**CHAPTER 22
Nutritional Supplements**

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| **OBJECTIVES** |
| This chapter should enable you to• Describe the components of dietary reference intakes• Discuss the development of the nutritional supplement industry• List factors to consider in assessing the need for supplements• Describe facts that are listed on supplement labels• List the antioxidants and their sources• Define the term *phytochemical*• Discuss health conditions for which nutritional supplements can be beneficial |

The importance of proper and sensible nutrition, as stated in a previous chapter, cannot be emphasized enough. In its *Healthy People 2020* report, the U.S. government’s Office of Disease Prevention and Health Promotion states that what people eat, especially when they exercise regularly and do not smoke and/or drink excessively, is the most significant controllable risk factor affecting their long-term health ([**U.S. Department of Health and Human Services, 2016**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib12)). Basic dietary principles supporting optimum health include the following:

• Eating a wide variety of foods that provide adequate nutrients, including plenty of fresh fruits and vegetables, complex carbohydrates, plant protein, and fiber.

• Keeping consumption of sugary foods, caffeinated beverages, and alcohol to a minimum.

• Eating only a small amount of animal protein and fat.

• Matching calories consumed with energy expenditure to assure the amount of energy derived from consumed food is sufficient to support biological and physiological activities

• Drinking plenty of water.

It was once thought that anyone who followed these principles was considered properly nourished and did not need supplementation; however, the dietary habits of most Americans lead them to be overweight and undernourished.

**Views on Nutritional Supplements**

There has been much debate regarding vitamins and minerals as nutritional supplements and how (or if) they should be taken daily. The early 1900s focused largely on deficiencies of vitamins and minerals that caused diseases such as scurvy and beriberi. Vitamins began to be added to food—a process called fortification. Through the 1950s and 1960s, a number of foods were fortified, such as breads, cereals, and milk. The addition of calcium has been among the recent fortification of many food products.

By the mid-1970s, however, the focus was less on vitamin deficiency and more on the value of vitamin and mineral supplementation for the prevention of illness and disease. Vitamin C was thought to prevent and alleviate symptoms of the common cold. Vitamin E was said to help keep the heart healthy. A low-fat, high-fiber diet was the order of the decade. The late 1970s saw the response of the [**U.S. Senate Select Committee on Nutrition (1977)**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib15) that listed the number one public health problem in this country as poor nutrition. Experts believed Americans consumed too much food of too little nutritive value and that this was a contributing factor to poor quality of life and increased disease.

| **KEY POINT** |
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| *In 1994, an office was created within the National Institutes of Health (NIH) for overseeing research on dietary supplements through the Dietary Supplement Health and Education Act (DSHEA). This requires manufacturers of dietary supplements to include the words* dietary supplement *on product labels.* |

**How the Government Is Involved**

**Recommended Dietary Allowances**

Since the 1940s, the Food and Nutrition Board of the National Academy of Sciences has made recommendations for nutrient intake. These recommendations have been termed *recommended dietary allowances (RDAs)* and represent the minimum standards that should meet the needs of most healthy people in the United States.

In the 1990s the Food and Nutrition Board determined that a different approach to guidelines was needed to address the growing use of dietary supplements, food fortification, and awareness of the role of higher intakes of some nutrients in disease prevention. Because RDAs did not provide guidelines that addressed the needs of specific groups (e.g., nursing homes, schools, prisons), Dietary Reference Intakes (DRIs) were developed by the Institute of Medicine to provide recommendations for different settings ([**U.S. Department of Agriculture, 2016**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib11)). DRIs include several reference values:

• RDAs: the average daily intake of a nutrient to meet the needs of nearly all healthy people

• Adequate Intake (AI): an alternative when RDAs cannot be determined which is based on the observed intakes of a nutrient by healthy people

• Tolerable Upper Intake Level (UL): the highest level of daily intake of a nutrient that is likely to be safe for most people

• Estimated Average Requirement (EAR): the amount of a nutrient estimated to meet the requirement of half of all healthy people in a population

Each of the values considers differences in life stages and gender.

| **KEY POINT** |
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| RDAs, AIs, and ULs offer dietary guidelines for individuals; EARs provide guidelines for groups and populations. |

EARs would satisfy 50% of requirements for men and women for specific age groups and are intended for use by nutritional professionals. If calculations of EARs are not available, adequate intakes are used instead of RDAs. RDAs continue to be considered as sufficient amounts of nutrients to meet nearly all needs. Tolerable upper intake levels indicate the largest amount of a nutrient that someone can ingest without adverse effect.

The Food and Drug Administration (FDA) describes acceptable claims that can be made for relationships between a nutrient and the risk of a disease or health-related condition. These claims must be clear as to the relationship of the nutrient to the disease and be understandable by the general public. The claims can be made in several ways—through third-party references (such as the National Cancer Institute), symbols (such as a heart), and vignettes or descriptions (see [**Exhibit 22-1**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22_box1)).

