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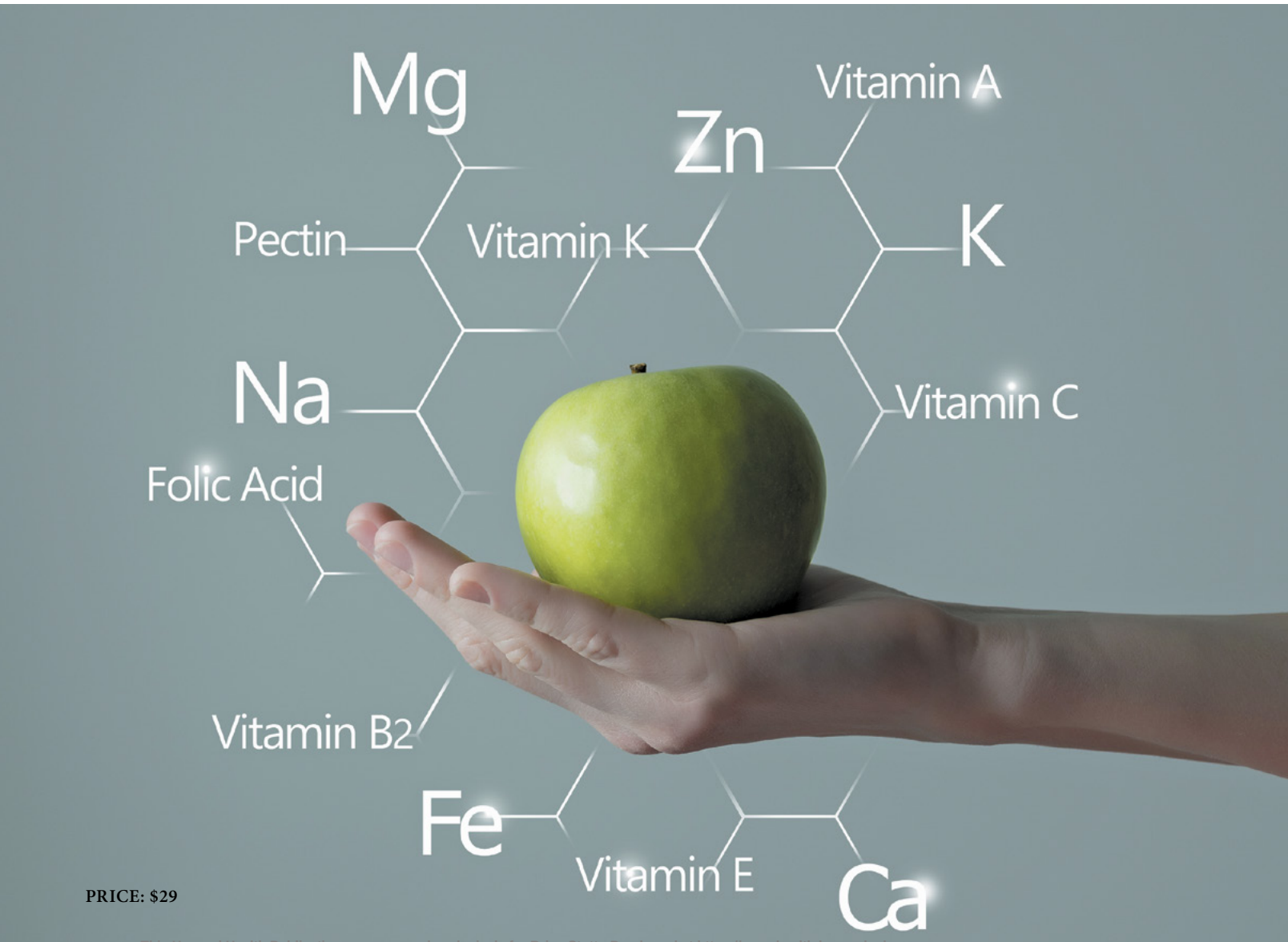
Making Sense of Vitamins and Minerals

Choosing the foods and nutrients you need to stay healthy



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MAKING SENSE OF VITAMINS AND MINERALS
SPECIAL HEALTH REPORT

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Dear Reader,

Welcome to the revised and updated edition of *Making Sense of Vitamins and Minerals: Choosing the foods and nutrients you need to stay healthy*. In the current version of the report, we provide the latest information to help you meet your nutritional needs—ideally by eating a healthy diet rather than taking supplements. Given the long list of vitamins and minerals you should consume every day, the goal of obtaining everything through your diet alone may seem daunting, but it's not as hard as it may appear. Globalization has created unprecedented access to a highly diverse food supply, replete with nutrient-rich fruits and vegetables that past generations did not have in such abundance. At the same time, however, a plethora of nutritionally poor foods and beverages (which also did not exist in times past) compete for your attention, bolstered by savvy labeling and purported health claims. As a result, it's more important than ever to be your own health advocate and to learn how to make wise nutritional choices.

Part of the challenge is learning to evaluate the constant barrage of new studies that you hear about in the media. Out of context, headlines may make individual findings appear more conclusive than they really are. This report will help you make sense of the research and provide you with the latest, most practical dietary strategies to ensure you get adequate, but not excessive, amounts of vitamins and minerals for your optimal health. We explain the many roles that vitamins and minerals play in your body, and list good food sources for each one, along with the recommended minimum and maximum amounts you should consume.

Among other things, you will learn

- what to look for when reading nutrition labels for foods and supplements
- why you might not be getting enough vitamin B_{12} from your diet
- the role of probiotics and prebiotics in keeping you healthy
- the benefits of good nutrition for your immune function and healthy brain aging.

Where do supplements fit in? They remain as adjuncts to a healthy diet, not replacements for nutritious food. Although most American adults take at least one vitamin and mineral supplement daily, the evidence remains inconclusive as to whether most of them confer long-term health benefits. This report will help you decide whether or not to make them part of your dietary strategy.

Yours in health,

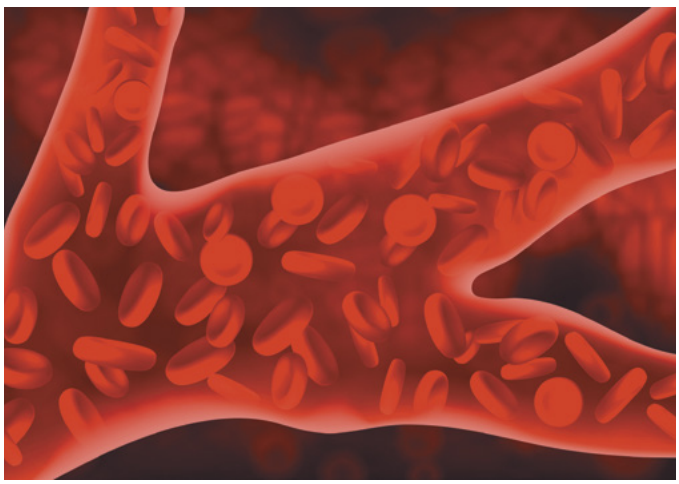
Howard D. Sesso, Sc.D., M.P.H.
Medical Editor

Vitamins and minerals: The basics

Every day, your body produces new skin, muscle, and bone cells. It makes tens of thousands of rich red blood cells that carry nutrients and oxygen to every part of your body, and it produces multitudes of white blood cells to fight invaders. Your nerves send electrical signals skipping along thousands of miles of brain and body pathways, and your tissues formulate protein and fatty acid chemical messengers that shuttle from organ to organ, issuing the orders that orchestrate and sustain your life.

To do all this, your body requires many different raw materials. These include nearly 30 vitamins and minerals that are considered "essential," meaning that your body cannot manufacture them in sufficient amounts on its own. Acting in concert, these compounds perform thousands of roles in the body, ranging from shoring up bones and healing wounds to boosting your immune system, converting food into energy, and repairing cell and tissue damage.

The essential vitamins and minerals are often called micronutrients because your body needs only tiny amounts of them. (This is in contrast to the macronutrients—carbohydrates, fats, and protein—which the body requires in large amounts for energy, metabolism, and other functions.) Yet failing to get even those small quantities virtually guarantees disease. For example, British sailors learned centuries ago that living for months without fresh fruits or vegetables—the main sources of vitamin C—caused the bleeding gums and listlessness of scurvy, a disease that often proved fatal. Even today in many low-income countries, people with limited access to a healthy and diverse food supply frequently suffer from nutrient-deficiency diseases, such as scurvy, rickets, or pellagra.



Nearly 30 "essential" vitamins and minerals enable the body to carry out myriad tasks—such as making rich red blood cells to deliver nutrients and producing white blood cells to fight invaders.

By contrast, people in the United States rarely develop true vitamin and mineral deficiencies—in which the lack of a single nutrient leads directly to a specific ailment—thanks to our extensive supply of food and the fortification of many common food products with key nutrients. That said, eating less than optimal amounts of important vitamins, minerals, and other compounds can still contribute to a number of major illnesses, such as heart disease, type 2 diabetes, cancer, and osteoporosis. Hence, concern about "nutritional insufficiency"—a controversial topic—is a major driver of both the U.S. dietary guidelines and the mass marketing of over-the-counter supplements.

So how can you make sure you're fulfilling your nutrient needs? Unfortunately, a welter of conflicting studies has led to general confusion—and all too many studies prompt new marketing claims that may or may not be upheld by later research. In fact, the best way to get vitamins and minerals is from a well-rounded diet, with plenty of fruits, vegetables, legumes, whole grains, and lean sources of protein, along with healthy fats, such as nuts and olive oil.

We'll explore all of this in this report. But first, it may help to review some important information about vitamins and minerals and their roles in the body.

Water-soluble vitamins—those that can dissolve in water—are packed into the watery portions of fruits and vegetables. Oranges, for example, are a good source of vitamin C.

Vitamins vs. minerals

What distinguishes a vitamin from a mineral? A vitamin, simply put, is an organic substance—one produced by a plant or an animal—that is required in small amounts for human life. (The first syllable, *vit-*, comes from the Latin word for "life.") With the exception of vitamin D, vitamins cannot be synthesized in the body and must come from food. They are therefore considered essential micronutrients.

A mineral is an inorganic element—one that comes originally from rocks, soil, or water (though it may enter your diet through a plant that has absorbed it from the environment, or an animal that has eaten such a plant). There are many minerals, but only certain ones are necessary for human health.

Another difference is that vitamins have complex structures that can be broken down by heat, air, or acid. Minerals are simpler elements that hold on to their chemical structures. That means minerals can easily find their way into your body through the plants, fish, animals, and fluids you consume. It's more difficult to shuttle vitamins from food into your body, because cooking, storage, and simple exposure to air can inactivate these more fragile compounds.

Despite their structural differences, vitamins and minerals often work together. For example, vitamin D enables your body to pluck calcium from food that is passing through your digestive tract, rather than harvesting it from your own bones. Vitamin C helps you absorb iron. However, the interplay of micronutrients isn't always cooperative. For example, too much vitamin C can block your body's ability to assimilate the essential mineral copper.

There are a few other distinctions to be aware of. Vitamins are subdivided into two categories—water-soluble and fat-soluble—with implications for your diet. Minerals, too, are subdivided into major minerals and trace minerals, depending on how much you need of each. This chapter will explore these concepts in greater depth.

Water-soluble vitamins

Water-soluble vitamins—those that can dissolve in water—are packed into the watery portions of the foods you eat. They are absorbed directly from the digestive tract into the bloodstream as food is broken down or as a supplement dissolves. (For this reason, you should consume water-soluble vitamin supplements with food and a beverage to ensure full absorption.) Because much of your body consists of water, many of the water-soluble vitamins circulate easily in your body. One exception is vitamin B_6, which is mostly stored in muscle tissue.

Your kidneys continuously regulate levels of water-soluble vitamins, shunting excesses out of the body in your urine. Because of this, the risk of harm from consuming supplements that contain large doses of these vitamins is relatively small in most cases. However, there are some exceptions. For example, excessive vitamin B_6 (many times the recommended daily amount of 1.3 milligrams for adults) can damage nerves, causing numbness and muscle weakness (see "B bonanza: Boon or bust?" on page 21).

Water-soluble vitamins

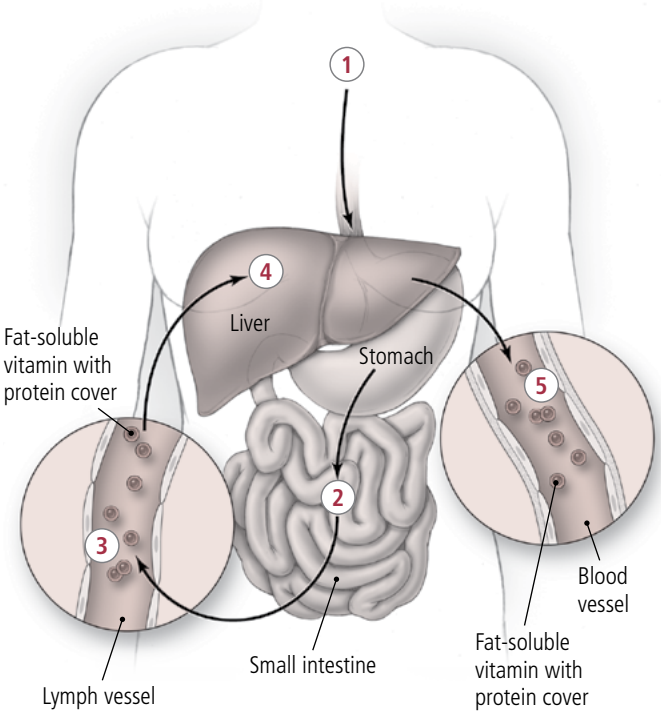
B vitamins:

- Thiamin (vitamin B_1)
- Riboflavin (vitamin B_2)
- Niacin (vitamin B_3)
- Pantothenic acid (vitamin B_5)
- Pyridoxine (vitamin B_6)
- Biotin (vitamin B_7)
- Folate, folic acid (vitamin B_9)
- Cyanocobalamin (vitamin B_{12})

Vitamin C

Although most water-soluble vitamins tend to pass out of the body quickly, some can stay for long periods of time. You probably have several years' supply of vitamin B_{12} in your liver. Even the body's stores of vitamin B_9 (folate or folic acid) and vitamin C can last more than a couple of days. Generally, though, water-soluble vitamins should be replenished every few days.

Figure 1: Absorption of fat-soluble vitamins



1. Food containing fat-soluble vitamins is ingested.
2. The food is broken down by stomach acid and then travels to the small intestine, where it is digested further. Bile, made in the liver, flows into the small intestine, where it breaks down fats in the food. That allows fat-soluble vitamins and other nutrients to be absorbed through the wall of the small intestine.
3. Upon absorption, fat-soluble vitamins enter the lymph vessels before making their way into the bloodstream. In most cases, fat-soluble vitamins must be coupled with a protein in order to travel through the body, which is why it is best to get them from food (or in the case of supplements, to take them with food).
4. These vitamins are used throughout the body, but excess amounts are stored in the liver and fat tissues.
5. As additional amounts of these vitamins are needed, your body taps into the reserves, and the liver releases them into the bloodstream.

Water-soluble vitamins perform many tasks in the body. One of the most important is helping to free the energy found in the food you eat. Thiamin, riboflavin, niacin, pantothenic acid, and biotin—all of them B vitamins—engage in various aspects of energy production. Vitamins B_6, B_9, and B_{12} metabolize amino acids (the building blocks of proteins) and help cells multiply. And one of many roles played by vitamin C is to help make collagen, which knits together wounds, supports blood vessel walls, and forms a base for teeth and bones.

Fat-soluble vitamins

As the name implies, fat-soluble vitamins can be dissolved by fat solvents and oils. In contrast to water-soluble vitamins, which travel freely via the bloodstream and are excreted in urine, fat-soluble vitamins require special help to move around the body. After being consumed in the diet, they gain entry to the bloodstream via lymph channels in the intestinal wall (see Figure 1, at left). Most fat-soluble vitamins travel through the body only under the escort of special fat-binding proteins, which act as carriers to allow these vitamins to interact with water-rich blood and cells.

The fat-soluble vitamins work in close coordination to keep many parts of your body in good repair. For example, vitamins A, D, and K are necessary for bone formation. Vitamin A also helps keep cells healthy and protects your vision—but without vitamin E, the fourth fat-soluble vitamin, your body would have difficulty absorbing and storing vitamin A. Vitamin E also acts as an antioxidant, potentially helping to protect your cells and even your DNA against damage from unstable molecules called free radicals (see "Antioxidants: Beyond the hype," page 36).

Fat-soluble vitamins are stored in your fat tissues and your liver, which together act as the main holding pens for these vitamins and release them into the body as needed. To some extent, you can think of these vitamins as time-release nutrients. Your body

Fat-soluble vitamins

- Vitamin A
- Vitamin D
- Vitamin E
- Vitamin K

squirrels away any excess you consume and doles it out gradually to meet your needs. Because these vitamins are stored for long periods, however, dangerous levels can build up. As a result, toxicity from fat-soluble vitamins is much more common than for water-soluble vitamins. However, this is more likely to happen if you take high doses of fat-soluble vitamin supplements over a prolonged period of time. It's very rare to get too much of any single vitamin just from food.

Major minerals

The body needs and stores relatively large amounts of the major minerals—calcium, chloride, magnesium, phosphorus, potassium, sodium, and sulfur. Calcium and phosphorus each account for more than a pound of your body weight. One of the key tasks of the major minerals is maintaining the proper electrical balance of all the cell membranes in your body—a vital property for cell signaling and the transport of nutrients and messengers into and out of cells. Sodium, chloride, and potassium take the lead in doing this. Three other major minerals—calcium, phosphorus, and magnesium—have similar activities and are also important for healthy bones. Sulfur helps stabilize protein structures, including some of those that make up hair, skin, and nails.

Major minerals travel through the body in various ways. Potassium, for example, is quickly absorbed into the bloodstream, where it circulates freely and is excreted by the kidneys, much like a water-soluble vitamin. In contrast, calcium requires a carrier for absorption and transport.

Having too much of one major mineral can result in a deficiency of another. Calcium binds with excess sodium in the body and is excreted when the body needs to lower the sodium level. That means that if you ingest too much sodium through table salt or processed foods, you could end up losing needed calcium as your body rids itself of the surplus sodium. Likewise, too much phosphorus can hamper your ability to absorb magnesium. These sorts of imbalances are usually caused by overloads from supplements, not food sources.

Major minerals

- Calcium
- Chloride
- Magnesium
- Phosphorus
- Potassium
- Sodium
- Sulfur

Trace minerals

A thimble could easily contain all the trace minerals normally found in your body. Yet their contributions are just as important as those of the major minerals. Trace minerals carry out a diverse set of tasks. Iron, for example, is best known for ferrying oxygen throughout the body, while fluoride strengthens bones and wards off tooth decay. Zinc helps your blood clot, enables you to taste and smell, and bolsters your immune response. Copper helps form several enzymes, one of which assists with iron metabolism and the creation of hemoglobin, which carries oxygen in the blood. The other trace minerals perform equally vital jobs, such as helping to block damage to body cells and forming parts of key enzymes or enhancing their activity.

Trace minerals interact with one another, sometimes in ways that can trigger imbalances. Too much of one can cause or contribute to a deficiency of another. For example, a minor overload of manganese can worsen an iron deficiency. By the same token, too little of a mineral can lead to health problems. When the body has too little iodine, thyroid hormone production slows, causing sluggishness and weight gain as well as other health concerns. The problem worsens if the body also has too little selenium.

However, the difference between "just enough" and "too much" of the trace minerals is often relatively small. Generally, food is a safe source of trace minerals, but if you take supplements, it's important to make sure you're not greatly exceeding recommended levels.

Trace minerals

- Chromium
- Copper
- Fluoride
- Iodine
- Iron
- Manganese
- Molybdenum
- Selenium
- Zinc

Understanding the federal guidelines

The field of nutrition is filled with confusing terms found on the labels of foods you purchase—Recommended Dietary Allowances (RDAs), Daily Values (DVs), dietary reference intakes (DRIs), and more. However, few people aside from nutritionists really understand the differences between these terms. To help you sort through it all, this chapter traces the history of the terms and explains why the different values are used in different situations.

