for Taking Supplements

Watch out for plausible-sounding, but false, reasons given by marketers trying to convince you, the consumer, that you need supplements. The invalid reasons listed below have gained strength by repetition among friends, on the Internet, and by the media:

- You fear that foods grown on today's soils lack nutrients (a common false statement made by sellers of supplements).
- You feel tired and falsely believe that supplements can provide energy.
- You hope that supplements can help you cope with stress.
- You wish to build up your muscles faster or without physical exercise.
- You want to prevent or cure self-diagnosed illnesses.
- You hope excess nutrients will produce unnamed mysterious beneficial reactions in your body.

People who should never take supplements without a physician's approval include those with kidney or liver ailments (they are susceptible to toxicities), those taking medications (nutrients can interfere with their actions), and smokers (who should avoid products with beta-carotene).

◆ Don't fall for meaningless labels such as, "Advanced Formula," "Maximum Power," "Stress formula," "Time Release," and the like.



This symbol means that a supplement contains the nutrients states and that it will dissolve in the system – the symbol does not guarantee safety, purity, or health advantages.

- ◆ Watch the dose you select.
 - ◆ Avoid any preparation that in a daily dose provides more than the DRI recommended intake of vitamin A, vitamin D or any mineral, or more than the Tolerable Upper Intake Level for any nutrient.
-

Conclusion

- ◆ People in developed nations are far more likely to suffer from *overnutrition* and poor lifestyle choices than from nutrient deficiencies.
 - ◆ Invest energy in eating a wide variety of fruits and vegetables in generous quantities, along with the recommended daily amounts of whole grains, lean meats, and milk products every day, and take supplements only when they are needed.
-