| **EXHIBIT** **22-1** **STATUS OF HEALTH CLAIMS** |
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| **Approved Health Claims for Dietary Supplements and Conventional Foods** |
| • Calcium and osteoporosis• Folate and neural tube defects• Soluble fiber from whole oats and coronary heart disease• Soluble fiber from psyllium husks and coronary heart disease• Sugar alcohols and dental caries |
| **Approved Health Claims for Conventional Foods Only**• Dietary lipids and cancer• Dietary saturated fat and cholesterol and coronary heart disease• Fiber-containing grain products, fruits, and vegetables and cancer• Fruits and vegetables and cancer (for foods that are naturally a “good source” of vitamin A, vitamin C, or dietary fiber)• Fruits, vegetables, and grain products that contain fiber, particularly soluble fiber, and coronary heart disease• Sodium and hypertension |
| **Health Claims Not Authorized**• Antioxidant vitamins and cancer• Dietary fiber and cancer• Dietary fiber and cardiovascular disease• Omega-3 fatty acids and coronary heart disease• Zinc and immune function in older individuals |
| *Data from* U.S. Food and Drug Administration. (2016). *Guidance for Industry: Substantiation for Dietary Supplement Claims Made Under Section 403(r)(6) of the Federal Food, Drug, and Cosmetic Act.* Retrieved from [**http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/DietarySupplements/ucm073200.htm**](http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/DietarySupplements/ucm073200.htm) |

The FDA does not allow claims for healing, treatment, or cure of specific medical conditions on the labels or advertisements of nutritional supplements. This would put supplements in the category of drugs. The DSHEA allows only three types of claims to be used with supplements—nutrient content, disease, and nutrition support claims. The nutrient content explains how much of a nutrient is in a supplement. Claims regarding disease must have a basis in scientific evidence and refer to health-related conditions or diseases and a particular nutrient. Nutrition support claims (which may be used without FDA approval, but not without notification to that agency) are set up to explain how a deficiency could develop if the diet was deficient in that nutrient. These claims are accompanied by an FDA disclaimer on the label of the supplement and are therefore easy to determine. In March 1999, the DSHEA required that all nutritional supplements carry a supplement facts panel (see [**Figure 22-1**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22_fig1)).

**Figure 22-1 Supplement Label**

Reproduced from United States Pharmacopeial Convention. (2016). How to read a supplement label. Retrieved from [**http://qualitymatters.usp.org/how-read-supplement-label**](http://qualitymatters.usp.org/how-read-supplement-label)

| **REFLECTION** |
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| What motivates you to use supplements? Do you carefully evaluate claims about them? |

**A Supplement Extravaganza**

Vitamins and minerals were what traditionally made up typical nutritional supplements. Today the definition of nutritional supplements is expanded to include vitamins, minerals, herbs, botanicals, and other plant-derived substances; and amino acids, concentrates, metabolites, constituents, and extracts of these substances ([**U.S. Food and Drug Administration, 2015**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib13)).

Consumers can easily become confused by the burgeoning of scientific studies on nutrients; the immediate release of single studies relating to nutrition, diet, and health; and supplement advertisements that use health claims to increase sales. In many cases, one report contradicts another—what was touted as good yesterday is considered harmful today. The following are some considerations when evaluating studies on supplements:

• Who conducted the research? Was it an independent source or a person/company with a financial interest in the product?

• Are the details of the studies provided or just the results?

• How many people participated in the research and how were they selected?

• Was the dose standardized?

• Have the findings been replicated?

• Has the research been published in a reputable journal and has it been included in the Cochrane Database of Systematic Reviews ([**http://www.cochranelibrary.com/**](http://www.cochranelibrary.com/)), which evaluates health-care research?

| **KEY POINT** |
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| More than half of all adults in the United States use nutritional supplementation on a regular basis. |

The new millennium was accompanied by buzzwords, such as *antioxidants*, *phytochemicals*, *functional foods*, and *nutriceuticals*. It is yet to be determined whether these new compounds deserve the onslaught of press, print, and manufacture they so readily receive. When a new study has been completed that suggests a benefit from a nutrient, it is released immediately. Americans rush to purchase the latest combination of vitamins, minerals, and nutritive supplements—spending billions of dollars on dietary supplements annually. Are the supplements worth taking, and are the claims made by manufacturers true? Nutritional supplements may be helpful, but they may also be harmful. Taking supplements without knowledge of their actions and interactions could lead to imbalances of other nutrients and, potentially, toxicity; however, if taken properly and with forethought, supplements can increase general health and ward off some diseases.

When making the decision to take nutritional supplements, evaluation of the information available should be done in a carefully planned manner as part of a total nutrition program. If people hear of studies that seem to relate to their circumstances, it is important for them to do some investigating on their own. Studies need to be assessed in the context they were performed and their relationship to a person’s particular situation. Health professionals can assist individuals in understanding what studies reveal. In any case, taking a supplement based on what has been read or heard in the news does not guarantee that a given person will have the same outcome.

The nutritional supplement industry is still young and grows exponentially each day. There continues to be an increasing variety of supplements readily available, which can be bought over the Internet, by mail order, at supermarkets, in drug stores, and in other types of stores. Supplements are no longer the domain of natural food stores. The FDA regulates and oversees manufacturing, product information, and safety; and the Federal Trade Commission regulates advertising of supplements; however, decisions regarding whether supplements should be taken, in what form, and how much, still remain a personal choice.

There is increasing interest among Americans to use nutritional supplements for optimum health. Some experts are also indicating a definite need for supplementation as part of a nutritional plan as relying solely on diet to meet the body’s needs for vitamins and minerals may not assure adequate intake. We no longer eat food picked fresh from the local garden and cooked within hours. Additionally, many food preparation practices decrease the nutritive value of food.