Recommended Dietary Allowances

In 1941, the U.S. Food and Nutrition Board published the first in a series of reports on Recommended Dietary Allowances (RDAs). These reports were directly inspired by concern about nutrient deficiencies, which in the early 20th century were still relatively common in the United States, and which the government and nutrition experts worried could be worsened by food shortages caused by the Great Depression and World

Alphabet soup: Understanding RDAs, DRIs, DVs, and other values

Most Americans recognize the abbreviation RDA. But how do RDAs differ from DRIs and DVs? And what are ULs and AIs? Here's some help.

Recommended Dietary Allowance (RDA): This value refers to the average minimum daily amount of a specific nutrient needed to prevent clinical nutrient deficiency in almost all healthy people in a particular group defined by age and sex. RDAs were developed to address only a selected set of nutrients and nutrient deficiency diseases, and are now just one category of measurements included in the broader dietary reference intakes.

Dietary reference intake (DRI): Introduced in 1997, DRI values were established to support guidelines for a broad range of nutrients and minerals, not only to prevent nutrient deficiencies, but also to enhance health and reduce the risk of chronic diseases such as osteoporosis, cancer, and cardiovascular disease. The DRIs include RDAs, AIs, ULs, and EARs (see the next three entries). The DRIs are what underlie the U.S. dietary guidelines and food labeling regulations.

Adequate intake (AI): This value is determined as a range of recommended intake (rather than just a minimum), and is used for nutrients—such as vitamin K, manganese, and potassium—for which there is not a corresponding clinical deficiency disease.

Tolerable upper intake level (UL): This is the maximum amount of a nutrient that is considered safe for individuals—including those in sensitive subgroups—to consume daily for an extended period. Exceeding the UL does not mean that harmful effects will always occur; rather, the more you exceed the UL, the greater the risk of adverse effects.

Estimated average requirement (EAR): This is the daily amount of a nutrient that is estimated to prevent clinical nutrient deficiency in half of all healthy people in a particular group defined by age and sex. EARs are used as the basis for RDAs, and as such, apply to a relatively limited set of nutrients and their corresponding nutrient deficiency diseases.

Daily Value (DV): This reference number, developed by the FDA, is designed to help consumers determine if a food contains a lot or a little of a specific nutrient, based on the DRI for that nutrient. It may be similar to the RDA or AI for that nutrient, but not always. DVs—which are used on Nutrition Facts panels—don't account for your age, sex, or other factors affecting your daily calorie needs. They're based on the highest average daily allowance value and are presented as percentages of total daily intake, calculated for an average individual eating 2,000 calories a day.

Note: Another point of confusion can be the units used for measuring various vitamins and minerals. Amounts may be presented as milligrams (mg), micrograms (mcg), or international units (IU). To convert one to another, consult this calculator: www.health.harvard.edu/iu-converter. An additional unit, called micrograms of dietary folate equivalents (mcg DFE), is used to measure vitamin B_9.

War II. The RDAs in turn were used as the foundation for the first U.S. Dietary Guidelines for Americans. These guidelines are revised every five years to reflect advances in nutrition knowledge.

This process—setting RDAs based on concern about potential nutrient deficiencies, and then basing the dietary guidelines on these standards—has continued with relatively little change since the 1940s. Although this has contributed to success at largely eliminating nutrient deficiencies in the United States, it has also had unintended consequences. The isolated focus of the RDAs on single nutrients—which works so well for preventing diseases like rickets or scurvy that are caused by a lack of single nutrients—has questionable relevance for staving off heart disease, cancer, and other chronic diseases.

The establishment of RDAs is now a highly complex—and expensive—process. New RDAs, or even a revised value for an existing RDA, can be determined by only one private, nonprofit agency—known as the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine—and only after it receives a special commission and special funding from the U.S. government. The process is lengthy and pricey, taking up to three years and millions of dollars to revise a single RDA. As a result, such revisions are infrequent. The most recent RDA revision—for vitamin D and calcium—was published in 2011.

Because RDAs were designed to prevent clinical nutrient deficiencies, they apply only to a limited set of nutrients and their corresponding nutrient deficiency diseases. To create guidelines for appropriate intakes of other nutrients, other criteria have been developed, such as adequate intakes, or AIs (see "Alphabet soup: Understanding RDAs, DRIs, DVs, and other values," page 6). Together, these sets of criteria for nutrient consumption are called dietary reference intakes (DRIs). The DRIs are intended to be evidence-based standards that go beyond amending single-nutrient deficiencies: they also suggest the amounts of nutrients needed for preventing complex chronic diseases and enhancing health.

To help people apply guidelines for selected vitamins and minerals to their daily food choices, the FDA created the Nutrition Facts panel that appears on almost all packaged foods (see Figure 2, below).

When you read nutrition labels, bear in mind that the limited information on vitamin and mineral content is only one factor to consider. Other factors—such as the extent of food processing, the quality of the carbohydrates, and the types of fat—are just as important, if not more important. To glean all this from the Nutrition Facts panel requires a little interpretation. For example, to assess carbohydrate quality, a rule of thumb is to look for no more than 10 grams of total carbohydrate for every 1 gram of fiber (a 10-to-1 ratio or lower). In the label shown in Figure 2, there are 37 grams of carbohydrate and 4 grams of fiber, making

Figure 2: A sample Nutrition Facts panel

Nearly every packaged food or beverage you toss into your shopping cart has a printed Nutrition Facts panel, which highlights certain basic information about the food, such as serving size and calories per serving. The amounts of fat, cholesterol, sodium, carbohydrate, and protein per serving are given both in grams or milligrams and as percentages of Daily Values (reference numbers designed to show if a food contains a lot or a little of a specific nutrient). Beyond that, there is limited information about vitamins and minerals. Labels must list the amounts of vitamin D, calcium, iron, and potassium per serving, and manufacturers can opt to include information on other vitamins and minerals if they want to. Listings for Vitamins A and C used to be required, but the FDA determined that the likelihood of deficiency in these vitamins was low and the benefit of increased consumption was unclear.

Nutrition Facts

8 servings per container

Serving size **2/3 cup (55g)**

Amount per serving

Calories **230**

	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 235mg	6%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

the ratio 37 to 4, or slightly less than 10 to 1. Looking for a 10-to-1 ratio is not a perfect rule of thumb, but it helps to capture the overall quality of the carbohydrate in any product. If you really want to maximize carbohydrate quality, aim for a 5-to-1 ratio—in other words, no more than 5 grams of carbohydrate for every 1 gram of fiber.

But even more important than the carbohydrate quality or fat content of one particular food is your overall dietary pattern. If you eat a diverse range of whole, minimally processed foods—fruits, vegetables, nuts, whole grains, fish, vegetable oils, and dairy—there's little need to become a nutrition label mathematician. Such a diet already delivers high-quality macronutrients (fats, carbs, and protein), as well as vitamins and minerals in sufficient amounts.

Tables 1 (below) and Table 2 (page 11) can give you a better understanding of how particular vitamins and minerals work in your body, how much of each nutrient you need every day, and what types of food to eat to ensure that you are getting an adequate supply. When reading the tables, note the following:

- The recommendations vary by age and sex. These tables apply to adults ages 19 and over. If you are looking for recommendations for someone younger, or for a woman who is pregnant or nursing, ask your doctor about what's appropriate.
- The recommended amount for each nutrient is either an RDA (if there is a deficiency disease, such as rickets, associated with it) or an AI (for most other nutrients; see "Alphabet soup," page 6).
- Pay attention to the column that lists the UL, which is the tolerable upper intake level. This is the maximum daily amount of a nutrient considered safe if consumed regularly. Beyond that limit, there is a rising risk for side effects, some of which can be serious. An upper limit hasn't been established for every nutrient; however, it's important to realize that very large amounts of these nutrients could still be harmful. Food sources of nutrients are almost never a problem. People run into trouble mostly through taking high doses of supplements.
- A good food source, as determined by the FDA, indicates a food that contains 10% to 19% of the RDA or AI of a specific nutrient.
- Vitamins A, D, and E are often measured in international units (IU) in addition to another unit like milligrams or micrograms. What constitutes an IU is different for each nutrient, because it indicates an amount with a certain biological effect.

Table 1: Vitamins: Recommended intake, uses in the body, and sources

The following recommendations are based largely on guidelines from the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine. Recommended amounts may be expressed in milligrams (mg), micrograms (mcg), international units (IU), or micrograms of dietary folate equivalents (mcg DFE), depending on the nutrient. Unless otherwise specified, values represent those for men (M) and women (W) ages 19 and older.

VITAMIN AND BENEFITS	RDA OR AI*	UL*	GOOD FOOD SOURCES (listed most to least)	DID YOU KNOW?
Vitamin A (retinol, retinal, and retinoic acid—three active forms of vitamin A in the body—are retinoids, called "preformed" vitamin A; the body can also easily convert a precursor, beta carotene, to vitamin A as needed) • Essential for vision • Keeps tissues and skin healthy • Plays an important role in bone growth	RDA M: 3,000 IU (900 mcg) W: 2,333 IU (700 mcg)	10,000 IU (3,000 mcg)	*Sources of preformed vitamin A:* beef liver, ricotta cheese, Atlantic herring, fortified milk and cereals *Sources of beta carotene:* sweet potatoes, spinach, carrots, pumpkin, cantaloupe, peppers, mangoes	Large amounts of supplemental, or preformed, vitamin A (but not beta carotene) can be harmful to bones. In current smokers, beta carotene supplements may raise the risk of lung cancer.
Thiamin (vitamin B_1) • Helps convert food into energy • Needed for healthy skin, hair, muscles, and brain	RDA M: 1.2 mg W: 1.1 mg	Not known	Fortified cereals, pork chops, rice, trout, black beans, mussels, tuna, acorn squash	Thiamin deficiency can occur with chronic, heavy alcohol consumption, leading to a condition called Wernicke-Korsakoff syndrome.

Table 1 *continued*

VITAMIN AND BENEFITS	RDA OR AI*	UL*	GOOD FOOD SOURCES (listed most to least)	DID YOU KNOW?
Riboflavin (vitamin B_2) • Helps convert food into energy • Needed for healthy skin, hair, blood, and brain	RDA M: 1.3 mg W: 1.1 mg	Not known	Beef liver, fortified cereals and oats, yogurt, milk, beef, clams, almonds, cheese	Most Americans get the RDA for riboflavin, mostly from milk and milk-based beverages. Riboflavin is destroyed by light, which is why most milk is sold in opaque containers.
Niacin (nicotinic acid, vitamin B_3) • Helps convert food into energy • Essential for healthy skin, blood cells, brain, and nervous system	RDA M: 16 mg W: 14 mg	35 mg	Fortified cereals, baker's yeast, salmon, tuna, beef, lamb, peanuts and peanut butter, chicken, veal, mushrooms, turkey	Niacin occurs naturally in food and can also be made by your body from the amino acid tryptophan, with the help of B_6.
Pantothenic acid (vitamin B_5) • Helps convert food into energy • Helps make lipids (fats), neurotransmitters, steroid hormones, and hemoglobin	AI 5 mg	Not known	Wide variety of foods, including fortified cereals, beef liver, mushrooms, sunflower seeds, chicken, tuna, avocados	The name pantothenic comes from the Greek word *pantothen*, meaning "from all sides"—a nod to its wide availability in many foods. Deficiencies are very rare.
Vitamin B_6 (pyridoxal, pyridoxine, pyridoxamine) • Aids in lowering homocysteine levels; not clear whether it reduces heart disease risk • Helps convert tryptophan to niacin and serotonin, a neurotransmitter that plays key roles in sleep, appetite, and moods • Helps make red blood cells • Influences cognitive abilities and immune function	RDA Ages 19 to 50: 1.3 mg M, ages 51+: 1.7 mg W, ages 51+: 1.5 mg	100 mg	Chickpeas, beef liver, tuna, salmon, chicken breast, fortified cereals, potatoes, turkey, banana, marinara sauce, ground beef, waffles, bulgur, cottage cheese, winter squash	Vitamin B_6 has been promoted as a treatment for carpal tunnel syndrome and premenstrual syndrome, but studies do not support any benefit for these conditions.
Biotin (vitamin B_7) • Helps convert food into energy and synthesize glucose • Helps make and break down some fatty acids • Needed for healthy bones and hair	AI 30 mcg	Not known	Organ meats such as beef liver and eggs are good sources; also found in lesser concentration in fish, pork, hamburgers, sunflower seeds, sweet potatoes, and almonds	Your body needs very little biotin. Some is made by bacteria in the gastrointestinal tract. However, it's not clear how much of this the body absorbs.
Vitamin B_9 (folate, folic acid, folacin) • Vital for new cell creation • Helps prevent brain and spinal birth defects when taken early in pregnancy • May reduce risk for colon cancer	RDA 400 mcg DFE	1,000 mcg DFE	Beef liver, spinach, black-eyed peas, fortified grains and cereals, rice, asparagus, spaghetti, romaine lettuce, avocado, broccoli, mustard greens, green peas, kidney beans, peanuts, wheat germ	It's easier to absorb B_9 from supplements and fortified grain products than from foods where it occurs naturally. Deficiencies very early in pregnancy can lead to birth defects, and women may not know they are pregnant in the first weeks of pregnancy. Some research suggests that all women of childbearing age should get 800 mcg per day. You can get this amount through a healthy diet and a daily multivitamin.

Table 1 *continued*

VITAMIN AND BENEFITS	RDA OR AI*	UL*	GOOD FOOD SOURCES (listed most to least)	DID YOU KNOW?
Vitamin B_{12} (cyanocobalamin) • Aids in lowering homocysteine levels; not clear whether it lowers heart disease risk • Assists in making new cells and breaking down some fatty acids and amino acids • Protects nerve cells and encourages their normal growth • Helps make red blood cells	RDA 2.4 mcg	Not known	Clams, beef liver, fortified cereals, fish (such as trout, salmon, tuna, and haddock), beef sirloin, milk, yogurt, cheese, ham, eggs	Many people, particularly older adults, are deficient in vitamin B_{12} because they have trouble absorbing this vitamin from food. Vitamin B_{12} occurs naturally only in animal food sources, so vegetarians and vegans should eat a fortified breakfast cereal or take a supplement to ensure that they get enough. A lack of vitamin B_{12} can cause memory loss, dementia, and numbness in the arms and legs.
Vitamin C (ascorbic acid) • Helps make collagen, a connective tissue that knits together wounds and supports blood vessel walls • Helps make the neurotransmitters serotonin and norepinephrine • Acts as an antioxidant, neutralizing unstable molecules that can damage cells • Required for healthy immune function	RDA M: 90 mg W: 75 mg Smokers: add 35 mg	3,000 mg	Red peppers, oranges and orange juice, grapefruit and grapefruit juice, kiwifruit, green peppers, broccoli, strawberries, brussels sprouts, tomato juice, cantaloupe, cabbage, cauliflower, potatoes, tomatoes, spinach, green peas	Megadoses of vitamin C do not appear to help prevent the common cold, and they may cause diarrhea. Large-scale randomized controlled trials of vitamin C have not found an effect on cardiovascular disease and cancer.
Vitamin D (calciferol) • Helps the body absorb dietary calcium • Helps maintain normal blood levels of calcium and phosphorus, which strengthen bones • Helps form teeth and bones • Supports healthy immune function	RDA Ages 1 to 70: 600 IU (15 mcg) Ages 71+: 800 IU (20 mcg)	4,000 IU (100 mcg)	Cod liver oil, swordfish, salmon, tuna, fortified milk, cereals, and juices, sardines, beef liver, eggs	Some Americans, especially African Americans, don't get enough of this nutrient. The major source of vitamin D is sunlight, not diet. (Your skin naturally makes vitamin D when exposed to the sun.) Vitamin D has been suggested to have a wide range of benefits on health outcomes, yet clinical trials have not yet produced definitive results.
Vitamin E (alpha tocopherol) • Acts as an antioxidant, neutralizing unstable molecules that can damage cells • Protects vitamin A and certain lipids from damage	RDA 22 IU (15 mg)	1,500 IU (1,000 mg)	Wheat germ oil, sunflower seeds and oil, almonds, safflower oil, hazelnuts, peanut butter and peanuts, corn oil, spinach	Vitamin E does not prevent wrinkles. The extent of its benefits for preventing cardiovascular disease is unclear.
Vitamin K (phylloquinone, menadione) • Activates proteins and calcium essential to blood clotting • Needed for healthy bones	AI M: 120 mcg W: 90 mcg	Not known	Collards, turnip greens, spinach, kale, broccoli, soybeans and soybean oil, carrot juice, edamame, pumpkin, pomegranate juice, okra, salad dressing, pine nuts, blueberries, iceberg lettuce, chicken breast, grapes, vegetable juice cocktail, canola oil, cashews, carrots, olive oil	Intestinal bacteria make a form of vitamin K that accounts for half of your requirements. If you take the anticoagulant warfarin (Coumadin), keep your vitamin K intake consistent.

**RDA = Recommended Dietary Allowance; AI = adequate intake; UL = tolerable upper intake level.*

Table 2: Minerals: Recommended intake, uses in the body, and sources

MINERAL AND BENEFITS	RDA OR AI*	UL*	GOOD FOOD SOURCES (listed most to least)	DID YOU KNOW?
Calcium • Builds and protects bones and teeth • Helps with muscle contractions and relaxation, blood clotting, and nerve impulse transmission • Plays a role in hormone secretion and enzyme activation • May help maintain healthy blood pressure	RDA M, ages 19 to 70: 1,000 mg M, ages 71+: 1,200 mg W, ages 19 to 50: 1,000 mg W, ages 51+: 1,200 mg	Ages 19 to 50: 2,500 mg Ages 51+: 2,000 mg	Yogurt, cheese, sardines, milk, soymilk, fortified juices, tofu, salmon, frozen yogurt, and leafy green vegetables such as turnip greens, kale, and broccoli (but not spinach or Swiss chard, which have binders that lessen absorption)	Adults absorb roughly 30% of calcium they ingest, but this can vary depending on the source. Some physicians recommend that pregnant women get more calcium than the current RDA. Ask your own doctor for advice.
Chloride • Balances fluids in the body • A component of stomach acid, essential to digestion	AI Ages 19 to 50: 2,300 mg Ages 51 to 70: 2,000 mg Ages 71+: 1,800 mg	3,600 mg	Salt (sodium chloride), soy sauce, processed foods, seaweed, rye, tomatoes, lettuce, celery, and olives	Chloride, sodium, and potassium help your body maintain the proper balance of water.
Chromium • Enhances the activity of insulin • Helps maintain normal blood glucose levels • Helps free energy from glucose	AI M, ages 19 to 50: 35 mcg M, ages 51+: 30 mcg W, ages 19 to 50: 25 mcg W, ages 51+: 20 mcg	Not known	Broccoli, potatoes, apples, orange juice, whole-grain bread, beef, garlic, basil	Most foods provide just small amounts of chromium (less than 2 mcg per serving).
Copper • Plays an important role in iron metabolism • Helps make red blood cells	RDA 900 mcg	10,000 mcg	Liver, shellfish, nuts, seeds, whole-grain products, beans, prunes, cocoa	The body absorbs more than half of dietary copper, and deficiency is not known to occur in adults.
Fluoride • Encourages strong bone formation • Keeps dental cavities from starting or worsening	AI M: 4 mg W: 3 mg	10 mg	Water that is fluoridated, toothpaste with fluoride, tea	Excessive amounts of fluoride are harmful to children.
Iodine • Part of thyroid hormone, which helps set body temperature and influences nerve and muscle function, reproduction, and growth • Prevents goiter and a thyroid disorder in newborns	RDA 150 mcg	1,100 mcg	Seaweed, fish, yogurt, iodized salt, enriched bread, shrimp, ice cream, pasta, eggs, tuna	To prevent iodine deficiencies, some countries add iodine to salt, bread, or drinking water.
Iron • Helps hemoglobin in red blood cells and myoglobin in muscle cells ferry oxygen throughout the body • Needed for chemical reactions in the body and for making amino acids, collagen, neurotransmitters, and hormones	RDA M, ages 19 to 50: 8 mg M, ages 51+: 8 mg W, ages 19 to 50: 18 mg W, ages 51+: 8 mg	45 mg	Fortified breakfast cereals, oysters, beans, dark chocolate, beef liver, lentils, spinach, tofu, sardines, chickpeas, tomatoes, beef, potatoes, nuts	Many women of childbearing age don't get enough iron. Eating meat, fish, or poultry with beans or dark leafy greens can increase your absorption of vegetable sources of iron. Foods rich in vitamin C can also increase iron absorption.

Table 2 *continued*

MINERAL AND BENEFITS	RDA OR AI*	UL*	GOOD FOOD SOURCES (listed most to least)	DID YOU KNOW?
Magnesium • Needed for many chemical reactions in the body • Works with calcium in muscle contraction, blood clotting, and regulation of blood pressure • Helps build bones and teeth	RDA M, ages 19 to 30: 400 mg M, ages 31+: 420 mg W, ages 19 to 30: 310 mg W, ages 31+: 320 mg	350 mg (Note: This upper limit applies to supplements and medicines, such as laxatives, not to dietary magnesium.)	Nuts, spinach, cereal, soymilk, black beans, edamame, peanut butter, bread, avocados, potatoes, rice, yogurt, fortified breakfast cereals	Many Americans don't get the required amounts. Most magnesium in the body is found in bones. If your blood levels are low, your body may tap these reserves to correct the problem.
Manganese • Helps form bones • Helps metabolize amino acids, cholesterol, and carbohydrates	AI M: 2.3 mg W: 1.8 mg	11 mg	Pineapple, nuts, whole grains, legumes, spinach, sweet potatoes, tea	If you take supplements or have manganese in your drinking water, be careful not to exceed the upper limit. People with liver damage or who have a lot of manganese in their diet should be especially vigilant.
Molybdenum • Part of several enzymes, one of which helps ward off a form of severe neurological damage in infants	RDA 45 mcg	2,000 mcg	Organ meats, whole grains, green leafy vegetables, milk, beans	Molybdenum deficiencies are rare.
Phosphorus • Helps build and protect bones and teeth • Part of DNA and RNA • Helps convert food into energy • Part of phospholipids, which carry lipids in blood and help shuttle nutrients into and out of cells	RDA 700 mg	Ages 19 to 70: 4,000 mg Ages 71+: 3,000 mg	Salmon, yogurt, milk, halibut, turkey, chicken, beef, lentils, almonds, cheese, peanuts, eggs, whole-grain bread, carbonated cola	Phosphorus deficiencies are rare. Certain drugs (including some diuretics, ACE inhibitors, and antacids) bind with phosphorus, keeping the body from absorbing it and causing bone loss, weakness, and pain.
Potassium • Balances fluids in the body • Helps maintain steady heartbeat and send nerve impulses • Needed for muscle contractions • May lower blood pressure • May improve bone health	AI 4,700 mg	Not known	Apricots, lentils, prunes, squash, raisins, potatoes, kidney beans, orange juice, soybeans, bananas, milk, spinach	Food sources do not cause toxicity, but high-dose supplements might. People with type 1 diabetes and those taking certain drugs—such as ACE inhibitors, certain diuretics, or nonsteroidal anti-inflammatory drugs—should speak with their doctor before increasing potassium intake.

Table 2 *continued*

MINERAL AND BENEFITS	RDA OR AI*	UL*	GOOD FOOD SOURCES (listed most to least)	DID YOU KNOW?
Selenium • Acts as an antioxidant, neutralizing unstable molecules that damage cells • Helps regulate thyroid hormone activity	RDA 55 mcg	400 mcg	Brazil nuts, tuna, halibut, sardines, ham, shrimp, pasta, beef steak, turkey, beef liver, chicken, cottage cheese, brown rice, eggs, fortified cereals, whole-wheat bread, oatmeal, spinach, milk, yogurt	A single 1-ounce serving of Brazil nuts can contain almost twice the RDA of selenium.
Sodium • Balances fluids in the body • Helps send nerve impulses • Needed for muscle contractions • Increases blood pressure in salt-sensitive people; even modest reductions in sodium intake can lower blood pressure	AI Ages 19 to 50: 1,500 mg Ages 51 to 70: 1,300 mg Ages 71+: 1,200 mg	2,300 mg	Salt, soy sauce, processed foods such as cereals, bread, hot dogs, cheese spreads, tomato juice, canned soups, macaroni and cheese, corned beef hash, pretzels, ham, potato chips, sunflower seeds	The 2,300-mg upper limit is roughly equivalent to the amount of sodium in 1 teaspoon of table salt. Americans typically report consuming 2,300 to 4,700 mg a day (and the real total may be higher, as this does not include salt added at the table).
Zinc • Required for making proteins and DNA • Supports immune system function	RDA M: 11 mg W: 8 mg	40 mg	Oysters, beef, crab, fortified cereals, lobster, pork chops, baked beans, chicken, yogurt, cashews	Zinc lozenges may slightly shorten the duration of the common cold.

**RDA = Recommended Dietary Allowance; AI = adequate intake; UL = tolerable upper intake level.*
NOTE: Sulfur is considered a major mineral, but there is no formal RDA, DV, AI, or UL for it. Therefore, we have not included it in the table.

Making sense of scientific studies

Even the most promising finding about a vitamin or mineral must work its way through a hierarchy of studies before scientists can draw firm conclusions about it. It's wise to read carefully and consider the weight of the evidence before you rush off to buy the latest food or supplement to garner headlines. When it comes to diet and nutrition, each type of study faces a special set of challenges and limitations.

Laboratory studies are done in test tubes or animals. They can suggest how and why a vitamin, mineral, or bioactive compound might work, but the findings don't automatically translate to the human body.

Observational studies (also called epidemiological studies) are done in large populations of people—sometimes 100,000 or more—and can run for decades. Scientists collect data at regular intervals. By comparing people who stay healthy with those who fall ill, researchers try to identify factors that could account for the differences. Such studies can be very powerful, since they follow what people actually do in their lives over many years. But they cannot prove cause and effect, only correlations. For example, people who eat blueberries might be healthier because they live healthier lives in general, not because they eat blueberries. Scientists try to adjust for such "confounding" factors, but still cannot draw firm conclusions.

Different types of observational studies have different limitations:

- In *case-control studies,* researchers first identify people with a particular condition (cases), then select similar people who don't have that condition (controls), and ask everone about factors in the past that may be related to the condition. These studies may be tainted by problems called selection bias (when the cases aren't similar enough to the controls) or recall bias (when people remember things differently from how they actually happened).
- *Cohort studies* (such as the Nurses' Health Study) begin when researchers identify a large group of people who are initially free of a particular condition, ask about current risk factors, and then follow participants prospectively (over time) to see who develops the condition and who does not. Because participants are routinely questioned about their diet and lifestyle *before* developing the condition, cohort studies have a stronger observational design. However, they often rely on self-reports from dietary questionnaires—which can be subjective and less accurate.

Epidemiological studies establish a correlation, but they do not prove cause and effect. People who eat blueberries might be healthy because they have healthy lifestyles, not because they eat blueberries.

Metabolic or feeding studies typically involve a small number of volunteers who eat specially prepared meals for short time periods. These studies are rigorous and closely controlled, but are too brief to show actual effects on disease over the long term. Instead, researchers use them to examine short-term changes in risk factors, such as high blood pressure or cholesterol.

Randomized controlled trials are typically considered the gold standard. The researchers randomly assign participants to either receive some form of dietary modification (a particular diet, food, or supplement) or serve as controls (remaining on their usual diet or taking a dummy pill, called a placebo). This enables scientists to see whether the dietary change makes a difference. The

Randomized controlled trials are considered the gold standard. Researchers randomly assign participants to either receive some form of dietary modification (a food, diet, or supplement) or serve as controls (with no change or a placebo). They then compare the outcomes.

same approach is used in testing drugs. However, the results in nutritional studies are often not as simple as those in drug trials, because a food or a diet contains thousands of active ingredients, not just one. While these trials can measure endpoints like changes in cholesterol levels, they are typically too short to demonstrate long-term consequences, such as a reduction in heart disease. Lastly, these studies may involve participants who are in better or worse health than you are, so they may not yield information that is relevant to you.

Meta-analyses take previously published studies containing comparable data and assess all the evidence together, looking for patterns—in effect, they're studies of studies. A key strength of this approach is the ability to combine data from multiple studies to obtain a statistically stronger result. However, the validity of the final conclusion still depends strongly on the quality of the individual studies that go into the meta-analysis—as the saying goes, "garbage in, garbage out." Good meta-analyses attempt to include only well-conducted studies. Still, if the studies are different from one another, the summary result may be harder to interpret and generalize.

Systematic reviews also combine multiple studies. They may or may not include meta-analyses of data. (If they do, the title will specify "meta-analysis and systematic review.") Researchers conduct systematic reviews by carefully defining a medical question that needs to be answered and then selecting studies to include based on clearly expressed criteria such as relevance to the question and how they were conducted. Rigorously applying those selection criteria is the "systematic" aspect of the review. The goal is to answer the question using only the most relevant and high-quality data available. Done well, systematic reviews offer a higher level of evidence than any individual study or meta-analysis can. Poorly done, researchers apply overly subjective opinions of the evidence at hand.

In this Special Health Report, you will see references to many systematic reviews of previously published randomized trials. Some of the best and most influential ones come from two organizations: the U.S. Preventive Services Task Force (USPSTF) and the Cochrane Collaboration.

- The USPSTF is an independent group of national experts who make treatment recommendations to primary care physicians based on strict methods and analyses of the available evidence.
- The Cochrane Collaboration is a global network of health practitioners, researchers, patient advocates, and others who publish comprehensive reviews of scientific studies on a topic, both published and unpublished, following a designated approach.

USPSTF recommendations and Cochrane reviews are influential because they offer a current progress report on what we know about a given health topic, based on the best evidence available.

Cast of characters: From vitamin A to zinc

This chapter features a broad overview of the best-known vitamins and minerals. For each nutrient described here, you'll find the following information:

- The Recommended Dietary Allowance (RDA) or adequate intake (AI) for people ages 19 and older (with sex and age differences noted when applicable) and a brief description of the nutrient's role in the body.
- A summary of the data linking the nutrient to protection against various health problems. If a condition is not listed, that means there is insufficient evidence to support a connection.
- Recommendations about taking the nutrient in supplement form.
- A table of selected food sources containing the nutrient, with an emphasis on the best sources in commonly consumed foods.

As a rule, your best strategy is to get vitamins and minerals from foods, not supplements. A vast amount of research has shown that you can cut your risk for chronic disease and disability by following a healthy diet, as well as by exercising regularly, maintaining a healthy weight, and not smoking. The evidence for taking high-dose, individual vitamin and mineral supplements is much less convincing. If you're worried about lung cancer, for example, quitting smoking will have a much greater impact on your health than taking supplements.

Before taking a supplement that delivers more than the recommended daily amount of any nutrient, discuss your decision with your doctor. Your medical history, genetic profile, and medications may affect the dosages and types of supplements you can safely take.

The best way to get your vitamins and minerals is from a healthy diet including fruits, vegetables, nuts, and fish. Supplements are an adjunct to a healthy diet, not a replacement for nutritious food.

Vitamin A and carotenoids

RDA for men: 3,000 IU (900 mcg)
RDA for women: 2,333 IU (700 mcg)

"Eat your carrots, they're good for your eyes!" This oft-heard advice is rooted in truth: carrots are rich in beta carotene, which can be converted in the body into vitamin A. The most usable form of vitamin A, retinol, is vital for the proper function of the retina, the light-sensitive tissue lining the back of the eye. But that's only one reason you need vitamin A (and should eat your carrots). In addition to its role in healthy vision, vitamin A aids bone growth and helps regulate the body's infection-fighting abilities.

Some of your vitamin A comes from compounds like beta carotene that the body converts to vitamin A. But most adults get far more of their vitamin A from animal-based foods, including liver, milk, and eggs, which contain preformed vitamin A. In addition, most fat-free milk and dried nonfat milk solids are fortified with vitamin A to replace the amount lost when the fat is removed. Many breakfast cereals are vitamin A–fortified as well. According to the National Health and Nutrition Examination Survey, a long-running study of the health status of Americans, men and women get slightly less than the amounts recommended, but enough to serve their body's needs.

Because vitamin A is a fat-soluble vitamin that's

Selected food sources of vitamin A and beta carotene*

FOOD	INTERNATIONAL UNITS (IU)
Sweet potato, baked, flesh only, 1 large	34,600
Beef liver, pan-fried, 3 ounces	22,200
Carrots, raw, chopped, 1 cup	21,400
Spinach, frozen, boiled, ½ cup	11,500
Cantaloupe, raw, balls, 1 cup	5,980
Milk, nonfat, 1 cup, fortified	500

**Animal sources contain preformed vitamin A; plant sources contain beta carotene.*
Source: USDA FoodData Central.

stored in the body, it is possible to build up toxic levels if you consume too much. It's much less likely that you'll overdose on beta carotene, since the body slows down the conversion to vitamin A when it already has enough.

Beta carotene is not the only natural substance that the body can convert to vitamin A. It is just one in a large family of bioactive compounds known as carotenoids. Found in many fruits and vegetables, carotenoids are yellow, orange, and red pigments that make carrots orange, for example, and tomatoes red. Although more than 600 carotenoids have been identified, most nutrition research has focused on alpha carotene, beta carotene, lycopene, lutein, zeaxanthin, and beta cryptoxanthin. The carotenoids may contribute to health in multiple ways. Alpha carotene and beta cryptoxanthin, for example, can be converted to vitamin A in the body, just like beta carotene. These are called provitamin A carotenoids. Many of the carotenoids also appear to function as antioxidants.

People in the United States obtain one-quarter to one-third of their vitamin A from carotenoids—most commonly from carrots, cantaloupe, sweet potatoes, and spinach. There is no RDA for beta carotene or other carotenoids.

Cancer

Epidemiological studies suggest that people who eat foods rich in beta carotene and vitamin A are less likely to develop many types of cancer, especially lung cancer. However, in people at risk for lung cancer because of smoking or exposure to asbestos, taking beta carotene supplements appears to *increase* the chance of getting cancer. In one clinical trial, heavy smokers took either a placebo or a daily supplement containing 30 mg of beta carotene plus 25,000 IU (7,500 mcg) of vitamin A. The planned six-year study was stopped two years early because taking the supplements, unexpectedly, had increased risk for lung cancer by 28%.

Subsequent trials in predominantly nonsmoking men and women did not find the same increase in risk, but instead found that taking supplements presented neither benefit nor risk for total and specific types of cancer. Experts now advise people—especially former and current smokers—not to take beta carotene supplements for cancer prevention.

Cardiovascular disease

Beta carotene supplements do not reduce the risk of developing cardiovascular disease. In one clinical trial—the Physicians' Health Study, involving 22,071 male physicians in the United States—half of the participants were given beta carotene supplements and half were not. After 12 years of supplementation, no differences between the two groups—positive or negative—emerged for heart attack, stroke, cancer, or overall death rates. A two-year study of the effects of beta carotene supplementation on 39,876 women, who were healthy at the start of the trial, also found no short-term benefit or harm related to cardiovascular disease, cancer, or death.

Eye diseases

Healthy eyes depend on vitamin A as well as carotenoids that aren't transformed into vitamin A. Lutein and zeaxanthin are the only carotenoids found in the retina, the light-sensing layer of cells in the back of the eye, where they are believed to help protect against damaging short wavelengths of light. Intake of spinach and kale, two lutein-rich vegetables, has also been linked to a moderately lower risk of cataracts (the clouding of the normally clear lens of the eye).

The Age-Related Eye Disease Study (AREDS) found that taking a dietary supplement, which included beta carotene, slowed the progression of a

retinal disease called age-related macular degeneration (AMD), a condition that leads to blurred, distorted sight and blind spots in the visual field. In the AREDS trial, researchers tested a formulation consisting of vitamin C (500 mg), vitamin E (400 IU), beta carotene (15 mg), copper (2 mg), and zinc (80 mg) in 3,640 people ages 55 to 80 years old with varying stages of AMD. (Copper was added to the mix because high levels of zinc may cause copper deficiency.) While not a cure, the formulation slowed progression to wet AMD (a more advanced from of the disease) by about 25%.

Some slightly altered formulations were tested in the subsequent AREDS2 trial. Because taking beta carotene supplements may raise lung cancer risk among smokers, the researchers replaced it with a combination of lutein (10 mg) and zeaxanthin (2 mg). They also tested versions of the supplement mix that contained omega-3 fatty acids (1,000 mg), both with and without the change in carotenoids. This time, the results showed that lutein and zeaxanthin were a safe and effective alternative to beta carotene for AMD, but omega-3s had no effect on eye health. In addition, none of the formulations tested in the AREDS trials reduced the overall risk of developing cataracts or needing cataract surgery, except among people with very low lutein and zeaxanthin in their diets.

The B list

The B vitamins consist of eight distinct vitamins that help cells function optimally:

- vitamin B_1: thiamin
- vitamin B_2: riboflavin
- vitamin B_3: niacin or nicotinic acid
- vitamin B_5: pantothenic acid
- vitamin B_6: pyridoxal, pyridoxine, pyridoxamine
- vitamin B_7: biotin
- vitamin B_9: folate, folic acid
- vitamin B_{12}: various cobalamins; commonly cyanocobalamin in vitamin supplements.

Missing from the list above are B_4, B_8, B_{10}, and B_{11}, which were once thought to be important to human health, but were later discovered to be nonessential to humans. Therefore, they are no longer considered vitamins.

Recommendations

- If you take a multivitamin, make sure most or all of the vitamin A comes in the form of beta carotene and not retinol or retinyl compounds (the preformed versions of vitamin A). These can be toxic at high levels.
- If you are taking a multivitamin to improve your eye health, look for a formulation that contains amounts of vitamins C and E, zinc, copper, lutein, and zeaxanthin similar to those found in the AREDS2 formulation.
- Recommendations from the U.S. Preventive Services Task Force advise against the use of beta carotene supplements to prevent either cardiovascular disease or cancer.

B vitamins

The B vitamins (see "The B list," below left) perform a wide range of important functions throughout the body, such as helping to convert food into energy and maintain the immune system, healthy skin, blood cells, the brain, and the nervous system. Many Americans, especially the elderly, don't meet the RDAs for three B vitamins—B_6, B_9, and B_{12}. These Bs have garnered the most attention from public health officials and researchers, so we, too, will zero in on them.

Vitamin B_6 (pyridoxine)

RDA, ages 19 to 50: 1.3 mg
RDA for men, ages 51 and older: 1.7 mg
RDA for women, ages 51 and older: 1.5 mg

Selected food sources of vitamin B_6

FOOD	MILLIGRAMS (MG)
Chickpeas, canned, 1 cup	1.1
Beef liver, pan-fried, 3 ounces	0.9
Tuna, yellowfin, fresh, cooked, 3 ounces	0.9
Salmon, sockeye, cooked, 3 ounces	0.6
Chicken breast, roasted, 3 ounces	0.5
Breakfast cereal, fortified with 25% of the DV for vitamin B_6, 1 serving	0.4
Banana, 1 medium	0.4

Source: USDA FoodData Central.

Selected food sources of vitamin B_9

FOOD	MICROGRAMS OF DIETARY FOLATE EQUIVALENTS (MCG DFE)
Beef liver, braised, 3 ounces	215
Spinach, boiled, ½ cup	131
Black-eyed peas (cowpeas), boiled, ½ cup	105
Breakfast cereal, fortified with 25% of the DV for folic acid, 1 serving	100
Spaghetti, enriched, cooked, ½ cup	93
Rice, white, medium-grain, cooked, ½ cup	90
Asparagus, boiled, 4 spears	89
Brussels sprouts, frozen, boiled, ½ cup	78

Source: USDA FoodData Central.

Your body needs vitamin B_6 to break down protein and build red blood cells. This vitamin occurs naturally in a variety of foods, including meat, poultry, fish, and some fruits and vegetables, and is added to some fortified cereals. Most younger people meet the RDA for B_6, but one survey showed that many people over 60 don't: men got 1.2 mg daily instead of the recommended 1.7 mg, and women got 1.0 mg daily instead of 1.5 mg.