Vitamins and minerals play an important role in optimum health and in reducing the risk of chronic diseases. Is the diet a person is consuming, however, giving him or her enough nutrients and meeting individual needs? If so, then all that may be needed is a good quality multivitamin and mineral; however, if a person has poor nutritional habits, is under a great deal of stress, is pregnant or planning a pregnancy, or has a health problem, supplementation is a must. The supplements that are needed, how much of each, and for how long they need to be taken then becomes the issue. The research is promising, but for many nutrients, the results are still not definite.

| **KEY POINT** |
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| Supplements can never substitute for a healthy, sensible nutrition program where whole foods, containing hundreds of substances, working together synergistically, are consumed. Poor food choices and eating habits cannot be banished by supplementation**.** |

Age, nutritional lifestyle, quality and quantity of food, gender, life stage, environment, family history, personal history, diet, exercise, and rest patterns should be considered in determining a person’s need for nutritional supplementation.

As with all holistic approaches, knowledge, self-care, balance, and using what nature provides are the keys. Individual nutritional needs can be determined by looking at the responses made on your nutritional lifestyle survey (earlier in this book) and by considering several factors, which include the following:

*Age.* There are factors that increase the need for nutrient supplementation with age. Some nutrients are not absorbed as well as a person ages, even if they are consumed in good quantity. Older adults may be affected by poor lifelong nutrition habits, social isolation, and chronic diseases that require special diets or affect food intake. Children need a balanced diet, along with a good quality multivitamin and limited sweets and fats to promote their growth and development.

*Chronic health problems.* Some chronic conditions create special nutritional needs, whereas others produce symptoms that threaten a healthy nutritional status. If a person has a chronic health problem, is taking medication, and wants to take nutritional supplements, a thorough knowledge of drug–supplement interactions is necessary. Nurses and other health practitioners can help in this area.

*Female issues.* Women who are pregnant, planning to become pregnant, breastfeeding, menopausal, or postmenopausal need added nutrients and/or supplementation. Different supplements are needed for different life cycles. Within the past decade, the National Academy of Sciences has addressed the unique DRIs for folate and calcium for women ([**National Institutes of Health, Office of Dietary Supplements, 2016a**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib06); [**National Institutes of Health, Office of Dietary Supplements, 2016b**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib07)).

*Lifestyle choices.* Cigarette and alcohol use reduces the levels of certain nutrients and predisposes the body to diseases for which added protection is helpful. A stressful lifestyle can deplete nutrients. Deficiencies also can arise from the high consumption of caffeine and sugar.

If people presently take multivitamin/mineral supplements and believe that they may benefit from taking additional supplements, they should first examine the labels of their food and supplements. They need to check the DVs of each vitamin and mineral listed. They should be receiving at least 100% of all nutrients from all food and supplements. If they are lower than 100%, they first need to determine whether they can meet this need through a change in diet. If they cannot meet the requirements through diet, then supplements of specific nutrients may be necessary. If the DV is over 100% for some or all nutrients, they may want to cut back on that supplement. The guideline is to keep below 300% DV of any nutrient. A nutritional analysis can be used, also. A registered dietician, nutritionist, or nutrition-knowledgeable health-care professional can help with an analysis.

| **TIP FOR PRACTITIONERS** |
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| For every supplement they are taking, clients should be advised to know: the purpose, recommended dosage, side effects, adverse effects, expiration date, and related precautions. |

**Supplement Labels**

Supplements come in many forms—tablets, capsules, softgels, powders, and liquids. The USP is the agency that oversees drug products and sets the standards for dietary supplements. All supplements now require labels, which are regulated by the USP. The USP has certain standards that must be met for single vitamins and those in combination, as well as dietary supplements, and botanical and herbal preparations. [**Figure 22-1**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22_fig1) shows the information that is contained on a supplement label.

One facet of the dietary supplement label that is important to read is the DV column. The DV is the percentage of the recommended daily amount of the nutrient that a serving gives. According to the USP, intake should be between 50% and 100% of the DV of each nutrient. One nutrient that would not provide 100% of the DV is calcium. If 100% of calcium were added to any supplement, it would be too big to swallow. Calcium should be taken in divided doses throughout the day.

The bioavailability of a particular nutrient is the amount of a nutrient that enters the bloodstream and actually reaches the various organs, tissues, and cells of the body. Nutrients have greater bioavailability when they are taken with compounds that help their absorption.

Fruits and vegetables contain many compounds that, when eaten, allow for synergy to take place in the body, increasing bioavailability. Fruits and vegetables are especially affected by mode of storage and preparation. Those that have been exposed to heat, light, or air have lost some or all of their nutrients; their bioavailability is lowered.

Two important factors when considering the bioavailability of a supplement are ease of absorption and the benefit of taking it in combination with another supplement. Disintegration (how quickly a tablet/supplement breaks apart) and dissolution (how fast the supplement dissolves in the intestinal tract) ([**U.S. Pharmacopeia, 2016**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib14)) are two additional factors directly related to bioavailability. Vitamin C assists with the absorption of iron into the body. If taking iron as a supplement, people also should consider their vitamin C intake. Taking an iron supplement with a glass of orange juice would increase the bioavailability of the iron. On the other hand, calcium inhibits iron and magnesium absorption. This is important to remember when adding supplements to a nutritional plan, especially if iron, calcium, and vitamin C individually or in a multivitamin are being taken. More research is needed to determine and document supplement interactions.