Vitamin B_9 (folate, folic acid)

RDA: 400 mcg DFE

The terms folic acid and folate refer, respectively, to the synthetic and natural forms of vitamin B_9. In either form, this nutrient plays a role in the synthesis, repair, and function of DNA, the genetic material found in all cells. Beef liver, leafy green vegetables, and dried beans are good sources. Some Americans, including a fair number of women of childbearing age, don't get enough of this vitamin. That's worrisome, because having insufficient levels just before and during the early stages of pregnancy increases the risk of having a baby with a neural tube defect—a serious malformation of the spine, skull, or brain, such as spina bifida or anencephaly.

To address this concern, FDA regulations require food manufacturers to fortify breads, cereals, flours, cornmeal, pastas, rice, and other grain products with folic acid. Since 1998, when the rule went into effect, folic acid intake has risen substantially, and the incidence of neural tube defects has fallen.

A word about labeling: Because folic acid is absorbed into the body more quickly than folate, the FDA has replaced the old RDA of 400 mcg of folate with a new RDA of 400 micrograms of dietary folate equivalents (mcg DFE) that accounts for both in a single formula. It is this new measurement that is now given on Nutrition Facts or Supplement Facts panels—if a manufacturer wants to include the information, which is not required by law. If a product such as cereal contains both folate (from the grain) and folic acid (from supplementation by the manufacturer), the total is given in mcg DFE, and the amount that comes from folic acid is listed underneath in mcg (see Figure 3, above).

Figure 3: How the new Nutrition Facts panel lists folate

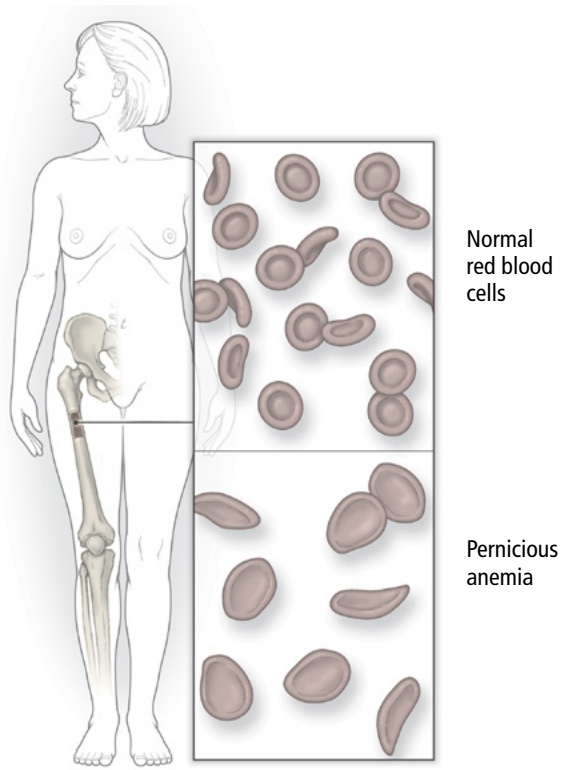
Vitamin B_9—which includes both naturally occurring folate and supplemental folic acid—is not one of the vitamins that manufacturers are required to list on the Nutrition Facts panel, but they can do so at their discretion. When they do, the FDA now requires them to give the total amount of the vitamin (listed under the single term folate) in mcg DFE, a standardized measure that takes into account the different properties of the two forms (A). The portion of that total that comes just from folic acid is then listed separately in mcg (B).

Vitamin B_{12} (cyanocobalamin)

RDA: 2.4 mcg

Vitamin B_{12}, which is required for proper brain function and a host of chemical reactions within the body, is found naturally only in animal foods such as fish, meat, poultry, eggs, and milk. Many fortified cereals contain a synthetic form. Vegans, who avoid all animal-based foods, need to ensure they get enough of this vitamin through fortified foods or supplements. About 6% of people ages 60 and older are deficient in vitamin B_{12}, and nearly one in five is borderline deficient. As you age, it often becomes harder to absorb enough B_{12} from food. This problem usually reflects reduced production of stomach acid, which liberates B_{12} from food. But since your body doesn't need this stomach acid in order to absorb B_{12} from supplements or fortified foods, you can avoid a deficiency by getting enough B_{12} from these sources. A B_{12} deficiency can cause pernicious anemia (see Figure 4, below left). This condition is usually treated with monthly injections of B_{12}.

Figure 4: B_{12} deficiency and anemia



In rare cases, low vitamin B_{12} levels can cause pernicious anemia, a condition in which the bone marrow produces red blood cells that are both larger and less numerous than normal. Symptoms can include yellowish skin, fatigue, shortness of breath, and headaches. Numbness or tingling in the hands and feet and trouble keeping balance are common. Confusion, depression, and memory loss can also occur and are sometimes chalked up to Alzheimer's disease.

Heart disease

Starting in the mid-1980s, numerous studies noted a link between an increased risk of cardiovascular disease and high blood levels of homocysteine, an amino acid associated with inflammation of blood vessels (including those that supply the heart and brain). Many people with high homocysteine levels are deficient in vitamin B_6, B_9, or B_{12} or a combination of these. Supplements with these vitamins can reduce homocysteine levels within weeks, but this does not reduce heart attacks or deaths from heart disease, according to clinical trials. A 2017 review by the Cochrane Collaboration of 15 clinical trials found no evidence that lowering homocysteine with B vitamin supplementation prevented heart attacks and strokes or reduced the risk of dying during the various trials included in the review.

Cancer

Understanding the relationship between cancer and B vitamins—B_9 in particular—has proved complex. There's evidence that people with low blood levels of B_9 are more prone to a variety of cancers, possibly because B_9 deficiency contributes to abnormal DNA synthesis. Some observational studies have shown that people who consume more B_9 in their diets are less likely to develop colon cancer. Other research has linked greater consumption of B_9 to a lower risk for breast cancer, at least among women who drink alcohol and have low B_9 levels.

However, randomized controlled trials have not provided definitive evidence that taking folic acid supplements prevents cancer. Most trials show either no benefit or a small protective effect. And while adequate amounts of folic acid supplements appear to stifle the formation and spread of early tumors, too much may speed up the growth of existing tumors, especially in certain parts of the body. Some studies

have linked folic acid supplementation to a higher risk of cancer of the colon, breast, or prostate.

Cognitive decline

Numerous studies have tested the theory that B vitamin supplements might protect the aging brain from the toxic effects of high homocysteine, an amino acid linked to inflammation of blood vessels. High homocysteine in the blood—potentially caused by inadequate B vitamin intake—has been linked to greater risk for mental decline and Alzheimer's disease. Since B vitamins tend to lower homocysteine, does supplementing with folic acid and other B vitamins prevent cognitive decline and dementia? So far, research findings have been inconsistent.

In a combined systematic review and meta-analysis published in 2020, researchers analyzed data from eight clinical trials that tested whether giving older adults B vitamin supplements decreased the chance of later mental decline. The scientists found no evidence that the supplements made a difference, although it's well established that adequate levels of B vitamins support the healthy functioning of the nervous system.

So far, the long-term picture remains unclear. You may need to take B vitamin supplements if you have trouble getting enough through your diet, but otherwise they do not have any proven benefit for brain health.

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Selected food sources of vitamin B_{12}

FOOD	MICROGRAMS (MCG)
Clams, cooked, 3 ounces	84.1
Beef liver, pan-fried, 3 ounces	70.6
Trout, rainbow, wild, cooked, 3 ounces	5.4
Salmon, sockeye, cooked, 3 ounces	4.5
Tuna fish, light, canned in water, 3 ounces	2.5
Breakfast cereal, fortified with 100% of the DV for vitamin B_{12}, 1 serving	2.4
Cheeseburger, double patty, with condiments, 1 sandwich	2.0
Milk, low-fat, 1 cup	1.2

Source: USDA FoodData Central.

B bonanza: Boon or bust?

Presumably because of their role in helping cells use energy, B vitamins are often added to energy drinks and nutrition bars—sometimes in extremely high amounts. An 8.4-ounce can of Red Bull, for example, contains 250% of the Daily Value* (DV) for vitamin B_6. And a single 2-ounce bottle of 5-Hour Energy includes a whopping 2,353% of the DV for vitamin B_6 and 20,833% of the DV for vitamin B_{12}—and the label even suggests you can drink two bottles per day. Various brands of bottled water, such as Vitaminwater, contain up to four B vitamins in amounts approaching 100% of the DV. These megadoses do nothing to enhance any bodily functions, and because B vitamins are water-soluble, they're not stored in the body, so any extra is excreted in the urine.

**As described on Nutrition Facts panels, percent Daily Values are based on a 2,000-calorie diet. Your needs may be higher or lower depending on your body size and activity level.*

Recommendations

- For most people, the best source of RDA-appropriate levels of B vitamins is a reasonably balanced diet, combined with a multivitamin-multimineral supplement if there are broader concerns about an overall healthy diet. Be wary of energy drinks and bars that may provide more B vitamins than necessary (see "B bonanza: Boon or bust?" above).
- *Vitamin B_6:* Avoid supplements that contain more than the RDA for this vitamin, as too much can harm the nerves. Though the body eventually excretes what it doesn't need, the danger threshold varies from one individual to the next, and the excess can cause damage before it leaves the body.
- *Vitamin B_9:* Beware of getting too much of this micronutrient from supplements and fortified foods. Most multivitamins contain 400 mcg DFE, but many fortified breakfast cereals also contain that much. Add a few other enriched grain products and you could be over your daily limit. If you take a daily multivitamin, avoid foods fortified with 300 to 400 mcg DFE of folic acid.
- *Vitamin B_{12}:* Vegans, who avoid all animal-based foods, and elderly people, who may have trouble absorbing vitamin B_{12} from food, should consider eating a vitamin B_{12}–fortified breakfast cereal or taking a supplement.

Vitamin C

RDA for men: 90 mg
RDA for women: 75 mg
Smokers: add 35 mg

In the body, vitamin C is crucial for making collagen, which lends structural support to tendons, ligaments, bones, and blood vessels. This vitamin is also a potent antioxidant, which is why smokers, who are exposed to more free radicals, are advised to consume extra vitamin C (see "Antioxidants," page 36). Most people meet the RDA via their diets. Citrus fruits are rich in vitamin C, but a small red sweet pepper contains roughly a third more than a medium-sized orange.

Upper respiratory infections

Vitamin C is perhaps best known for claims that it can prevent and treat the common cold—an idea first promoted in the 1970s by Nobel laureate Linus Pauling. But the evidence for this has come up short. A major Cochrane Collaboration review found no conclusive proof that taking 200 mg or more of vitamin C daily made the common cold less common, although it may slightly shorten the duration of symptoms. Many experts who insist on the cold-defying power of vitamin C state that even higher amounts are needed to achieve this effect. However, so far there is no evidence from randomized controlled trials to support this assertion.

High blood pressure and heart disease

Vitamin C supplements might have a modest effect on blood pressure, according to a meta-analysis of data from 29 small randomized controlled trials that compared vitamin C against a placebo. Researchers found that people who were given a median dose of 500 mg per day of supplemental vitamin C had a drop in systolic blood pressure of 3.8 millimeters of mercury (mm Hg) over the short term. Among participants who had a diagnosis of high blood pressure (hypertension), the drop appeared to be greater, at nearly 5 mm Hg.

However, there is little evidence that vitamin C lowers the risk of heart disease, despite preliminary research hinting that it might. The Physicians' Health Study II, which followed 14,641 men who took 500 mg of vitamin C daily for a decade, found no difference in the number of heart attacks, strokes, or deaths from cardiovascular disease compared with men who took placebos. Results were similar in the Women's Antioxidant Cardiovascular Study (WACS), which included 8,171 female health professionals with a history of cardiovascular disease or several risk factors for it. Women who took 500 mg of vitamin C per day, along with 600 IU of vitamin E and 50 mg of beta carotene every other day, did not see any decrease in cardiovascular events during nine years of follow-up.

Selected food sources of vitamin C

FOOD	MILLIGRAMS (MG)
Red sweet pepper, raw, chopped, ½ cup	95
Grapefruit juice, ¾ cup	70
Orange juice, ¾ cup	68
Orange, 1 medium	68
Kiwifruit, 1 medium	64
Green sweet pepper, raw, chopped, ½ cup	60
Broccoli, cooked, ½ cup	51

Source: USDA FoodData Central.

Eye diseases

Vitamin C is an antioxidant (see "Antioxidants: Beyond the hype," page 36), and in the eye, it is thought to help protect against damage from free radicals generated by exposure to sunlight. Over time, too much sun exposure can lead to cataracts and increase the risk of age-related macular degeneration (AMD), both of which can severely impair vision.

Eating plenty of antioxidant-rich fruits and vegetables seems to make people less likely to develop cataracts. The role of supplements is less clear. One observational study found that people who consume about eight to 10 times the RDA of vitamin C, through both foods and supplements, were less likely to develop cataracts than people who consumed the RDA. However, a Cochrane Collaboration review of

nine clinical trials—involving 117,272 people ages 35 or older—found no evidence that taking antioxidant supplements containing beta carotene or vitamins C or E at levels above the RDA prevented cataracts.

As for AMD, vitamin C is included in the dietary supplement that was shown in the AREDS and AREDS2 trials to prevent progression of AMD to its most damaging form (see "Eye diseases," page 17). But taking vitamin C supplements has not been demonstrated to lower the chance of developing AMD over all.

Recommendation

- A healthy diet supplies the vitamin C you require. Taking vitamin C supplements in amounts substantially higher than the RDA offers no apparent health benefits but is probably harmless.

Vitamin D

RDA, ages 1 to 70: 600 IU (15 mcg)
RDA, ages 71 and older: 800 IU (20 mcg)

This fat-soluble vitamin is unique because its primary natural source is sunlight, not food. In fact, it's found naturally in only a few foods. What's more, fatty fish, the leading food source of vitamin D, isn't something most Americans eat daily. Milk, which doesn't naturally contain vitamin D, has been fortified with it since the 1930s to help fill the gap; however, dairy products made from milk (such as cheese and ice cream) aren't typically fortified with vitamin D and contain only small amounts. Some brands of yogurt are fortified, and so are some juices and breakfast cereals. For older adults to meet the RDA of 800 IU, they would have to drink at least a quart of fortified milk per day.

Selected food sources of vitamin D

FOOD	INTERNATIONAL UNITS (IU)
Cod liver oil, 1 tablespoon	1,360
Salmon (sockeye), cooked, 3 ounces	570
Swordfish, cooked, 3 ounces	566
Yogurt, fortified with 15% of the DV for vitamin D, 6 ounces	120
Milk, nonfat, calcium fortified, 1 cup	116
Orange juice, fortified, ¾ cup	79
Tuna fish, white, canned in water, drained, 3 ounces	68
Egg, 1 large	50

Source: USDA FoodData Central.

Fortunately, food is not the only source of vitamin D. Exposing your skin to sunshine—more specifically, ultraviolet B (UVB) rays—enables the body to make vitamin D, which is why it's also known as the "sunshine vitamin." Most of us aren't getting nearly as much as our ancestors did, however.

Humans first evolved near the equator in Africa, where the sun shines directly overhead for much of the year. They wore little or no clothing and therefore probably produced tens of thousands of IU of vitamin D each day. Heavy pigmentation protected the deeper layers of their skin from sun-induced damage. As some groups of humans migrated away from the equator, they developed lighter skin, which enabled faster vitamin D production in conditions with less direct sunshine.

However, since then, our habits have changed, leading to less sun exposure. For centuries, people typically spent plenty of time outdoors during much of the year. But in the last 300 years, more people began working indoors, and in the last 100 years, began riding in cars and greatly reduced their daily time outside. All of this reduced the amount of vitamin D their bodies naturally produced.

In the past few decades, putting on sunscreen before heading outdoors has also become more common. In sharp contrast to the trend favoring the "healthy tan" in the mid-20th century, many Americans now intentionally avoid the sun in order to prevent skin cancer—a valid concern, given that UV radiation is an established risk factor for most of the estimated 3.5 million skin cancers that occur each year in the United States. But it also lessens the amount of vitamin D produced in the skin.

Where you live, the season of the year, and the time of day are also factors. The sun's rays are most direct between 10 a.m. and 3 p.m. However, the farther you live from the equator, the less UVB radiation you receive, and it is UVB that prompts your body to produce vitamin D. People who live north of about 37°

latitude (imagine a line extending from San Francisco, Calif., to Richmond, Va.) make little if any vitamin D from sunlight from November to March, even if they stay outside all day. This phenomenon has to do with the angle of the sunlight: during the winter months, the northern hemisphere tilts away from the sun, increasing the angle at which the sun's light reaches North America. When this happens, more UVB radiation is absorbed by the ozone layer, lessening or eliminating the amount that can reach a person's skin.

All of these changes mean that some of us may be getting less vitamin D than our bodies need. However, true vitamin D deficiency—a level low enough to cause the bone disease rickets—is far less common in the United States than vitamin D *insufficiency*, meaning a blood level that falls below the normal range (see "How much vitamin D do you need?" below). It is easy to make up shortfalls through supplements, food, and modest sun exposure (see "Recommendations," page 26, and "Selected food sources of vitamin D," page 23).

How much vitamin D do you need?

Despite widespread assertions in the popular and scientific press that many Americans are deficient in vitamin D, the term "deficiency" isn't strictly accurate. The official definition of a vitamin deficiency means that specific health problems stem solely from the lack of (or inability to use) a specific nutrient. An actual deficiency of vitamin D results in the bone disease known as rickets, which is rare in the United States.

On the other hand, lower-than-optimal levels of certain vitamins, including vitamin D, may increase your risk of numerous health problems, even though they are not solely responsible for these problems. "Insufficiency" may be a better term for these lower levels.

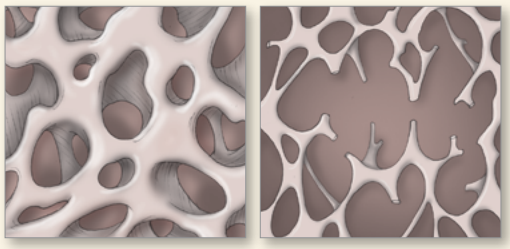
The most clearly established benefit of vitamin D is that it helps the body absorb calcium and therefore promotes healthy bones. However, beginning in the 1980s, a steady drumbeat of studies produced findings linking low blood levels of D with a variety of chronic health problems, leading some researchers to argue that the RDA for D was way too low. The confusion and controversy surrounding optimal vitamin D intake and blood values prompted the U.S. and Canadian governments to request that the Institute of Medicine (IOM, now called the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine) review the evidence on vitamin D and calcium and update the RDAs.

The long-awaited report, *Dietary Reference Intakes for Calcium and Vitamin D*, was published in 2011. The IOM concluded that evidence for benefits other than improved bone health came from studies that could not be considered reliable and provided often-conflicting results.

Based on the evidence for bone benefits, however, the IOM panel increased the RDA for vitamin D to 600 IU for people up to age 70 and to 800 IU for those over 70. That's a fairly sizable boost over the previous recommendations of 200 IU per day through age 50, 400 IU for ages 51 to 70, and 600 IU for ages over 70. The IOM also raised the safe upper limit of daily intake for most age groups from 2,000 to 4,000 IU.

But ultimately, the amount of vitamin D that makes it into your bloodstream—whether from food, supplements, or sun exposure—is likely more important than how much you're consuming. There again controversy reigns. While some people argue for much higher levels, the IOM report concluded that vitamin D blood levels above 20 ng/ml are adequate for maintaining healthy bones, and that most people in the United States have values in that range.

Other organizations, including the American Association of Clinical Endocrinologists, assert that values between 30 and 50 ng/ml have potential health benefits beyond bone health, so the issue is still not resolved. However, the IOM report cautioned that exceptionally high levels of vitamin D have not been proven to confer additional benefits and have been linked to health problems, challenging the notion that "more is better."



Vitamin D helps the body absorb calcium, making it an important part of any strategy to keep bones strong (above left). This can help prevent the bone-thinning disease osteoporosis (above right).