**Birth Defects**

One of the first vitamins addressed by the advisory committee on dietary supplements was folic acid. The original aim was to reduce neural tube birth defects, especially spina bifida. The RDA for folic acid was doubled from 200 to 400 mcg/day. The Centers for Disease Control, the USP, the FDA, and the March of Dimes have all recommended that women of childbearing age consume 0.4 mg (400 mcg) per day of folic acid, either through diet or supplements ([**Centers for Disease Control and Prevention, 2016**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib02)). Women who are planning to become pregnant and who are of childbearing age should eat a varied diet and also take folic acid through supplementation. Sufficient folate (folic acid) is critical from conception through the first 4 to 6 weeks of pregnancy when the neural tube is formed. This means adequate diet and supplement use should begin well before pregnancy occurs.

**Antioxidants**

Antioxidants are compounds that naturally protect the body from free radicals by reducing their oxidative damage and help to depress the effects of metabolic by-products that cause degenerative changes related to aging. Free radicals have a helpful function in the body, but in higher levels, they can damage cells and tissues. They are produced by the body’s own metabolism and are generated from exposure to environmental factors and toxins. Antioxidant nutrients are said to neutralize the harmful free radicals that occur in the body constantly and arise from improper nutrition, eating fatty foods; smoking; drinking alcohol; taking drugs; and exposure to environmental pollutants (such as herbicides and pesticides), toxins, carcinogens, iron, smog, and radiation.

| **KEY POINT** |
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| The neural tube is a type of membrane that grows into the spinal cord and brain in utero (during pregnancy). Neural tube defects are problems in the development of the brain and spinal cord that arise during pregnancy. This is now believed to be a result of folate deficiency of the mother in the weeks before and in the early weeks of pregnancy. It is estimated that nearly 50% of all neural tube defects that occur can be arrested by adequate folate intake. |

The body has natural antioxidant enzymes that regulate the effects of free radicals. These enzymes are catalase, superoxide dismutase, and glutathione peroxidase. Vitamins A (as beta-carotene), C, and E and selenium assist the enzymes in the body to fight free radical damage.

Although antioxidant supplements have been promoted as a means to prevent heart disease, cancer, and other conditions, research has not supported these claims ([**Harvard School of Public Health, 2016**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib03)).

**Benefits Versus Risks of Antioxidant Supplementation**

A diet low in fats, sweets, and animal protein that includes at least five fruits and vegetables per day, in variety, is a much safer way to obtain antioxidant protection than through supplementation. A greater chance of imbalances and toxicity exists when supplements are being used ([**Tables 22-1**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22_tbl1) and [**22-2**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22_tbl2) show guidelines for information on vitamins and minerals); however, there continues to be increased evidence supporting antioxidant supplements as part of a nutritional lifestyle.

| **TABLE** **22-1** **VITAMINS** |
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| **Vitamin** | **Deficiency May Cause** | **How It Works** | **Excess May Cause** | **Best Foods to Eat** |
| A | Night blindness; skin problems; dry, inflamed eyes | Bone and teeth growth; vision; keeps cells, skin, and tissues working properly | Birth defects, bone fragility, vision and liver problems | Eggs, dark green and deep orange fruits and vegetables, liver, whole milk |
| B-1 | Tiredness, weakness, loss of appetite, emotional upset, nerve damage to legs (late sign) | Helps release food nutrients and energy, appetite control, helps nervous system and digestive tract | Headache, rapid pulse, irritability, trembling, insomnia, interference with B2, B6 | Whole grains and enriched breads, cereals, dried beans, pork, most vegetables, nuts, peas |
| B-2 Riboflavin | Cracks at corners of mouth, sensitivity to light, eye problems, inflamed mouth | Helps enzymes in releasing energy from cells, promotes growth, cell oxidation | No known toxic effect. Some antibiotics can interfere with B2 being absorbed | Whole grains, enriched bread and cereals, leafy green vegetables, dairy, eggs, yogurt |
| Niacin | General fatigue, digestive disorders, irritability, loss of appetite, skin disorders | Fat, carbohydrate, and protein metabolism; good skin, tongue, and digestive system; circulation | Flushing, stomach pain, nausea, eye damage, can lead to heart and liver damage | Whole wheat, poultry, milk, cheese, nuts, potatoes, tuna, eggs |
| B-6 Pyridoxine | Dermatitis, weakness, convulsions in infants, insomnia, poor immune response, sore tongue, confusion, irritability | Necessary protein metabolism, nervous system functions, formation of red blood cells, immune system function | Reversible nerve injury, difficulty walking, numbness, impaired senses | Wheat and rice bran, fish, lean meats, whole grains, sunflower seeds, corn, spinach, bananas |
| Biotin | Rarely seen since it can be made in body if not consumed. Flaky skin, loss of appetite, nausea. | Cofactor with enzymes for metabolism of macronutrients, formation of fatty acids, helps other B vitamins be utilized | Symptoms similar to vitamin B1 overdose | Egg yolks, organ meats, vegetables, fish, nuts, seeds, also made in intestines by normal bacteria there |
| Folic Acid | Anemia, diarrhea, digestive upset, bleeding gums, | Red blood cell formation, healthy pregnancy, metabolism of proteins | Masking of B12 deficiency and interference with zinc absorption | Green leafy vegetables, organ meats, dried beans |
| B12Cobalamin | Elderly, vegetarians, or those with malabsorption disorder are at risk of deficiency-pernicious anemia, nerve damage | Necessary to form blood cells, proper nerve function, metabolism of carbohydrates and fats, builds genetic material | None known except those born with defect to absorb | Liver, salmon, fish, lean meats, milk, all animal products |
| Pantothenic Acid | Not usually seen; vomiting, cramps, diarrhea, fatigue, tingling hands and feet, difficult coordination | Needed for many processes in the body, converts nutrients into energy, formation of some fats, vitamin utilization, making hormones | Rare | Lean meats, whole grains, legumes |
| C Ascorbic Acid | Bleeding gums, slow healing, poor immune response, aching joints, nose bleeds, anemia | Helps heal wounds, collagen maintenance, resistance to infection, formation of brain chemicals | Diarrhea, kidney stones, blood problems, urinary problems | Most fruits, especially citrus fruits, melon, berries, and vegetables |
| D | Poor bone growth, rickets, osteoporosis, bone softening, muscle twitches | Calcium and phosphorus, metabolism and absorption, bone and teeth formation | Headache, fragile bones, high blood pressure, increased cholesterol, calcium deposits | Egg yolks, organ meats, fortified milk, also made in skin when exposed to sun |
| E | Not usually seen, after prolonged impairment of fat absorption, neurological abnormalities | Maintains cell membranes, assists as antioxidant, red blood cell formation |  | Vegetable oils and margarine, wheat germ, nuts, dark green vegetables, whole grains |
| K | Tendency to hemorrhage, liver damage | Needed for prothrombin, blood clotting, works with Vitamin D in bone growth | Jaundice (yellow skin) with synthetic form, flushing and sweating | Green vegetables, oats, rye, dairy |