Most healthy adults without symptoms related to vitamin D deficiency do not need to have their blood levels measured. People who should consider vitamin D testing are those with medical conditions that affect fat absorption (including weight-loss surgery) and people who routinely take anticonvulsant medications, glucocorticoids, or other drugs that interfere with vitamin D activity.

Forms of vitamin D

Vitamin D comes in two forms: D_3 (cholecalciferol) and D_2 (ergocalciferol). D_3, the form made naturally by the body in response to sunlight, is also the form most often used to fortify milk and other foods, such as breakfast cereals. D_2 is made from plant material. Vitamin supplements contain either D_3 or D_2. If you take supplements, some experts recommend choosing one that contains D_3. However, a definitive government analysis (see "How much vitamin D do you need?" on page 24) concluded that D_2 is just as effective as D_3 at the recommended dosage levels.

Osteoporosis and fractures

One of vitamin D's most important and best-known roles is to signal the intestines to absorb calcium into the bloodstream. Without sufficient vitamin D, your body will break down bone to get the calcium it needs, no matter how much calcium you consume. Thus, the goal of ensuring adequate intake of both calcium and vitamin D is to prevent the bone-thinning disease osteoporosis and the fractures that can result from it.

Many older adults take daily vitamin D and calcium supplements for this purpose. But does it work? It depends on your age, your overall risk for fractures, and the amounts of vitamin D and calcium you take, according to a 2018 systematic review of clinical trials by the U.S. Preventive Services Task Force (USPSTF). The organization reviewed 11 clinical trials of supplementation with vitamin D and calcium for 51,419 adults over 50 living independently (as opposed to residing in assisted living or full-time nursing facilities). The USPSTF review found insufficient evidence to determine the balance of risks and benefits of taking vitamin D and calcium supplements to prevent fractures at the amounts older adults are generally advised to take: 600 to 800 IU of vitamin D, and 1,000 to 1,200 mg of calcium.

This doesn't mean that you should stop taking vitamin D. But it does suggest that supplements may not always deliver the benefits you hope for—at least in the generally recommended amounts. You and your doctor may feel that it's prudent to follow the general guidelines, even if the current clinical trial evidence has some soft spots or gaps.

Preventing falls

In addition to strengthening bones, vitamin D supplementation could hypothetically reduce the risk of falling and, hence, of suffering fractures. Low blood levels of D have been linked to muscle weakness and poorer muscle function, both of which make falls more likely. However, a 2018 review of 20 clinical trials by the USPSTF found insufficient evidence to recommend that adults over age 65 take vitamin D to prevent falls, unless they already have osteoporosis or low vitamin D levels. By contrast, the review found clear evidence that regular exercise reduces falls and fall-related injuries.

Cardiovascular disease and high blood pressure

Observational studies have linked low vitamin D levels to a higher risk for cardiovascular disease or high blood pressure. However, more rigorous studies have failed to substantiate this connection. Two large randomized controlled trials of vitamin D supplementation at comparatively low doses of 400 IU—including one that was part of the large Women's Health Initiative—showed no benefit in reducing the likelihood of heart disease or stroke. Even very large doses (an initial dose of 200,000 IU, followed by 100,000 IU taken orally once a month) failed to reduce cardiovascular risk more than a placebo in a three-year randomized controlled trial published in *JAMA Cardiology*.

A 2019 meta-analysis combined data from 21 randomized controlled trials involving older adults (average age 66) who received either vitamin D supplements over a wide range of doses or a placebo. In the end, taking vitamin D did not reduce the risk of major cardiovascular problems such as heart attack or stroke, heart-related death, or death regardless of cause.

Observational studies have also linked low vitamin D levels to high blood pressure, a major risk factor for heart attacks, heart failure, and stroke. However, a review of 46 clinical trials involving 4,541 participants found that vitamin D supplements were not effective for controlling blood pressure.

Cancer

Higher blood levels of vitamin D are linked to a lower risk of colon cancer in observational studies—

although most of the differences in blood vitamin D levels were related to sunlight exposure, not dietary intake from food or supplements.

Randomized trials, however, have yet to find benefits for vitamin D supplementation when it comes to cancer risk. For instance, one trial that examined vitamin D and calcium supplementation over four years in relation to the incidence of cancer in older women found the combination didn't significantly lower the risk of cancer. And re-analysis of data from the Vitamin D Assessment (VIDA) trial, which was conducted in New Zealand, also found no protective benefit against cancer from consuming high doses of vitamin D once a month for four years.

A large trial called VITAL (the Vitamin D and Omega-3 Trial) was primarily designed to find out if vitamin D and omega-3 fatty acid supplements prevent cardiovascular disease, but also checked to see if the supplements reduced the risk of invasive cancer of any kind (including colon cancer). The trial included 25,871 participants over 50 years old. They were randomly assigned to one of four groups—taking 2,000 IU of vitamin D, 1,000 mg of fish oil, both supplements, or placebos. In the end, vitamin D supplementation did not lower the risk of developing breast, prostate, or colorectal cancers (though there was a hint of an overall reduction in cancer deaths). Nor did omega-3 fatty acid supplements protect against these cancers.

Recommendations

- When possible, get your vitamin D from foods and from modest sun exposure, making sure to avoid a sunburn. (According to the Skin Cancer Foundation, just five sunburns in your lifetime are enough to double your risk for melanoma.) Generally, five to 10 minutes of sun exposure on some or most days to the arms, legs, or back without sunscreen will enable you to make enough of the vitamin without overdoing your exposure. If you live north of the 37th parallel, which broadly cuts the United States in half horizontally, you can only get adequate sun exposure to make vitamin D during the summer months. If you live south of it, the sun is strong enough for this purpose almost year-round.
- If getting enough sun-generated vitamin D is not feasible and you don't consume much vitamin D in your diet, then consider a daily multivitamin or separate supplement to meet the recommended dietary intake of 600 to 800 IU per day. (Many multivitamins now contain 1,000 IU.)
- If you do take more than 1,000 IU daily in the form of oral supplements, be sure to stay well below the safe upper limit of 4,000 IU. The potential benefits of higher amounts remain controversial.
- At all costs, avoid indoor tanning. The Skin Cancer Foundation calls it "a proven human carcinogen."

Vitamin E

RDA: 22 IU (15 mg)

Your body needs vitamin E. It acts as an antioxidant and plays a role in immune function and blood clotting. But you probably don't need a lot of it. Multiple studies and clinical trials have shown no beneficial effects from vitamin E supplements for heart disease, cancer, or cognitive decline (see "Mind and memory," page 27), making a strong case for avoiding these amber-colored capsules altogether. Also, there is a hypothetical risk for bleeding associated with very large amounts of supplemental vitamin E, so if you do take supplements, stay well below the safe upper limit of 1,500 IU per day.

Vitamin E exists in eight different chemical forms in plants. Alpha tocopherol is the most biologically active and second most available form of vitamin E in the diet, whereas gamma tocopherol is the most common dietary form of vitamin E but is not as biologically active.

Nuts, seeds, and vegetable oils (as well as salad dressings and margarines made from these oils) are the

Selected food sources of vitamin E

FOOD	MILLIGRAMS (MG)
Wheat germ oil, 1 tablespoon	20.3
Sunflower seeds, dry roasted, 1 ounce	7.4
Almonds, dry roasted, 1 ounce	6.8
Sunflower oil, 1 tablespoon	5.6
Safflower oil, 1 tablespoon	4.6

Source: USDA FoodData Central.

Sunflower seeds and oil are among the best sources of vitamin E. Your body needs vitamin E for immune function and blood clotting, as well as its role as an antioxidant.

best food sources of vitamin E. The National Health and Nutrition Examination Survey suggests that most Americans don't get the RDA for vitamin E, but these estimates likely underestimate actual intake because people typically don't recall how much fat (often vegetable oils) they add during cooking or don't know how much is in the prepared foods they consume.

Heart disease

As is the case with many vitamins, observational studies provided the first suggestion of a potential benefit—in this case, that people with higher vitamin E intakes were less likely to develop heart disease. But multiple clinical trials have failed to show that vitamin E supplementation can help to reduce the burden of cardiovascular disease.

For example, the HOPE-TOO (Heart Outcomes Prevention Evaluation—The Ongoing Outcomes) trial included almost 4,000 people, ages 55 and older, with vascular disease or diabetes. Half were randomly selected to take 400 IU of vitamin E daily, and the others to take a placebo. After seven years, vitamin E had not provided any more protection against heart disease or cancer than the placebo. In addition, the vitamin E takers were more likely to have developed heart failure and to have been hospitalized for it.

Similarly, the Physicians' Health Study II found no benefit from 400 IU of vitamin E taken every other day for preventing heart disease, stroke, or death from heart disease. In fact, vitamin E appeared to increase the risk of bleeding (hemorrhagic) stroke. Based on these and other findings, the USPSTF recommends against taking vitamin E supplements to prevent cardiovascular disease.

Cancer

Some observational studies have linked higher vitamin E intake with lower risks of breast and prostate cancers. However, a series of major clinical trials failed to find an anti-cancer benefit to vitamin E supplements. These included the Alpha-Tocopherol, Beta-Carotene Cancer Prevention (ATBC) Study, the HOPE-TOO trial, the Physicians Health Study II, and the Women's Health Study.

One major trial actually found that vitamin E supplementation slightly *increased* the risk of cancer. The Selenium and Vitamin E Cancer Prevention Trial (SELECT) was designed to test whether 200 mcg of selenium and 400 IU of vitamin E, taken alone or in combination, could lower the risk of prostate cancer in nearly 35,000 men. Contrary to expectations, the fewest cases of prostate cancer occurred in the placebo group. For this reason, the USPSTF recommends against taking vitamin E supplements for the purpose of preventing cancer.

Mind and memory

Despite some promising early suggestions that large amounts of vitamin E might slow the progression of Alzheimer's disease, later research provided mixed results. A 2017 Cochrane review found only one moderately strong study suggesting that vitamin E slows functional decline in people with Alzheimer's. And the review found *no* evidence that large amounts slow the progression of disease from mild cognitive impairment (MCI) to full-blown dementia or improve mental functioning in people with either MCI or dementia. That said, it is common for doctors to offer treatment with daily amounts of up to 2,000 IU of vitamin E for mild to moderate dementia based on the possibility that it may help and the overall lack of effective treatments for dementia at present.

Eye diseases

People whose diets include about 30 IU of vitamin E daily—well over the recommended daily amount—

appear to have about a 20% lower risk of developing age-related macular degeneration (AMD), a leading cause of vision loss in people over 60, compared with people who get less than the RDA, according to observational studies. However, in the Physicians' Health Study II, long-term alternate-day use of vitamin E alone or in combination with daily vitamin C had no appreciable effect on the risk of either AMD or cataracts. And in the SELECT trial, long-term daily supplementation with either vitamin E or selenium alone or in combination did not prevent cataracts.

That said, vitamin E does play an important role in AMD care. The AREDS and AREDS2 studies found that a nutritional supplement containing 400 IU of vitamin E and other nutrients slowed the progression from moderate to advanced AMD by about 25%. However, neither trial found that the supplements reduced the risk of cataracts or stalled their progression.

Recommendations

- Do not take vitamin E supplements in hopes of preventing heart disease, cancer, cataracts, or AMD (although vitamin E plays a role in treatment for people who already have AMD).
- If you take a multivitamin, make sure it does not contain more than 100 to 200 IU of vitamin E.

Vitamin K

AI for men: 120 mcg
AI for women: 90 mcg

This relatively unknown vitamin got its name from *koagulation*, the German word for coagulation (blood clotting), because vitamin K is necessary for that process. Vitamin K also plays an important role in bone remodeling (the body's continual process of renewing bone tissue). Moreover, vitamin K helps regulate the body's excretion of calcium in urine.

Vitamin K is found in green leafy vegetables, soybeans, and commonly used cooking oils. People who shy away from salads and other greens may be low in this vitamin. If you take the blood-thinning medication warfarin (Coumadin), it's important to keep your vitamin K intake about the same every day, because the drug interferes with the way vitamin K helps produce clotting proteins. The more vitamin K you consume, the more warfarin you need in order to reach the desired anti-clotting levels.

Fractures

A limited number of observational studies have looked for links between low vitamin K and the risk of bone fractures. Some studies, but not all, have found a connection. In a meta-analysis combining data from five large prospective studies involving 80,962 participants, people with the highest levels of vitamin K in their systems had a 22% lower risk of fractures than people with the lowest levels. However, this isn't strong enough evidence to justify boosting your vitamin K levels with supplements in hopes of improving bone strength or preventing fractures.

Recommendations

- Try to meet your daily requirement for vitamin K from the foods you eat.
- If you take warfarin and a multivitamin, check to see if the multivitamin contains vitamin K, which is found in some preparations in amounts ranging from 10 mcg to 80 mcg. For people who usually get a fair amount of vitamin K from food, the extra vitamin K found in a multivitamin is probably not enough to affect your daily warfarin requirement. But if you get little or no vitamin K in your diet, even a small amount (25 mcg) could upset the balance between vitamin K and warfarin and require a higher daily dose of the drug. Consult your clinician for more detailed advice.

Selected food sources of vitamin K

FOOD	MICROGRAMS (MCG)
Collards, frozen, boiled, ½ cup	530
Turnip greens, frozen, boiled, ½ cup	426
Spinach, raw, 1 cup	145
Kale, raw, 1 cup	82
Broccoli, chopped, boiled, ½ cup	81
Soybeans, roasted, ½ cup	43
Edamame, frozen, prepared, ½ cup	21

Source: USDA FoodData Central.

Calcium

RDA for men, ages 19 to 70: 1,000 mg
RDA for men, ages 71 and older: 1,200 mg
RDA for women, ages 19 to 50: 1,000 mg
RDA for women, ages 51 and older: 1,200 mg

Mention calcium, and most people think of bones. It's true that calcium builds strong bones and teeth, but it also helps muscles to contract, blood to clot, and nerves to send signals to one another.

People who eat a couple of servings a day of dairy products along with some fruits and vegetables probably get close to the RDA of this common mineral. Still, doctors often advise women to take calcium and vitamin D supplements to prevent osteoporosis—the bone-weakening disease that is a common cause of fractures and is far more prevalent among women than men.

The IOM's 2011 report *Dietary Reference Intakes for Calcium and Vitamin D* found that most people get adequate amounts, with the exception of girls ages 9 to 18, who have higher requirements for this mineral. The report also concluded that some postmenopausal women who take calcium supplements to protect against osteoporosis might be getting too much.

Some experts believe that the RDAs for calcium may be higher than necessary, given that very high calcium intake from supplements doesn't necessarily protect against major fractures. Some studies have also linked supplemental calcium to a higher risk for prostate cancer.

Fractures

Although calcium is clearly important for sturdy bones, evidence that a high calcium intake can prevent fractures isn't as strong you might think. For example, observational results from the Physicians' Health Study and Nurses' Health Study showed that people with low milk intake (one glass or less per week) were no more likely to break a hip or forearm than people who drank two or more glasses per week.

The USPSTF has concluded, based on a systematic review of relevant clinical trials, that there is not enough evidence to say whether calcium and vitamin D supplements taken together can prevent bone fractures in otherwise healthy adults. (For more information, see "Osteoporosis and fractures," and "Preventing falls," both on page 25.)

Selected food sources of calcium

FOOD	MILLIGRAMS (MG)
Yogurt, plain, low-fat, 1 cup	415
Mozzarella, part skim, 1.5 ounces	333
Milk, nonfat, 1 cup	316
Soymilk, calcium fortified, 1 cup	301
Orange juice, calcium fortified, ¾ cup	274
Tofu, soft, made with calcium sulfate, ½ cup	138
Turnip greens, fresh, boiled, ½ cup	99

Source: USDA FoodData Central.

High blood pressure and heart disease

Some research suggests a low calcium intake may contribute to high blood pressure (hypertension), but calcium's exact role is unknown. One theory holds that a lack of calcium in the diet predisposes your body to retain sodium, which raises blood pressure. For this reason, it may be especially important that salt-sensitive people with high blood pressure get enough calcium. (Nearly half of all people with high blood pressure are salt-sensitive, meaning their blood pressure rises in relation to the amount of salt in their diet.)

Efforts to control blood pressure with calcium supplements have had mixed results. Studies found that calcium supplements successfully reduced blood pressure in pregnant women with elevated blood pressure. But clinical trials involving people with essential hypertension (that is, hypertension with no known cause) have been largely disappointing. For most people, calcium supplements either made no difference or reduced blood pressure only slightly—by an average of 1 to 2 mm Hg for systolic blood pressure (the first and higher number in a blood pressure reading). Although some people taking the supplements experienced larger reductions in blood pressure, there seems to be no common denominator, such as race or sex,

among those who achieved such improvements.

Most importantly, calcium supplements have raised the risk for heart attacks in some randomized trials. A meta-analysis of nine randomized controlled trials suggested that people who were assigned to take calcium supplements had about a 25% higher risk of heart attacks, compared with those taking a placebo.

Cancer

Many observational studies show that people whose diets are rich in calcium and dairy products tend to have a lower risk of colon cancer. Less certain are findings that suggest some protective effect against lung and breast cancers. And some observational studies have linked calcium and dairy intake to *higher* risks of ovarian cancer and prostate cancer. For example, data from the Health Professionals Follow-up Study showed that men who got more than 2,000 mg of dietary calcium a day were almost three times as likely to develop advanced prostate cancer as men who got less than 500 mg of dietary calcium a day. The Nurses' Health Study investigators noted that milk, which is a major source of calcium, might contain another substance that raises ovarian cancer risk. The risk, if it is real, is probably not caused by calcium itself—since calcium supplements seem safe for women—but by the high levels of natural hormones or lactose found in milk.

Kidney stones

The Women's Health Initiative included a randomized clinical trial of calcium and vitamin D supplements among more than 36,000 postmenopausal women ages 50 to 79. For seven years, half the women took daily doses of 1,000 mg of calcium carbonate and 400 IU of vitamin D_3, and half took a placebo. Among the women taking active pills, 449 developed kidney stones, compared with only 381 in the placebo group—an increased risk of 17%.

Recommendations

- Since calcium supplements may increase the risk of heart attacks, kidney stones, and (in men) prostate cancer, try to get adequate calcium from your diet.
- If you aren't meeting the recommended intake of calcium—say, because you don't drink milk or eat other dairy and calcium-rich foods—you may want to consider a supplement at a lower amount, although the evidence that this actually prevents fractures is not strong.
- If you take calcium carbonate supplements, which include antacid pills like Tums and Rolaids, take them just after a meal, since they require stomach acid to be absorbed.
- Calcium citrate isn't as dependent on stomach acid, so it can be taken any time. Calcium citrate is preferred if you take medications that reduce stomach acid—for instance, esomeprazole (Nexium), lansoprazole (Prevacid), omeprazole (Prilosec), or cimetidine (Tagamet).
- The body can absorb only about 500 to 600 mg of calcium at a time, so divide your dose if you take more than that amount.

Magnesium

RDA for men, ages 19 to 30: 400 mg
RDA for men, ages 31 and older: 420 mg
RDA for women, ages 19 to 30: 310 mg
RDA for women, ages 31 and older: 320 mg

If you eat whole-grain bread and your tap water is "hard"—meaning it contains relatively high levels of minerals—you probably consume more magnesium than a person who favors white bread and drinks "soft" water. Why? The refining process used to make white flour strips away the mag-

© rimglow | Getty Images

Selected food sources of magnesium

FOOD	MILLIGRAMS (MG)
Almonds, dry roasted, 1 ounce	80
Spinach, boiled, ½ cup	78
Cashews, dry roasted, 1 ounce	74
Cereal, shredded wheat biscuits, 2 large	61
Soymilk, plain or vanilla, 1 cup	61
Peanut butter, smooth, 2 tablespoons	54
Edamame, shelled, cooked, ½ cup	50

Source: USDA FoodData Central.

nesium-rich germ and bran of the wheat, along with several other nutrients (see Figure 5, at right). And hard water, which is more common in the Midwestern and Southwestern states, contains more magnesium than soft water. Magnesium is also found in nuts, legumes (beans and peas), and seeds, as well as many vegetables.

Many American adults don't get recommended amounts of magnesium, which is key for proper muscle, nerve, and immune function. Magnesium also plays a role in maintaining normal blood sugar and blood pressure.