| **TABLE** **22-2** **MINERALS** |
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| **Minerals** | **Deficiency May Cause** | **How It Works** | **Excess May Cause** | **Best Foods to Eat** |
| Calcium | Rickets, soft bones, osteoporosis, cramps, numbness and tingling in arms and legs | Strong bones, teeth, muscle and nerve function, blood clotting | Confusion, lethargy, blocks iron absorption, deposits in body | Dairy, salmon and small bony fish, tofu |
| Phosphorus | Weakness and bone pain, otherwise rare | Works with calcium; helps with nerve, muscle, and heart function | Proper balance needed with calcium | Meat, poultry, fish, eggs, dairy, dried beans, whole grains |
| Magnesium | Muscle weakness, twitching, cardiac problems, tremors, confusion, formation of blood clots | Needed for other minerals and enzymes to work, helps bone growth, muscle contraction | Proper balance needed with calcium, phosphorus, and vitamin D | Nuts, soybeans, dried beans, green vegetables |
| Potassium | Lethargy, weakness, abnormal heart rhythm, nervous disorders | Fluid balance; controls heart, muscle, nerve, and digestive function | Vomiting, muscle weakness | Vegetables, fruits, dried beans, milk |
| Iron | Anemia, weakness, fatigue, pallor, poor immune response | Forms of hemoglobin and myoglobinsupplies oxygen to cells, muscles | Increased need for antioxidants, heart disorders | Red meats, fish, poultry, dried beans, eggs, leafy vegetables |
| Iodine | Goiter, weight gain, increased risk of breast cancer | Helps metabolize fat, thyroid function | Thyroid-decreased activity, enlargement | Seafood, iodized salt, kelp, lima beans |
| Zinc | Poor growth, poor wound healing, loss of taste, poor sexual development | Works with many enzymes for metabolism and digestion, immune support, wound healing, reproductive development | Digestive problems, fever, dizziness, anemia, kidney problems | Lean meats, fish, poultry, yogurt |
| Manganese | Nerve damage, dizziness, hearing problems | Enzyme cofactor for metabolism; controls blood sugar, nervous, and immune functions | High doses affect iron absorption | Nuts, whole grains, avocados |
| Copper | Rare, but can cause anemia and growth problems in children | Enzyme activation, skin pigment, needed to form nerve and muscle fibers, red blood cells | Usually by taking supplements. Liver problems, diarrhea. | Nuts, organ meats, seafood |
| Chromium | Impaired glucose tolerance in low blood sugar and diabetes | Glucose metabolism | Most Americans have low intakes | Brewer’s yeast, whole grains, peanuts, clams |
| Selenium | Heart muscle abnormalities, infections, digestive disturbances | Antioxidant with vitamin E, protects against cancer, helps maintain healthy heart | Nail, hair, and digestive problems, fatigue, garlic odor of breath | Meat and grains, dependent on soil in which they were raised |
| Molybdenium | Unknown | Element of enzymes needed for metabolism, helps store iron | Gout, joint pains, copper deficiency | Beans, grains, peas, dark green vegetables |

**Vitamin A**

Vitamin A is necessary for good immune function, tissue repair, healthy skin and hair, bone formation, and vision. Fat-soluble vitamin A can cause toxicity and even be fatal in amounts higher than 10,000 IUs per day.

Beta-carotene, one of the family of carotenoids and a precursor to vitamin A, is a natural antioxidant that enhances the immune system and may protect against certain cancers, cataracts, and heart disease. Beta-carotene is converted in the intestines and liver into preformed vitamin A; its sources are bright, orange-yellow fruits and vegetables.

Lycopene is another carotenoid and powerful antioxidant shown to reduce the risk of prostate and other cancers. The sources are fruits and vegetables of deep red to pink color. Some orange fruits and vegetables, some green leafy vegetables, and broccoli contain lutein, another carotenoid that has been found to arrest the development of macular degeneration and help protect the eyes from other diseases ([**Saad & Washington, 2016**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib09)).

**Vitamin C**

The Food and Nutrition Board at the Institute of Medicine recommends a daily intake of vitamin C of 75 mg for adult women and 90 mg for adult men ([**National Institutes of Health, Office of Dietary Supplements, 2016c**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib08)). Despite this recommendation, vitamin C often is promoted at higher dosages, with tolerable intake levels being as high as 2,000 mg for adults ([**National Institutes of Health, Office of Dietary Supplements, 2016c**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib08)). High doses have the risk of disrupting bowel function, causing diarrhea. Long-term high intakes of vitamin C can reduce vitamin B12 and copper levels, erode dental enamel, and heighten the metabolism or excretion of ascorbic acid.

**Vitamin E and Selenium**

Vitamin E, discovered in the early 1920s, has antioxidant proprieties. It has been shown to decrease the risk of cardiovascular disease and some cancers (e.g., prostate, colorectal) and may offer protection from Parkinson’s disease and slow the progression of Alzheimer’s disease.

Vitamin E comes in two forms—natural and synthetic. The natural type is preferred and usually is listed on the label as d-alpha tocopherol (d-alpha tocopheryl) acetate. Synthetic vitamin E is listed on the label as dl-alpha tocopherol (tocopheryl) acetate.

There is little evidence of vitamin E toxicity, but at high levels, it can increase the effect of anticoagulant (blood thinning) medications and may also interfere with vitamin K’s action in the body (blood clotting).

Vitamin E has been shown to help immune response, keep low-density lipoprotein cholesterol levels in check, and assist other antioxidants to be more available for use against free radicals. A diet that includes whole grains, wheat germ, nuts, sunflower oil, and corn oil will meet vitamin E RDAs. If you wish to consume 400 to 800 IUs per day, supplementation is necessary.

Vitamin E together with selenium offers powerful antioxidant properties. High selenium use has been shown to lower cancer incidence and cancer mortality (**[Vinceti et al., 2014](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml%22%20%5Cl%20%22ch22-bib17)**).

**Phytochemicals**

Phytochemicals (plant chemicals) are compounds that exist naturally in all plant foods and give them their color, flavor, and scent. They are the nonnutritive substances of plants and are not vitamins or minerals; nevertheless, phytochemicals have been associated with assisting the immune system, working as antioxidants, and fighting cancer ([**Howes & Simmons, 2014**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib04)). Foods that have been identified as having these health benefits are fruits, vegetables, legumes, grains, seeds, soy, licorice, and green tea. Researchers have discovered many classes of phytochemicals in food. Isoflavones (phytoestrogens) and lignins (soy), lycopene (tomatoes), anthocyanins and proanthocyanidins (grapes, blueberries, cherries, and other red crops), saponins (whole grains and legumes), flavonoids (cherries, tea, and parsley), and isothiocyanates and indoles (broccoli, cauliflower, and cabbage), have antioxidant properties that may lower LDL (bad cholesterol levels) and curb growth of tumors (**[Arumuggam, Bhowmick, & Rupasinghe, 2015](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml%22%20%5Cl%20%22ch22-bib01)**).

One example of a vegetable that has gotten much press over the last several years is broccoli. Broccoli is in the cruciferous family, which includes cauliflower, cabbage, kale, brussels sprouts, bok choy, and Swiss chard. Cruciferous vegetables are excellent sources of fiber, beta-carotene, vitamin C, and other vitamins and minerals. Their cross-shaped flowers give them their name. The phytochemicals that have been found in these vegetables are indoles, isothiocyanates, and sulforaphane, which assist the body in triggering the formation of enzymes that block hormones and may protect cells against damage from certain carcinogens. Research is promising with regard to these and other phytochemicals and cancer; however, more studies are needed.

**Benefits and Risks of Phytonutrient Supplementation**

The benefits of soy products have been clearly established in studies showing that soy fights cancer and lowers cholesterol levels; however, the use of soy products, especially in women who are vegetarians, has been linked to iron deficiency. One reason cited is that a vegetarian diet uses soy to replace the meat of conventional diets; therefore, supplementing the diet with vitamin C to enhance iron absorption is recommended ([**Lane & Richardson, 2014**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib05); **[Venderley & Campbell, 2006](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml%22%20%5Cl%20%22ch22-bib16)**).

Optimum levels for phytochemicals have not yet been determined. Individual foods contain different phytochemicals in varying amounts, and experts believe that it is the combination of these compounds that may make the difference. Some scientists believe there are thousands of phytochemicals in a single food. Because researchers have advanced the most active phytonutrients found in fruits and vegetables over the last few years, it was inevitable that these components, in supplement form, would soon follow.

Although this provides an extremely convenient way of receiving the benefits of phytonutrients, supplements contain only isolated components and not the entire compound as it is found in the whole-food state. Currently, it would be best to consume phytochemicals by eating a variety of fruits, vegetables, grains, and legumes. Supplementation with isolated phytochemicals is discouraged until more information is obtained.

**Cardiovascular Health**

Heart disease is the number one killer of Americans, although it is largely preventable. The main issue leading to cardiovascular problems is arteriosclerosis (buildup of fatty deposits on the inner wall of arteries) more commonly known as hardening of the arteries. There has been a preponderance of literature explaining many factors affecting a person’s risk of heart disease. Some factors include diet, stress, heredity, and lifestyle. Over the last several years, researchers have indicated the important role that some B vitamins—especially B6, B12, and folic acid—play in cardiovascular health by lowering blood levels of homocysteine.