Diabetes

Magnesium may influence the release and control of insulin, the hormone that regulates blood sugar levels. People with type 2 diabetes (the most common form of the disease) have high blood sugar levels because their bodies have become resistant to insulin or are not producing enough insulin. They also frequently have low magnesium levels. In observational studies such as the Nurses' Health Study and Health Professionals Follow-up Study, researchers found a higher incidence of type 2 diabetes among men and women with low magnesium intakes.

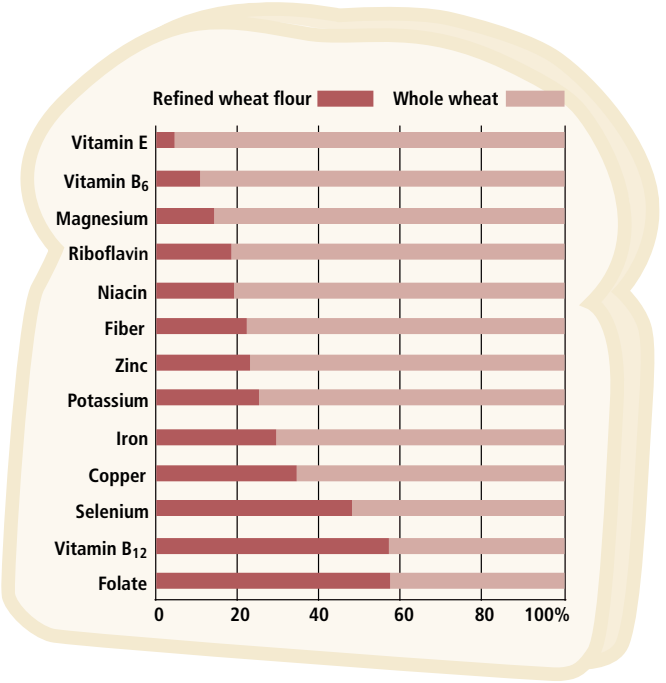
Does this mean taking magnesium supplements could help people with diabetes control their blood sugar better? Randomized controlled trials of magnesium supplementation have yielded conflicting results. One, which tested high-dose (300-mg) liquid magnesium supplements in people with diabetes and low initial magnesium levels, suggested the mineral helps improve blood sugar control. But another, which tested even higher doses (600 mg), showed no such benefit. The American Diabetes Association has stated that there is not enough evidence to justify taking magnesium supplements to improve blood sugar in people with diabetes.

High blood pressure and heart disease

Research suggests a potential role for magnesium supplements in maintaining healthy blood pressure. A meta-analysis in the journal *Hypertension* combined data from 34 randomized controlled trials involving 2,028 participants with and without high blood pressure. The analysis found that magnesium supplements at a median amount of 368 mg per day for a median duration of three months lowered blood pressure by roughly 2 mm Hg for both systolic and diastolic pressure, compared with a placebo. In early 2022, the FDA approved a qualified health claim for magnesium, allowing manufacturers to say that there is some evidence that magnesium may reduce the risk of high blood pressure, although the evidence is inconsistent.

There are other problems associated with low magnesium. Blood levels that are below the normal range—typically seen in people with kidney disease or people taking drugs like diuretics that lower magnesium levels—are clearly related to a higher risk of heart electrical disturbances and death. Various observational studies have also linked low intake of magnesium to a higher risk for cardiovascular disease.

Figure 5: The grain drain



Important nutrients disappear when whole wheat or other grains are refined. As this baker's dozen shows, the losses can be dramatic. For example, refined wheat flour has only 5% of the vitamin E of whole-wheat flour and roughly 10% of the B_6.

Recommendations

- Try to get sufficient magnesium from healthy foods, such as nuts, spinach, whole grains, and beans. If

necessary, consider a multivitamin as a backup source. (Most popular multivitamin brands only contain 10% to 30% of the RDA for magnesium.)

- Magnesium supplements should be considered only if your diet contains little to no magnesium or if you take medications that lower your magnesium; in that case, consult your doctor before starting use.
- Magnesium supplements appear to modestly lower blood pressure, but do not take high amounts for this purpose without a doctor's guidance.

Potassium

AI: 4,700 mg

Potassium is necessary for the normal functioning of all cells. It regulates the heartbeat, ensures proper function of the muscles and nerves, and is vital for synthesizing protein and metabolizing carbohydrates. Thousands of years ago, when humans roamed the earth gathering and hunting, potassium was abundant in the diet, while sodium was scarce. The so-called Paleolithic diet delivered about 16 times more potassium than sodium.

Today, most Americans get barely half of the recommended amount of potassium in their diets. The average American diet contains about twice as much sodium as potassium, because of the preponderance of salt in processed or prepared foods, not to mention the dearth of potassium in those foods. This imbalance—low potassium intakes combined with high sodium—is thought to be a major contributor to high blood pressure, which affects one in three American adults.

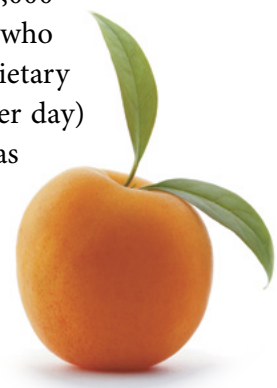
Bananas are often touted as a good source of potassium, but other fruits (such as apricots, prunes, and orange juice) and vegetables (such as squash and potatoes) also contain this often-neglected nutrient.

High blood pressure

The American Heart Association recommends diets with foods rich in potassium to help keep blood pressure in a healthy range. One way to get more potassium is the DASH (Dietary Approaches to Stop Hypertension) diet, which emphasizes potassium-rich fruits, vegetables, and low-fat dairy products. In a major trial, a diet rich in all three of these food groups lowered blood pressure by an average of 5.5 mm Hg and 3.0 mm Hg. It worked even better in people with high blood pressure, reducing systolic pressure by as much as 11 mm Hg and diastolic pressure by 5.5 mm Hg. The DASH diet provides three times more potassium than the average American diet. However, it also increases the intake of other blood pressure–lowering nutrients, such as magnesium and calcium, so the effect cannot be attributed solely to potassium. This is just one of many reasons to maintain a healthy overall dietary pattern such as the DASH plan.

Stroke

High blood pressure is a leading risk factor for stroke, so it's no surprise that higher potassium is also associated with a lower stroke incidence. One prospective study that followed nearly 44,000 men for eight years found that men who consumed the highest amounts of dietary potassium (a median of 4,300 mg per day) were 38% less likely to have a stroke as those whose median intake was just 2,400 mg per day. A similar prospective study that followed more than 85,000 women for 14 years found a more modest association



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Selected food sources of potassium

FOOD	MILLIGRAMS (MG)
Apricots, dried halves, ½ cup	755
Lentils, cooked, 1 cup	731
Acorn squash, mashed, 1 cup	644
Prunes, dried, ½ cup	635
Potato, baked, flesh only, 1 medium	610
Raisins, ½ cup	600
Banana, 1 medium	422
Milk, low-fat, 1 cup	397
Orange juice, ¾ cup	295

Source: USDA FoodData Central.

between potassium intake and the risk of strokes. The FDA allows the following statement to appear on food labels: "Diets containing foods that are a good source of potassium and that are low in sodium may reduce the risk of high blood pressure and stroke."

Recommendations

- Try to eat more colorful produce. Higher potassium consumption from foods, especially fruits and vegetables, may lower blood pressure and the risk of heart disease and strokes.
- Never take potassium supplements without a doctor's prescription, as this can easily lead to dangerously high (and potentially fatal) blood potassium levels, especially in people with advanced kidney disease.
- Pay attention to the potassium content of salt substitutes, since it can be high.

Selenium

RDA: 55 mcg

Selenium is a trace mineral known for its antioxidant properties (see "Antioxidants: Beyond the hype," page 36). It also helps regulate thyroid function and the immune system. Very low intakes cause selenium deficiency, and very high doses can be toxic. True selenium deficiency and toxicity are rare in the United States, however.

The amount of selenium in foods varies widely, as it depends on the selenium content of the soil where plants are grown or animals are raised. For example, the high plains of northern Nebraska and the Dakotas are rich in selenium, and people living there have the highest selenium intakes in the United States. People who snack on Brazil nuts may also have high selenium levels, because just an ounce of these nuts contains as much as 10 times the RDA for selenium—a value so high that you shouldn't eat them on a regular basis. Meats, fish, breads, and other nuts are the most common sources of selenium in the American diet, and most people get the RDA. In one observational study, researchers used toenail clippings (which provide a good measure of selenium intake over time) to assess factors that influence long-term average selenium levels in the body. Greater regular cigarette smoking was related to lower selenium levels, and people with a higher body mass index (BMI) had higher selenium levels.

Selected food sources of selenium

FOOD	MICROGRAMS (MCG)
Brazil nuts, 1 ounce	544
Mixed nuts, oil roasted, without peanuts, salted, 3.5 ounces	421
Tuna, yellowfin, cooked, dry heat, 3 ounces	92
Halibut, cooked, dry heat, 3 ounces	47
Ham, roasted, 3 ounces	36
Cottage cheese, 1% milkfat, 1 cup	20

Source: USDA FoodData Central.

Cancer

Observational studies have found a link between greater dietary selenium intake and a lower risk of colorectal, prostate, lung, bladder, skin, esophageal, and stomach cancers. A 34-year follow-up of a Swedish cohort study called ULSAM found that smokers with low selenium levels at age 50 had higher rates of prostate cancer later in life.

However, the evidence that taking selenium supplements prevents cancer is mixed or inconclusive. A study of people with nonmelanoma skin cancer who took a 200-mcg selenium supplement daily found that it did not affect skin cancer recurrence rates, although it did lower cases and deaths from all cancers combined. Notably, the Selenium and Vitamin E Cancer Prevention Trial (SELECT) found no reduced risk of cancer from long-term selenium supplementation. (For more on this randomized trial, see "Vitamin E," page 26.) A Cochrane review found only limited evidence that selenium helps prevent stomach cancer.

Diabetes

The relationship between selenium intake and diabetes is unclear. Observational studies have suggested a link between high selenium intake and a greater risk for diabetes. That's potentially concerning, consider-

ing the relatively high levels of selenium in the soil in some U.S. regions and the widespread use of multivitamin supplements containing selenium. However, a number of clinical trials have found the opposite—that greater selenium intake is associated with a *lower* risk for diabetes. So the evidence remains inconsistent and inconclusive.

Eye disease

In the eye health analysis report from the SELECT trial, long-term daily supplementation with selenium either alone or in combination with vitamin E did not prevent cataracts.

Recommendation

- There are no known benefits to taking individual selenium supplements. If you want to take supplemental selenium, consider it as part of a daily multivitamin-multimineral supplement.

Zinc

RDA for men: 11 mg
RDA for women: 8 mg

Found in cells throughout the body, zinc helps your immune system fight off bacteria and viruses, which explains why it has been investigated as a potential treatment for the common cold. Your body relies on zinc for wound healing as well as the ability to taste and smell. However, zinc is one of the micronutrients with a small difference between an adequate dose and a harmful one. If you routinely take excessive amounts of zinc, it can lead to side effects such as a depressed immune system, hair loss, and temporary interference with the ability to taste and smell. Most Americans already get the RDA for zinc from their diets, since the mineral is found in seafood, meat, fortified cereals, beans, poultry, and dairy products. Therefore, supplements aren't generally needed.

The common cold

A systematic review and meta-analysis of 28 high-quality clinical trials, published in 2021 in *BMJ Open*, provides limited evidence for using zinc to fight the common cold, although with important caveats. Zinc lozenges or nasal sprays reduced the duration of cold symptoms by about two days, and symptoms were somewhat less severe over all. However, the products prevented upper respiratory infections in only one out of 20 people.

Selected food sources of zinc

FOOD	MILLIGRAMS (MG)
Oysters, cooked, breaded and fried, 3 ounces	74.0
Crab, Alaskan king, cooked, 3 ounces	6.5
Beef, chuck roast, braised, 3 ounces	5.8
Beef patty, broiled, 3 ounces	4.1
Lobster, cooked, 3 ounces	3.4
Baked beans, canned, plain or vegetarian, ½ cup	2.9
Breakfast cereal, fortified with 25% of the DV for zinc, 1 serving	2.8
Pork chop, loin, cooked, 3 ounces	1.8

Source: USDA FoodData Central.

Cancer

An observational study in older men in Sweden found that high dietary zinc consumption was associated with a lower risk of death from prostate cancer among those men who were already diagnosed with this cancer. A meta-analysis of seven studies found that the highest dietary intakes of zinc were linked to lower risk of pancreatic cancer. Zinc may fight cancer via its antioxidant properties or by supporting a healthy immune response.

Recommendations

- If you try zinc lozenges to shorten the duration of a cold, read the label to be sure you're not taking more than the safe upper limit (40 mg a day), particularly over an extended period of days.
- If you take a multivitamin, don't take an additional zinc supplement. Most already contain the RDA for zinc.

Beyond vitamins: Bioactives, probiotics, antioxidants, and more

We hope that it's clear by now that a well-stocked pantry and refrigerator with a representative mix of wholesome foods should be a big part of your strategy for staying healthy. Not only do the foods you eat supply essential vitamins and minerals, they also contain many other components that can be beneficial, such as the ones below.

Bioactives

Even the most humble fruits and vegetables are replete with compounds called phytochemicals that affect the plants' flavor, color, scent, and other properties. In recent years, many of these compounds have become known as bioactives, because they also have physiological effects on the human body. The searing bite of hot peppers, the pungent whiff of garlic, the enticing smell of curry, the deep orange hue of carrots, and the red blush on tomatoes all come from bioactives.

A well-stocked refrigerator and pantry, chock-full of wholesome foods, should be a big part of your strategy for staying healthy, giving you vitamins, minerals, bioactives, probiotics, and omega-3s.

Plants develop these compounds for their own purposes, including defense against predators. But many of these substances appear to be beneficial for people, too. The results of certain studies are now well known—the lutein in dark leafy greens may help protect against specific eye ailments; the lycopene in tomatoes may help defend against prostate disease; the proanthocyanidins in cranberries may help ward off urinary tract infections; the flavan-3-ols found in tea, cocoa, berries, and grapes may have a role in the prevention of cardiovascular disease. Many serve as antioxidants (see "Antioxidants: Beyond the hype," page 36). Others have anti-inflammatory properties. Still others activate your body's natural detoxification systems.

There are thousands of bioactives in your fruits and vegetables, and in many cases, they work in networks, so taking a few in supplement form will not necessarily deliver the best results. Instead—you guessed it—try to get them from your food. Here's a bonus: you'll get plenty of vitamins and minerals, too.

Probiotics and prebiotics

Probiotics and prebiotics are a hot topic in nutrition these days because of their connection to the gut microbiome. Your large intestine contains 100 trillion "good" bacteria that are essential to your health. These beneficial microbes help maintain healthy bowel function, fending off ailments like inflammatory bowel disease and *Salmonella* and *E. coli* infections. They may even play a role in regulating weight, liver function, and mood.

All people start out with a colony of these beneficial microorganisms in their gut, courtesy of physi-

cal contact with their mothers—in the womb, during the birth process, and via breastfeeding. But you take in others—known as probiotics—through food. The microbes that turn milk into yogurt and kefir are among the most helpful probiotics, but they can be destroyed during processing. When you buy commercial yogurt and kefir, look for the words "live and active cultures" on the label, to make sure the manufacturer has tested production methods and knows the bacteria can survive.

Prebiotics are foods rich in the insoluble fibers that your beneficial gut bacteria like to feed on. These include whole-grain breads, sweet potatoes, corn, beans, peas, and lentils.

Fermented foods are another good source, under the right circumstances. Beneficial microbes turn cabbage into sauerkraut, cucumbers into sour pickles, soybeans into miso, and sweetened tea into kombucha. But if the products have been pasteurized—as with most fermented foods in packages—the microbes will be dead. In addition, most pickles and sauerkraut are canned and pickled in hot vinegar solutions with high acidity that combines with heat to kill live, active bacteria. The best solution is to buy from delis where they do the pickling themselves or natural food stores that carry fermented foods. Or make your own; you can find clear and easy instructions in books and online.

There are also probiotic supplements on the market, of course. But it's not easy to sift through them and find exactly what you need. Usually these products contain just a few bacterial strains, compared with 3,000 or so strains in your gut. And not all gut bacteria are alike. Different ones play different roles

Antioxidants: Beyond the hype

Antioxidants are a very broad category that includes many bioactive compounds, as well as certain vitamins and minerals—for example, vitamins C and E and the minerals copper, zinc, and selenium. For a while, they were a nutritional fad, and a vast array of food labels touted "antioxidants!" in big, bold letters. The fad has died down, but has not completely disappeared. You can still find potato chips that boast "antioxidants and vitamin C," making them sound almost like health food.

"Antioxidant" is a general term for any compound that can counteract unstable molecules called free radicals that damage DNA, cell membranes, and other parts of cells. Free radicals are produced as a natural result of many normal body processes, like converting food into energy and defending you against bacteria and viruses. This means you are continuously exposed to free radicals. To keep things in check and prevent damage to body tissues, you need an adequate supply of antioxidants.

Plants produce abundant antioxidants. For example, broccoli, spinach, and tomatoes contain alpha lipoic acid (ALA). Spinach, avocados, and asparagus contain glutathione. Citrus fruits famously deliver large helpings of vitamin C. Cooking oils extracted from soybeans and other sources provide the antioxidant vitamin E. Among the scores of other antioxidants in plant foods are the carotenoids (such as lycopene in tomatoes and lutein in kale) and the flavonoids (such as flavanols and epicatechins in cocoa, anthocyanins in blueberries, quercetin in apples and onions, and catechins in green tea).

Many observational studies have linked a variety of health benefits to diets rich in antioxidant-packed fruits and vegetables. Such benefits include lower risks of cardiovascular disease, cancer, age-related eye disease, and memory impairment.

But your body doesn't rely solely on plants to supply antioxidants. It also makes its own, including the powerful antioxidants ALA and glutathione.

Where does that leave supplements? Randomized placebo-controlled trials do not generally support the extravagant claims made for supplemental antioxidants. It is better to obtain your antioxidants from a well-rounded diet. If you really want to benefit from antioxidants, walk past the supplement aisle and go straight to the produce section or the nearest farmer's market.

in the body, so if you're trying to treat a specific condition, like irritable bowel syndrome or diarrhea, you need to find the right ones with documented benefits for that condition. In 2020, the American Gastroenterological Association released guidelines for the use of probiotics. These experts concluded that good evidence for taking probiotic supplements exists for only a handful of conditions. For general health, look for brands that contain both *Lactobacillus* and *Bifidobacterium*.

Another way to nurture your gut bacteria is to make sure your diet includes prebiotics—foods rich in the insoluble fibers that the bacteria themselves like to feed on. These fibers are found in abundance in whole-grain products such as oatmeal and whole-grain breads, as well as in vegetables like asparagus, leeks, onions, and garlic, and starchy vegetables like sweet potatoes and corn. Beans, lentils, and peas are also good sources.

Finally, stick with whole foods. The beneficial bacteria in your gut can be depleted if you eat a lot of sugar, saturated fat, and processed foods.

Omega-3 fatty acids

Omega-3s are a group of essential fatty acids; "essential" here refers to vital nutrients the body cannot manufacture for itself and must obtain from food. Omega-3s are believed to be particularly beneficial for the cardiovascular system. Omega-3s are abundant in certain fatty fish and other seafood. They are also available in much smaller quantities from plant-based foods, such as walnuts, flaxseed, and canola oil.

Several observational studies have reported a potential link between intake of omega-3 fatty acids from food or supplements and lower risk for cardiovascular disease. For example, research based on data from the Physicians' Health Study found that men who ate fish once a week were half as likely to die suddenly from a heart attack as men who ate fish less than once a month. Among the potential explanations for this finding are the favorable effects of omega-3s on blood pressure, heart rate, cholesterol, and inflammation, and their likely role in maintaining normal heart rhythm and blood vessel function.