Homocysteine, an amino acid, forms in the blood vessels and can accumulate there as a result of the breakdown of protein in foods (such as meats and dairy). High levels of homocysteine may be a leading cause of atherosclerosis. Second, research shows that people over the age of 50 have been found to have lower levels of vitamin B12. Although older adults may get sufficient vitamin B12 in their food, some may have a reduced ability to adequately absorb the naturally occurring form of B12, therefore, supplementation may be beneficial. B vitamins often work synergistically with each other as well as with other body processes, such as enzymes being activated; B vitamins in combination are the best way to supplement (see [**Exhibit 22-2**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22_box2)).

| **EXHIBIT** **22-2** **RISKS WITH VITAMIN B GROUP SUPPLEMENTATION** |
| --- |
| There are risks associated with excess doses of certain vitamin B group vitamins, particularly niacin, B6, folate, and choline. Vitamin B6, when taken in amounts in excess of 100 mg per day can cause neuropathy (a disorder of the nerves), which could lead to weakness, pain, and numbness of the limbs. Niacin’s upper level intake is 35 mg per day. Symptoms of overdose with niacin include flushing, itching, and warm sensation. The folate upper level limit is set at 1,000 mcg (1 mg), whereas choline is set at 3.5 grams per day. Excess choline may lead to low blood pressure.Thiamine, riboflavin, B12, pantothenic acid, and biotin do not have upper limits set because of the lack of evidence suggesting adverse effects from high intakes of these B vitamins; however, excessive consumption of these B vitamins is not wise. |

Strong evidence exists for the benefits of fish oil supplements in promoting cardiovascular health and improving outcomes in persons with cardiovascular disease. Vitamin A, as beta-carotene, vitamin C, calcium, magnesium, selenium, vitamin E, manganese, potassium, bioflavonoids, choline, and essential fatty acids (EFAs) are some nutrients that also have been linked to optimum cardiovascular health. These nutrients are needed to repair, protect, and prevent degeneration of the blood vessels.

**Hypertension**

High blood pressure responds very well to lifestyle changes. Increased fiber, low sodium intake, relaxation techniques, and exercise are helpful in lowering and maintaining blood pressure. The DASH diet (see [**Figure 22-2**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22_fig2)) suggests foods that tend to be rich in potassium, magnesium, and calcium; these are the minerals experts believe to be important for controlling blood pressure. Foods rich in potassium include bananas, apricots, grapes, oranges, spinach, lentils, and almonds.

**Figure 22-2 The Dash Diet**

Modified from National Heart, Lung, and Blood Institute. (n.d.). Integrated guidelines for cardiovascular health and risk reduction in children and adolescents. Nutrition and diet. Retrieved from [**http://www.nhlbi.nih.gov/health-pro/guidelines/current/cardiovascular-health-pediatric-guidelines/full-report-chapter-5**](http://www.nhlbi.nih.gov/health-pro/guidelines/current/cardiovascular-health-pediatric-guidelines/full-report-chapter-5).

When diuretics (fluid pills) are used, the addition of magnesium as a supplement may be needed. Diuretics cause fluid loss, and when fluid is lost from the body it takes potassium and magnesium with it. Magnesium assists potassium to keep blood pressure levels optimum.

**Diabetes Mellitus**

Diabetes is a chronic disease that is one of the major causes of blindness in the United States. It is caused from either a defect in or insufficiency of insulin that does not allow for the management of appropriate blood glucose levels.

Food is broken down and absorbed by the body when you eat. Enzymes—chemicals made by the body with the help of nutrients—turn protein into amino acids and starches and sugars into their simple sugars. Fats are broken down into fatty acids. After this happens, there is usually a rise in blood sugar, leading to the hormone insulin being secreted by the pancreas (a gland located behind the stomach). Insulin assists in the movement of nutrients from the bloodstream into the muscles and fat tissues and also the liver. This allows the liver to stop producing glucose (blood sugar). If there is not enough insulin being excreted or if what is excreted is unable to be used, then diabetes develops.

Chromium was first found to have a relationship with insulin control in the body in the mid-1950s, and in the late 1970s, it was finally accepted as a nutrient. Chromium is a mineral, essential to the body, which acts cooperatively with other substances that control metabolism. It is a component of the glucose tolerance factor used to help with fat metabolism by transporting glucose to the cells (and being metabolized to produce energy) and activates certain enzymes. The recommended daily allowance of chromium is 50 to 200 mcg. It is believed that only 10% of the population of the United States receives enough chromium in their diet. Deficiency or inadequacy of chromium effectively blocks insulin function, resulting in elevated glucose levels. Supplementation decreases fasting glucose levels and insulin levels, improves glucose tolerance, and suppresses cholesterol and triglyceride levels.

| **KEY POINT** |
| --- |
| Omega-3 oils are found in fish oils and flaxseed; the omega-6 oil sources are borage (an herb), evening primrose, and black currant oils. |

**Essential Fatty Acids**

The two essential fatty acids necessary for life and the proper function of the body are omega-3 (alpha-linoleic) and omega-6 (linoleic). EFAs enhance immune function, protect the lining of the gastrointestinal system, increase kidney blood flow, reduce inflammation, and inhibit platelet aggregation (cells of the blood sticking together). These fatty acids become converted with the help of eicosanoids, which are produced by enzymes. Prostaglandins are probably the most commonly known eicosanoids. One to two tablespoons of flaxseed ground fresh and sprinkled on food will provide an adequate amount of omega-3 oil for the average person. Cold-pressed and fresh canola, sunflower, and safflower oils are excellent sources of EFAs. These can be easily incorporated into your daily nutritional plan. Supplementation should be considered if a person has cardiovascular risks or conditions or does not include these nutrients in his or her diet.

**Osteoporosis**

Calcium is an important mineral and may help prevent osteoporosis. When bones are calcium rich, they are less susceptible to fractures. DRIs suggest that Americans take between 1,000 and 1,300 mg of calcium per day. After menopause, some women may require up to 1,500 mg of calcium per day. The upper tolerable limit for calcium is set at 2,500 mg per day. Excess calcium can cause muscle cramps, kidney stones, high blood calcium, or poor absorption of iron, zinc, or magnesium.

When considering calcium intake, it is important to know that vitamin D is essential in metabolizing and absorbing the calcium that you are ingesting. Magnesium and phosphorus are minerals that work together with calcium. Meeting calcium requirements means consuming adequate quantities of calcium and vitamin D. If people depend on dietary sources for these nutrients they may have to eat a very large quantity of calcium-rich foods in addition to consuming foods that include vitamin D, phosphorus, and magnesium in the proper ratios. There are several forms of calcium available in supplements; the most bioavailable form is calcium citrate; the least absorbable is calcium carbonate.

**Rheumatoid Arthritis**

Rheumatoid arthritis is a painful, debilitating autoimmune disorder that causes cartilage damage, bone erosion, and joint pain and deformity. Prescription medications for this condition can be expensive and produce undesirable side effects. Research from a group at Wayne State University has revealed that a phytochemical found in green tea (epigallocatechin-3-gallate [EGCG]) has anti-inflammatory properties and can be effective in blocking signals that cause inflammation and destruction of tissues ([**Singh, Umar, Riegsecker, Chourasia, & Ahmed, 2016**](https://jigsaw.vitalsource.com/books/9781284141382/epub/EPUB/xhtml/31_Chapter22.xhtml#ch22-bib10)). They conclude that there is a rationale for using green tea in the treatment of rheumatoid arthritis.

**Sorting It All Out**

The concept that people must be constantly on guard and change course to follow the most recent scientific study, not really knowing if they are heading in the right direction, is ominous. Nutritional supplementation can seem like a daunting task and quickly becomes overwhelming, unless the basics are implemented. Rather than becoming overloaded with facts regarding optimum nutritional supplementation, people should focus on eating basic, well-balanced diets. When a balanced diet is eaten, many compounds that help with the protection, breakdown, absorption, and integration of all that is ingested are consumed. Nature provides what is needed with the proper ingredients in the right amounts for the body—if a nutritious and healthful food plan is followed. If people are confused or have any doubt regarding what or how much they should be taking, consulting a health-care practitioner who is knowledgeable in nutrition and nutrition supplementation for guidance is beneficial.

### Summary

RDAs represent minimum standards of food intake to meet the needs of an average person, whereas DRIs go beyond RDAs to describe nutrient requirements for optimal health.

In 1994, the Dietary Supplement Health and Education Act required dietary supplement manufacturers to include the words *dietary supplement* on product labels. It also established an oversight office within the NIH.

It is important to read supplement labels. Factors to consider when contemplating the use of supplements include age, the presence of chronic health problems, gender, and lifestyle habits. Supplements can never replace a healthy diet.

Antioxidants include vitamins A, C, E, and selenium. Phytochemicals are compounds that exist naturally in all plant foods.

Supplements can be beneficial in the treatment of many chronic conditions; however, they must be used wisely. People need to learn about the actions, interactions, and risks associated with the specific supplements they use.

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### Resources

* **American Council on Science and Health**
* [**www.acsh.org**](http://www.acsh.org/)
* This site covers many issues regarding nutrition and health with links to other sites.
* **Ask Dr. Weil Bulletin**
* [**www.drweil.com**](http://www.drweil.com/)
* The online information features Dr. Andrew Weil, founder of the Integrative Medicine Program, University of Arizona Health Sciences Center, Tucson, Arizona. Offers many topics on integrative medicine and health.
* **DASH Diet Eating Plan**
* [**http://dashdiet.org/default.asp**](http://dashdiet.org/default.asp)
* This site offers the DASH diet plan with recipe suggestions for downloading or to order by mail.
* **Dietary Supplement Label Database**
* [**http://dsld.nlm.nih.gov/dsld/**](http://dsld.nlm.nih.gov/dsld/)
* A joint project of the National Institutes of Health Office of Dietary Supplements and the National Library of Medicine, this database provides a description of label contents from a sample of dietary products marketed in the United States.
* **Healthfinder Webpage**
* [**www.healthfinder.gov**](http://www.healthfinder.gov/)
* This is an online consumer health information service provided by the U.S. Department of Health and Human Services. It contains links to medical journals and databases with special resources on health.
* **National Institutes of Health Office of Dietary Supplements**
* [**www.ods.od.nih.gov**](http://www.ods.od.nih.gov/)
* The International Bibliographic Information on Dietary Supplements database provides access to bibliographic citations and abstracts from published international, scientific literature on dietary supplements. This database was set up to help consumers, health-care providers, educators, and researchers.
* **USDA Food Composition Database**
* [**http://ndb.nal.usda.gov/**](http://ndb.nal.usda.gov/)
* This database gives facts about the composition of food, a glossary of terms, and links to other agencies.
* **PlaneTree Health Library**
* [**www.planetree-sccl.org**](http://www.planetree-sccl.org/)
* This is a consumer health and medical library that is free and open to the public with the aim of providing access to information to make informed decisions about health. There is a range of information from professional/technical to easy-to-understand materials for all areas of medical treatment. They also offer some materials in Spanish and Vietnamese.