According to both the U.S. Dietary Guidelines and the American Heart Association, everyone should try to eat fish, especially oily fish like salmon, sardines, or herring, at least twice a week. However, a Cochrane review published in 2020 cast doubt on the value of fish oil *supplements* for preventing cardiovascular disease. The review looked at 86 clinical trials, most of which raised participants' omega-3 intake using supplement capsules, although some did so with dietary changes. The review found that raising intake of omega-3s has "little or no effect" on serious events like heart attacks and strokes, and "probably" has no effect on the risk for dying of heart disease or of having a stroke or heart-rate irregularities.

This doesn't necessarily mean you should rule out taking omega-3 supplements if you can't get sufficient amounts from food. Some people, after all, simply don't like seafood, the richest source. But it does mean that the evidence that you will ultimately benefit, and how much you benefit, may be less than you would prefer.

Does your diet deliver the daily recommended dose?

It's easy to look up the recommended daily allowance for every vitamin and mineral based on your age and sex. (For vitamins, see Table 1, page 8, and for minerals, see Table 2, page 11, or visit the USDA's website, which you can reach via www.health.harvard.edu/RDA.) But how much of each of these nutrients are you actually getting from the foods you eat every day—and do they meet your daily needs?

Focus on food

There are several ways to approach healthy eating. One is to analyze the nutrient content of everything you eat. The other, which we prefer, is to focus on the big picture: eating a balanced diet that contains a variety of colorful fruits and vegetables, whole grains, beans, nuts, dairy products, seafood, lean meats, and poultry. When choosing what to eat, emphasize nutrient-dense foods, which are packed with vitamins and minerals and have relatively few calories (see "Examples of nutrient-dense foods," at right).

Try the Mediterranean diet

One way to get plenty of vitamins and minerals from food is to use the Mediterranean diet as your guide to healthy eating. This eating pattern, with its emphasis on vegetables, fruits, whole grains, olive oil, fish, yogurt, beans, and nuts (plus wine in moderation) provides a wide array of vitamins and minerals (see "How Mediterranean is your diet?" on page 39). Numerous studies affirm the disease-fighting powers of this approach.

The first U.S.-based study of the diet confirmed that the more closely people followed the Mediterranean eating style, the lower their risk of dying from either heart

Examples of nutrient-dense foods

In contrast to potato chips, which contain a lot of calories but not a lot of nutrients, a baked sweet potato delivers a bounty of nutrients with relatively few calories. (Just be sure to avoid adding excessive toppings, such as marshmallows, or you'll pile on empty calories.) Following are some other nutrient-rich foods. You'll notice that these are all unprocessed or minimally processed foods.

- Almonds, cashews, peanuts
- Avocados
- Barley, oats, quinoa, brown rice
- Beans (garbanzo, kidney, navy, pinto)
- Bell peppers
- Berries (blackberries, blueberries, raspberries, strawberries)
- Brussels sprouts
- Cantaloupe, kiwi, papaya
- Chard, collard greens, kale, mustard greens, spinach
- Chicken, turkey
- Eggs
- Lean beef, lamb, venison
- Lentils, peas
- Mushrooms (crimini, shiitake)
- Onions, leeks, garlic
- Salmon, halibut, cod, scallops, tuna
- Seeds (flax, pumpkin, sesame, sunflower)
- Tomatoes
- Yogurt

disease or cancer. The Spanish PREDIMED clinical trial of 7,447 men and women ages 55 to 80 at high risk for cardiovascular disease found that a Mediterranean-style diet—primarily through the consumption of extra-virgin olive oil and mixed nuts each day—reduced heart attack, stroke, and death by about 30% compared with a standard low-fat diet over the course of almost five years. An observational study examining the relative importance of each component of the Mediterranean diet suggested that its life-extending benefits stemmed mainly from eating plenty of vegetables, fruits, nuts, legumes, and olive oil; eating little meat; and drinking a glass or two of wine with meals.

Another bonus: Research suggests that people are able to maintain a healthy weight on the Mediterranean eating pattern. However, it's unclear whether a Mediterranean-style diet is more effective than any other for losing weight. Usually the most effective weight-loss diet for you is one you can stick with over the long haul.

How Mediterranean is your diet?

Does your diet measure up? Give yourself one point for each "Yes." If you score 6 or higher, you're eating like an Aegean.

	YES	NO
Vegetables (other than potatoes), 4 or more servings a day		
Fruits, 4 or more servings a day		
Whole grains, 2 or more servings a day		
Beans (legumes), 2 or more servings a week		
Nuts, 2 or more servings a week		
Fish, 2 or more servings a week		
Red and processed meat, 1 serving or less a day		
Dairy foods, 1 serving or less a day		
More unsaturated fat (olive oil and other liquid vegetable oils) than saturated fat (butter, palm oil, bacon fat, etc.)		
TOTAL		

Or … try the DASH diet

The DASH (Dietary Approaches to Stop Hypertension) diet was created in the 1990s to help people lower their blood pressure. It has also been shown to help reduce cholesterol levels, can be adapted for weight loss, and has been recognized as a healthy eating plan that is easy to follow and adopt.

Like the Mediterranean diet, the DASH diet emphasizes the consumption of vegetables, fruits, fat-free or low-fat dairy products, whole grains, fish, poultry, beans, seeds, nuts, and "good" fats, such as vegetable oils. The dietary plan also recommends reducing the intake

One way to get plenty of vitamins and minerals from food is to use the Mediterranean diet as your guide to healthy eating. The first U.S.-based study of the diet confirmed that the more closely people followed this eating style, the lower their risk of dying from heart disease or cancer.

Getting the most from foods

Whether you're a gourmet chef or a novice in the kitchen, you can learn to squeeze the most nutritional benefit from your diet. Choosing nutritious foods is the most important step, but the following tips can help you preserve the nutritional content of your foods:

Don't forgo frozen or canned. The fruits and vegetables stocked in supermarket freezer aisles are usually picked ripe and flash frozen, which captures their flavor and seals in nutrients. And larger stores carry everything from old standards like frozen blueberries or chopped broccoli to newer additions like frozen turnip greens, gooseberries, and plantains. Canned fruits and vegetables are also a good alternative, but make sure to choose products that are canned in water and low in salt and sugar.

Steam, stir-fry, grill, or roast vegetables. Boiling veggies can lead to a loss of nutrients into the cooking water. But don't get caught up in little details of the "best" way to prepare vegetables. The key step is to buy them and eat them—you'll be doing your body a favor no matter how you prepare them.

Wrap it up. Properly store or refrigerate any cut fruits or vegetables in order to ensure that they will last and retain their key nutrients. Cap juice bottles.

Cook it well. Foods such as meat, fish, and poultry must be cooked well in order to destroy dangerous microorganisms. If you grill your food, be sure not to char it, in order to avoid formation of cancer-causing compounds.

of red meats, sodium, sweets, and sugar-containing beverages. For the particulars of the plan, go to www.health.harvard.edu/dash.

Make healthy food choices

Some essential nutrients are packed into every food, and certain foods—such as flour, cereal, and salt—are fortified with specific nutrients as well. Vitamin and mineral supplements from a bottle cannot encompass all the biologically active compounds teeming in a well-stocked pantry. A simple apple or floret of broccoli contains scores of nutrients besides vitamins and minerals that might interact to improve your health. For example, broccoli contains bioactive compounds called isothiocyanates, which appear to have anti-tumor properties.

Highly processed wheat and other grains have the same effect on the body as table sugar, so minimize your intake of doughnuts, white bread, and most breakfast cereals.

Here are some rules of thumb that will help you make good choices.

Limit liquid sugars

Liquid sugars, which are found in soft drinks, sports drinks, fruit drinks, iced teas, and sweetened waters, have no benefits for health and are clearly linked to a higher risk of obesity, diabetes, and perhaps heart disease. There is no reason to include these in your diet. Skip the sugary drinks—and even artificially sweetened drinks, which also have been associated with deleterious health effects. Have some unsweetened tea or sparkling water instead.

Minimize refined carbohydrates

Highly processed wheat, rice, and other grains have the same effects in the body as table sugar. So minimize your intake of white bread, French fries, most breakfast cereals, and most high-carbohydrate packaged and processed foods, such as pretzels and chips. Instead, choose whole grains, high-fiber breakfast cereals, brown rice, steel-cut oats, and fruits and vegetables.

When choosing carbs, a good rule of thumb is to be sure that they have no more than 10 grams of carbohydrate for every gram of dietary fiber (maximum 10-to-1 carbohydrate-to-fiber ratio). Even better, if possible, aim for no more than 5 grams of carbohydrate for every gram of dietary fiber (maximum 5-to-1 carbohydrate-to-fiber ratio).

Choose healthy fats

Fish, nuts, and vegetable oils contain healthy monounsaturated and polyunsaturated fats, which help lower heart disease risk. Eat these foods regularly and in moderation. Don't focus on the amount of fat (for example, low-fat salad dressing), but rather the type of fat.

Limit your consumption of saturated fat and cholesterol.

Don't forget fiber

Eat plenty of foods that contain dietary fiber (the edible, indigestible parts of plant foods). Good sources include fruits, vegetables, whole grains, beans, and nuts. Fiber from grains helps lower the risk of heart disease. Your daily fiber goal depends on your age and sex, as follows:

- men ages 50 or younger: 38 grams
- men over 50: 30 grams
- women ages 50 or younger: 25 grams
- women over 50: 21 grams.

Favor fruits and vegetables

Most Americans don't eat nearly the recommended amounts of fruits and vegetables (see Figure 6, at right). Preparation time, unfamiliarity, and old habits are common hurdles. Here are some suggestions to break these barriers and boost your intake.

Set a goal. Start by eating one extra fruit or vegetable a day. When you're used to that, add another and keep going. For example, add fruit to your breakfast cereal every morning. Then try eating a piece of fruit for an after-lunch snack. Next, add at least one vegetable to your dinner plate.

Be sneaky. Adding finely grated carrots or zucchini to pasta sauce, meat loaf, chili, or a stew is one way to get an extra serving of vegetables.

Try something new. It's easy to get tired of apples, bananas, and grapes. Try a kiwi, mango, fresh pineapple, or some of the more exotic choices now found in many grocery stores. The same goes for vegetables. You might find you love kale, leeks, or bok choy.

Blend in. A fruit smoothie (see "Simple fruit smoothie," page 42) is a delicious way to start the day or tide you over until dinner. You can add spinach to a fruit smoothie without sacrificing the sweet taste.

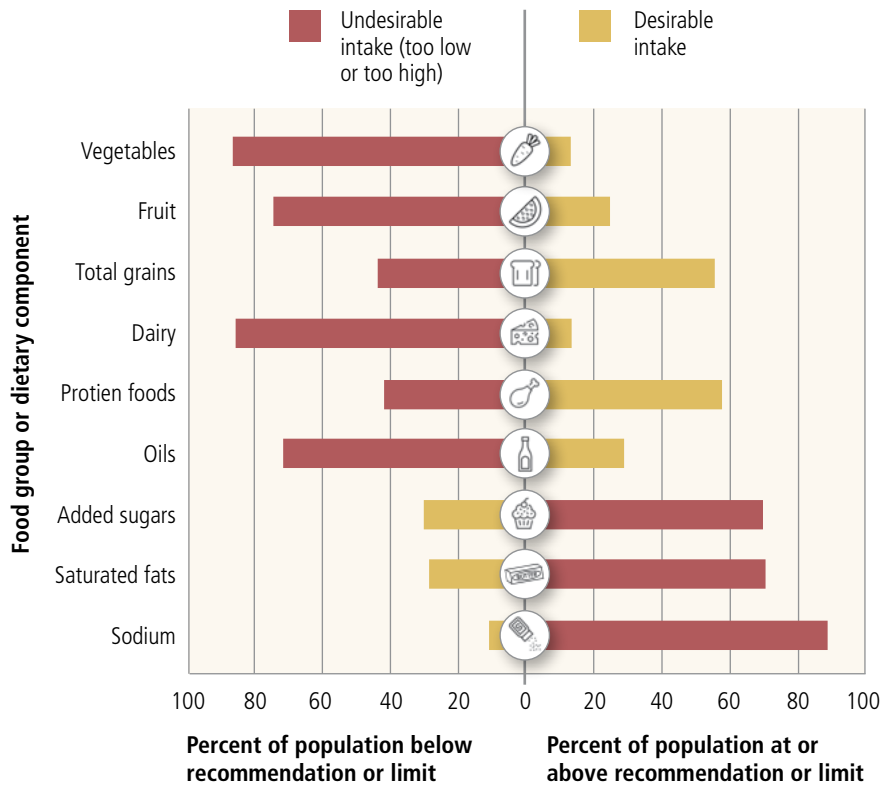
Be a big dipper. Try dipping vegetables into hummus or another bean spread, some spiced yogurt, a bit of ranch dressing, or mashed avocado mixed with diced tomatoes and onions. Dip fresh or dried fruit in melted dark chocolate.

Spread it on. Slather peanut butter on a banana or slices of apple. Try mashed avocado as a sandwich spread, topped with spinach leaves, tomatoes, and a slice of cheese.

Start off right. Ditch your morning doughnut for an omelet with onions, peppers, and mushrooms. Top it with some salsa to

Figure 6: A diet out of balance

In general, Americans tend to consume too many nutrient-poor foods, like sugary drinks and other sweets, and not enough foods that are rich in vitamins, minerals, and other nutrients.



Source: Dietary Guidelines for Americans, 2015–2020.

wake up your palate. Or boost your morning cereal or oatmeal with a handful of strawberries, blueberries, or dried fruit.

Drink up. Having a 6-ounce glass of low-sodium vegetable juice instead of a soda gives you a full serving of vegetables and spares you 10 teaspoons or more of sugar. You can also make your own vegetable juice with a blender or juicer.

Give them the heat treatment. Roasting vegetables is easy and brings out new flavors. Cut up onions, carrots, zucchini, asparagus, turnips—whatever you have on hand—coat with olive oil, add a dash of balsamic vinegar, and roast at 350° until done. Grilling is another way to bring out the taste of vegetables. Use roasted or grilled vegetables as a side dish, put them on sandwiches, or add them to salads.

Let someone else do the work. If peeling, cutting, and chopping are too time-consuming, food companies and grocers offer an ever-expanding selection of prepared produce, including ready-made salads, frozen stir-fry mixes, and take-along sliced apples and dip.

Grilling and roasting are two good ways to bring out the natural sweetness in vegeables, from peppers to onions. You can serve them as a side dish or on sandwiches.

Improve on nature. Don't hesitate to jazz up vegetables with spices, chopped nuts, balsamic vinegar, olive oil, or a specialty oil like walnut or sesame oil. Most grocers carry several spice blends made specifically for vegetables. Even a dash of grated Parmesan cheese can liven up the blandest green beans.

Decoding your diet

If you're really curious to know how your diet stacks up nutrition-wise, you have two options: hire a professional or do it yourself.

A registered dietitian can scrutinize your current diet and set up a plan that precisely meets your nutritional needs, taking into consideration your food preferences and allergies or other health issues (such as lactose intolerance or celiac disease). Dietitians have access to computer programs and databases that ease the most difficult calculations, such as nutrient analyses of menus. You can ask your clinician for a referral (check to see if your insurance covers the cost of nutritional counseling), or ask at a local hospital or medical center.

But if you have the time and the inclination to do the work yourself, there are free online tools and calculators that can help. Here are some questions you'll need to ask and some of the websites where you can find the answers.

How many calories do I need?

It depends on your age, height, weight, and activity level. You can get a rough estimate of how many calories you need each day

Simple fruit smoothie

Makes: 1 serving

This is a great way to use bananas that are beginning to get too ripe. (You can always cut ripe bananas into thick slices, freeze in a plastic bag, and thaw when you're ready to make another smoothie.)

- ¾ cup plain yogurt or kefir
- ½ ripe banana
- ½ cup pineapple juice
- ½ cup berries (fresh or frozen strawberries, blueberries, or other berry of your choice)

Optional: 1 tablespoon ground flaxseed (for healthy omega-3 fats).

Put all ingredients in a blender or food processor and blend to combine. You can branch out by adding a dash of ground cinnamon, a splash of vanilla, some mint, or another flavoring.

to maintain your weight simply by multiplying your weight by a value ranging from 11 to 15, depending on whether you are short or tall, sedentary or active, and so forth. For a more precise figure, try the calculator at Calculator.net (www.calculator.net/calorie-calculator.html).

What should I eat?

For a list of nutrient-dense foods to try to incorporate into your diet, go to the Aggregate Nutrient Density Index (ANDI), which you can find at www.health.harvard.edu/ANDI). It ranks foods according to the amount of micronutrients they contain—vitamins, minerals, and bioactives—per calorie. It was created by Dr. Joel Fuhrman, who devised the concept of the "nutritarian" (micronutrient-rich) diet. Because the ANDI score balances nutrient density against caloric density, some healthy but higher-calorie foods end up with lower rankings than you might have anticipated.

How do I know if my diet provides what I need?

To look up the nutrient content of specific foods—or to find out which foods contain specific nutrients—go to the USDA's FoodData Central database at https://fdc.nal.usda.gov. You can also research the nutrient content of various foods using the Nutrition Facts section of the consumer website for Blue Cross and Blue Shield of Massachusetts (www.ahealthyme.com/Library/NutritionFacts). Another good source of information on the nutrients in specific foods (including brand-name and fast-food items) is Calorie King (www.calorieking.com). Entering everything you eat can be cumbersome, but if you try it for just a few days, you'll learn a lot about food quality and how to get the best nutritional return on the calories you consume.

There are several ways to approach healthy eating. One is to analyze the nutrient content of everything you eat. The other is simply to eat a produce-rich diet.

Alternatively, you can take a more relaxed approach—not worrying too much about the details and focusing instead on the big picture: eating a balanced diet that is packed with nutrient-dense foods.

Putting it into practice

Sometimes it seems that you can't possibly meet all your daily requirements for vitamins and minerals from food without vastly increasing the amount of food (and calories) you consume. Rest assured, you can. The single most important step you can take to meet your goal is simply to increase your intake of fruits and vegetables. If you look at "A typical diet vs. a nutrient-dense diet" on page 44, you'll see how one dietitian managed to make over the diet of a 52-year-old woman, boosting her nutrient intake while actually reducing the woman's daily calorie intake.

Notice that this woman was initially consuming the recommended daily amounts for only about half the vitamins and minerals (nine out of 20). That's because her diet included less than half of the recommended servings of vegetables and no fruit at all. But once she switched to the nutrient-dense diet, which is rich in vegetables, fruits, and lean protein, she began meeting all but one of her nutrient goals, including 1,200 mg of calcium a day, thanks to foods such as nonfat dairy products and bok choy (Chinese cabbage).

A typical diet vs. a nutrient-dense diet

If you want to meet your vitamin and mineral requirements through diet rather than supplements—by far the best way to do it—your best bet is to adopt a nutrient-dense diet. But for someone who hasn't already been eating this way, it might not be obvious how to do that. The two menus below show how one 52-year-old woman managed the shift, with the help of clinical dietitian Ellen di Bonaventura at Harvard-affiliated Massachusetts General Hospital in Boston.

The "typical day's menu" shows the kind of regimen the woman was following before consulting di Bonaventura. The "nutrient-dense menu" shows an example of a day's intake after she overhauled her eating to include more produce. Note that she boosted her nutrients into the recommended range without relying on fortified food products or supplements. At the same time, she slashed calories from roughly 2,000 a day to just under 1,200—a level often recommended for female dieters.

A typical day's menu

Breakfast
1 whole-wheat bagel
2 tablespoons light cream cheese
10 ounces coffee
2 ounces skim milk
6 ounces nonfat strawberry yogurt

Lunch
2 slices oatmeal bread
1 tablespoon light mayonnaise
4 ounces tuna, canned in water
1 ounce chips
12 ounces diet cola

Snack
1 oat-and-honey granola bar
6 ounces black tea with 1 teaspoon milk and ½ teaspoon sugar

Menu provides 1,959 calories:
32% from fat
43% from carbohydrate
20% from protein
5% from alcohol

Dinner
5 ounces grilled chicken marinated in 2 tablespoons Italian dressing
½ cup white rice
1 tablespoon margarine
1 cup broccoli florets
5 ounces white wine

Dessert
½ ounce dark chocolate

Nutrient analysis of this menu

The amounts of vitamins and minerals this woman consumed through her diet are shown below, next to the recommended daily amounts in parentheses. Bold type denotes success in meeting or exceeding the RDA.

Vitamin A, 529 mcg (700 mcg)	**Vitamin K, 137 mcg (90 mcg)**
Thiamin, 1.5 mg (1.1 mg)	Calcium, 477 mg (1,200 mg)
Riboflavin, 1.8 mg (1.1 mg)	Copper, 881 mcg (900 mcg)
Niacin, 52 mg (14 mg)	**Iron, 13 mg (8 mg)**
Pantothenic acid, 4.6 mg (5 mg)	Magnesium, 268 mg (320 mg)
Vitamin B_6, 1.3 mg (1.5 mg)	**Manganese, 5.1 mg (1.8 mg)**
Vitamin B_9, 379 mcg DFE (400 mcg DFE)	**Phosphorus, 1,148 mg (700 mg)**
Vitamin B_{12}, 4.0 mcg (2.4 mcg)	Potassium, 2,000 mg (4,700 mg)
Vitamin C, 44 mg (75 mg)	**Selenium, 179 mcg (55 mcg)**
Vitamin D, 280 IU (600 IU)	Zinc, 7.2 mg (8 mg)

A nutrient-dense menu

Breakfast
8 ounces nonfat yogurt
½ cup sliced papaya
½ cup sliced kiwi
1 ounce (14 halves) walnuts
8 ounces black coffee
4 ounces skim milk

Lunch
1 small whole-wheat pita
Green salad (1 cup dark green lettuce, 1 red or orange pepper, 1 cup grape tomatoes, ½ cup edamame beans, 1 tablespoon unsalted sunflower seeds)
Salad dressing (1 tablespoon olive oil plus balsamic vinegar and pepper)
Unsweetened iced tea or water

Menu provides 1,155 calories:
33% from fat
40% from carbohydrate
27% from protein

Dinner
4 ounces broiled wild salmon and yogurt sauce (1 tablespoon Greek nonfat yogurt, 1 teaspoon lemon juice, 1 clove chopped garlic)
¼ cup cooked barley
¼ cup cooked lentils with spices to taste
1 cup steamed baby bok choy
Water

Nutrient analysis of this menu

The amounts of vitamins and minerals this woman consumed through her new diet are shown below, next to the recommended daily amounts in parentheses. Note that there is now only one nutrient shortfall—vitamin D, which can be hard to obtain through food.

You may not want such a calorie-restricted diet. For example, you might want to add healthy snacks of fruit or a handful of nuts. The point is that you can boost your nutrient intakes even while you're reducing your calories.

Vitamin A, 1,031 mcg (700 mcg)	**Vitamin K, 156 mcg (90 mcg)**
Thiamin, 1.3 mg (1.1 mg)	**Calcium, 1,222 mg (1,200 mg)**
Riboflavin, 1.8 mg (1.1 mg)	**Copper, 900 mcg (900 mcg)**
Niacin, 14 mg (14 mg)	**Iron, 11 mg (8 mg)**
Pantothenic acid, 5.5 mg (5 mg)	**Magnesium, 355 mg (320 mg)**
Vitamin B_6, 2.23 mg (1.5 mg)	**Manganese, 2.8 mg (1.8 mg)**
Vitamin B_9, 556 mcg DFE (400 mcg DFE)	**Phosphorus, 1,530 mg (700 mg)**
Vitamin B_{12}, 10.6 mcg (2.4 mcg)	**Potassium, 4,700 mg (4,700 mg)**
Vitamin C, 383 mg (75 mg)	**Selenium, 90 mcg (55 mcg)**
Vitamin D, 480 IU (600 IU)	**Zinc, 8.6 mg (8 mg)**

Getting too little

Serious deficiencies of most essential vitamins and minerals are relatively rare in the United States. More often, people get enough to avoid overt deficiency diseases such as scurvy or rickets, but because of nutrient-poor diets, they get too little of some nutrients to help ward off chronic health problems, such as osteoporosis, cardiovascular disease, and some types of cancer. How can you tell if you could be compromising your health by not getting enough? While definitive proof is hard to come by, there are certain clues.

Age

According to the Framingham Heart Study, 30% of people ages 67 and over lack adequate vitamin B_9, 20% do not get sufficient vitamin B_6, and 20% to 25% do not get enough B_{12}. The Baltimore Longitudinal Study on Aging found that most older men and women are deficient in calcium, zinc, iron, magnesium, and vitamin D. Malabsorption, poor diet, or other causes may underpin this pervasive problem. A lack of stomach acid—which often occurs among the elderly—makes it hard to absorb calcium and vitamin B_{12} from food.

Sex

Women who menstruate need more iron than do men, postmenopausal women, and women who've had a hysterectomy. Because most of the body's iron circulates in the blood as part of hemoglobin, menstruating girls and women lose substantial amounts of iron during their monthly periods, which is why iron deficiency is a common problem for women of childbearing age. For women ages 31 to 50, the recommended daily amount of iron is 18 mg. For adult men of any age and for women starting at age 50 (or whenever menstruation ends), 8 mg a day is enough.

Any woman who might get pregnant also needs extra vitamin B_9 (folate, folic acid). During the first three weeks of pregnancy, vitamin B_9 is crucial to preventing birth defects of the brain and spine. Some research suggests that the daily dose for women of childbearing age should be 800 mcg DFE, not the 400 mcg DFE currently in most multivitamins. Combining a healthy diet with a multivitamin should provide you with about 700 to 800 mcg DFE a day. Most prenatal multivitamin and mineral supplements in the United States contain 800 to 1,000 mcg of folic acid.

Medical conditions

Some digestive diseases can block absorption of vitamin B_{12}. Cystic fibrosis, chronic liver disease, and short-bowel syndrome can impair the absorption of fat-soluble vitamins, such as vitamin E. Liver disease, kidney disease, or absorption problems can trigger a deficiency of vitamin K, which is necessary for blood clotting and may help keep bones healthy. Celiac disease, inflammatory bowel disease, and other conditions that affect the small intestine can interfere with vitamin D absorption. In addition, medications can interfere with the absorption of some vitamins and minerals (see "Medications and micronutrients," page 46).

Genes

People lacking a particular gene variant have a less-active form of an enzyme that helps the body use vitamin B_9 (folate, folic acid) and consequently have a higher risk for colorectal cancer if they take in too little of this vitamin. Other genetic abnormalities hamper the body's ability to make and use vitamin D, thus increasing the risk for bone fractures.

Vegetarian and vegan diets

Unlike other vitamins, B_{12} is almost exclusively found in animal products (eggs, milk, fish, poultry, and meat). Vegans are at heightened risk for B_{12} deficiency, which can inflict neurological damage and contribute to heart disease. Taking a multivitamin will solve the problem. Vegetarians who aren't quite so strict—who avoid meat but eat milk and eggs—can get their B_{12}

that way. People who follow a plant-based diet should also eat plenty of deep-hued vegetables and fruits, to ensure that they get enough essential vitamins and minerals, along with other healthful compounds.

Alcohol consumption

Heavy drinking (at least several drinks per day) is known to cause vitamin B_9 (folate, folic acid) deficiency. It can also contribute to deficiencies of vitamin A, thiamin, vitamin D, magnesium, calcium, and potassium. And tissue studies show it may increase the need for niacin, vitamin C, and sometimes zinc.

Even moderate drinking—no more than one drink per day for women and two for men—may pose a problem. Women in the Nurses' Health Study who drank moderate amounts of alcohol and also took in relatively low amounts of vitamin B_9 (folate, folic acid) from their diets had a higher risk for breast cancer compared with women who had higher intakes. The same pattern—moderate alcohol plus a low intake of vitamin B_9—has been linked to colon and pancreatic cancers, too. Experts advise even moderate drinkers to step up their vitamin B_9 intake—for example, by taking a regular multivitamin that contains folic acid.

Alcohol lacks vitamins and minerals while delivering "empty" calories. And although the media have brought attention to the potential health benefits of the bioactive compounds in red wine and other alcoholic beverages, the promise is far greater than the actual findings from research conducted to date.

A systematic analysis of the worldwide burden of alcohol use published in 2018 in *The Lancet* provides additional evidence that alcohol should be kept to a minimum: it found that alcohol use may increase the risk of various cancers and overall death rates, and this risk increases as consumption rises. The only level of alcohol intake that was not associated with health risks was zero consumption. The American Cancer Society now says "it's best not to drink alcohol," or, if you do, to stick to a limit of no more than one drink per day for women and two drinks per day for men.

Blood loss

When you lose blood, you lose iron, too. Women who menstruate need extra iron (see "Sex," page 45). So do frequent blood donors—an estimated 3 to 4 mg more per day for each unit of blood you donate during the course of a year.

Medications and micronutrients

Some medications can interfere with the absorption of certain nutrients or speed their excretion from the body. You're more likely to suffer from nutrient depletion and worrisome interactions if you take several medications, regularly drink alcohol, eat poorly, or have health problems that increase your need for certain nutrients.

It's also true that certain nutrients in food and supplements can interfere with the medications you take. Prime examples are calcium and iron, which bind to the antibiotic tetracycline so that both the nutrients and the drug simply pass through the body in an unusable form. Megadoses of vitamin C can acidify your urine, which curbs the excretion of acidic drugs, such as aspirin. That means the aspirin will stay in your body longer than usual.

Generally, when you begin using a medication, your pharmacist should warn you about any foods to avoid. But you should never take a dietary supplement without finding out whether it might interfere or interact with the medications you take. Ask your pharmacist or doctor—not the clerk at a health-food store—for this information. It helps to buy all your prescription drugs and supplements at one pharmacy, especially if the store maintains computerized customer records to track possible drug interactions.

The following classes of medications may cause nutrient depletion and, possibly, nutritional deficiencies. (If you take any of these medicines, ask your doctor whether you should adjust your intake of any vitamins or minerals. Generally, occasional use will not matter, but long-term use can make a difference.)

- antacids
- antibacterial agents
- antibiotics
- anticancer drugs
- anticoagulants
- anticonvulsants
- antidepressants
- antifungal agents
- anti-inflammatory agents
- antimalarials
- anti-ulcer drugs
- cholesterol-lowering medications
- contraceptives
- corticosteroids
- diabetes medications
- diuretics
- laxatives
- tranquilizers.

Getting too much

While getting too little of essential micronutrients can harm your health over the long haul, getting too much can have equally worrisome effects, many of which show up more swiftly. Most concerning are excesses of fat-soluble vitamins from supplements, which the body may stockpile to the point of toxicity. The ones most likely to cause harm are vitamins A, E, and K, as explained in this chapter. (D is also fat-soluble, but excesses don't tend to cause problems.)

High amounts of nutrients from supplements—usually from taking individual vitamin and mineral supplements in addition to a powerful multivitamin—are often at fault. It's much harder to get dangerous amounts of micronutrients from food, partly because of the body's natural checks and balances. When iron stores are full, for example, your body absorbs less iron from food unless a genetic disorder or other problem interferes. Your body also slows the conversion of beta carotene to vitamin A when it already has enough vitamin A from supplements or food sources. But it is still possible to overdo it.

Many consumers are spurred to take excessive supplement doses by overenthusiastic news stories on the potential benefits of certain vitamins and minerals. Remember, though, that the good news from the latest study may be refuted by other studies. Promising test-tube and animal studies often don't pan out in people. And certain types of human studies offer more definitive information than others. Sometimes, exciting results from initial observational studies aren't confirmed by randomized controlled trials, which are considered the gold standard of research. And even these studies often have their limitations.

It's hard to get too much of the essential micronutrients from food, but very easy to get too much through supplements. Stick to the RDA unless you have specific advice from your doctor or dietitian.

The bottom line is clear: Don't take more than the recommended dose of any micronutrient through supplements unless there is a good reason to do so, such as specific advice from your doctor, dietitian, or other qualified health professional. It is especially important to avoid taking too much of the following vitamins and minerals.

Vitamin A

It can be easy to ingest 10,000 IU (3,000 mcg) of vitamin A—more than three times the amount recommended for men and four times the amount recommended for women—if you eat a lot of fortified cereal in addition to taking a multivitamin containing retinol or retinyl compounds every day.

Plenty of research shows that too much vitamin A can reduce bone density, possibly leading to osteoporosis or hip fractures. Excess vitamin A can have other effects as well. For example, a person suffering from vitamin A "intoxication" can experience seizures, headaches, and blurred vision. Birth defects occur more often when pregnant women take more than 10,000 IU of supplemental vitamin A. To protect yourself, get most or all of your supplemental vitamin A in the form of beta carotene, and try to stick to the RDA for vitamin A.

Vitamin E

Despite considerable and consistent evidence from clinical trials showing that vitamin E supplements don't help and may

even be harmful (see "Vitamin E," page 26), some people still take these supplements. If you take more than 1,200 IU (800 mg) per day, you risk side effects such as bleeding, headache, fatigue, and blurred vision. Two clinical trials have also found evidence that high intakes of vitamin E from supplements may raise the risk for hemorrhagic (bleeding) strokes. To be on the safe side, talk with your doctor before taking more than the RDA for vitamin E to avoid increasing your risk of bleeding, especially if you also take the blood thinner warfarin (Coumadin).

Vitamin K

Because vitamin K can influence blood clotting, if you take warfarin it's important to keep your vitamin K intake consistent from day to day. Discuss this with your doctor if you are taking this medication.

Calcium (for men)

Some large observational studies and clinical trials have linked calcium supplement use to a higher risk of cardiovascular disease, although others found no such association. In 2016, an expert panel convened by the American Society for Preventive Cardiology and the National Osteoporosis Foundation concluded that getting calcium from foods or supplements, with or without vitamin D, neither increases nor decreases the risk for cardiovascular problems, based on moderate-quality evidence.

Some observational studies have linked a high intake of calcium (from foods as well as supplements) to increased risk of prostate cancer, though others have tried and failed to find such a connection. In some—but not all—studies, higher calcium intake was associated with greater risk for more aggressive, more advanced, or more lethal forms of prostate cancer.

As there are many food sources of calcium available, men should avoid getting excessive calcium through supplements unless there are concerns about insufficient intake—which would warrant a discussion with a physician or a nutritionist.

Iron

Hemochromatosis is the medical term for too much iron in the body. A common genetic glitch called hereditary hemochromatosis leaves about 1.5 million Americans prone to a glut of iron, although not automatically doomed to it. Large amounts of iron supplements, multiple blood transfusions, drinking too much alcohol, and some rare metabolic disorders can also trigger an iron overload, which can damage body tissues and raise risks for infection, heart disease, liver cancer, and arthritis over time.

In addition, taking large quantities of vitamin C from supplements allows your body to absorb more iron than it normally would accept and to release more stored iron than necessary. This causes an upswing in free iron, which attacks DNA, cell lipids, and protein. Free iron also rises when abnormally high levels of iron accumulate in the body for other reasons.

Excess iron is not easily shed. More men than women suffer from an overabundance of iron; in fact, men are twice as likely to have iron overload than iron deficiency.

The tolerable upper intake level for iron is 45 mg a day. A child can die from poisoning after taking as few as five pills that each contain 200 mg of iron. Any supplements that contain iron—especially chewable children's multivitamins that look like candy—should be stored well away from children.

Zinc

Getting enough—but not too much—of the trace mineral zinc is a bit of a balancing act. The RDA for zinc is 8 mg for women and 11 mg for men, and the upper limit for all adults is 40 mg. Because taking large amounts of zinc for an extended period can have harmful effects, it's best to get your zinc from food, not supplements.

Your overall diet affects how much zinc your body typically absorbs from food. Interestingly, you are likely to absorb less zinc if you choose a diet rich in healthy whole grains and with very little animal protein.

So, should you take supplements?

In the 1980s, many nutritionists and some physicians began to recommend (and take) vitamin supplements. However, as described earlier in this report, the evidence for the health benefits of most supplements is not strong. And taking individual supplements is not generally advised unless your clinician or a dietitian recommends it. Notable exceptions are vitamin D for bone health and folic acid during pregnancy, and older Americans and vegans should also consider a B_{12} supplement. Although foods that contain vitamin A and beta carotene, as well as vitamins B, C, and E, are clearly good for health, taking supplements of these vitamins has no proven health benefits.

What about a simple multivitamin-multimineral supplement—a product that is designed to meet the RDAs and to compensate for dietary shortfalls? "Multis" are the most popular among all dietary supplements—half of Americans take them on a regular basis, shelling out more than $20 billion annually on these products. On an individual basis, a daily multivitamin won't set you back that much: a year's supply of many popular brands costs about $30 to $50.

However, the composition of these tablets varies widely, with some containing all of the essential vitamins and minerals, and some containing just a few of them. And despite the widespread belief that multivitamin-multimineral supplements will prevent chronic diseases such as cancer and heart disease, the U.S. Preventive Services Task Force has concluded that there isn't enough evidence to support such claims.

In the first large-scale, long-term randomized controlled trial that tested the effects of a regular multivitamin—the Physicians' Health Study II, which involved 14,641 male doctors—men who took a daily multi for over a decade had *no less* risk of having a heart attack or stroke or dying of cardiovascular disease than those who did not take one. However, they did have an 8% reduction in cancer and a 9% reduction in the development of cataracts.

Observational studies have shown no consistent benefits to taking multis for major clinical outcomes such as cardiovascular disease and cancer. For example, in the Nurses' Health Study—a prospective, 32-year observational trial of 86,142 women—the use of multis was not found to reduce the incidence of stroke or death, even in women with a poor-quality diet—the very women who should gain the most from taking supplements. And a 2018 systematic review and meta-analysis of 179 studies found no proof that multivitamin-multimineral supplements prevent or treat cardiovascular disease.

The upshot of this is that we need more high-quality, large-scale research to carefully evaluate any potential benefits and risks of multivitamin-multimineral supplements. The most recent example is the Cocoa Supplement and Multivitamin Outcomes Study (COSMOS). In a 3.6-year randomized controlled trial, researchers at Harvard Medical School and the Fred Hutchinson Cancer Center in Seattle recruited 12,666 women ages 65 and older and 8,776 men 60 and older. The study was designed to find out whether taking cocoa extract supplements (500 mg per day of cocoa flavanols) or a common multivitamin reduces the risk for heart disease,

When choosing a mutlivitamin, look for one with 100% of the DV for vitamin D, vitamin B_{12}, and folic acid. Higher amounts of other vitamins may do more harm than good.

stroke, cancer, and other important age-related health problems. In COSMOS, the cocoa flavanols reduced total cardiovascular disease by 10% (however, this was not statistically significant). Of note, cocoa flavanols reduced deaths from cardiovascular disease by 27%. On the other hand, the cocoa supplementation had no effect on invasive cancer. The multivitamin, in contrast, had no overall effect on either cardiovascular disease or cancer, but did raise blood levels of important nutrients such as vitamin D and several B vitamins.

The good news is that of all vitamin or mineral supplements you could take, a standard multivitamin-multimineral supplement has the fewest potential downsides and the most potential benefits for your health. In addition, taking one is already part of some official recommendations. The federal government's Dietary Guidelines for Americans suggest that people over age 50 consider a vitamin B_{12} supplement or a multi as a way to ensure adequate vitamin B_{12} intake. And the CDC advises all women of childbearing age to take folic acid—typically included in a multi—because doing so lowers the risk of birth defects (see "Vitamin B_9," page 19).

When choosing a multi, look for an inexpensive preparation from a mainstream manufacturer to ensure quality and consistency. It should contain 100% of the DV for vitamin D, vitamin B_6, vitamin B_{12}, and folic acid. Extra vitamin D is unlikely to be harmful—as noted earlier, many experts recommend 1,000 IU, which is well above the DV, and is now found in many formulations. But extra amounts of other vitamins may do more harm than good.

What about supplements aimed at women, men, and seniors? While some of these formulas may be helpful in certain cases, others are merely marketing gimmicks designed to enhance profits rather than your health. Products vary widely; read the labels to make sure you get what you need while staying within safe limits for your age and sex.

Don't waste your money on high-potency, "all natural," or designer vitamins that tend to be more expensive and less rigorously tested for safety. Above all, remember that your daily multi is not a substitute for a healthy diet. It is, at best, an insurance policy covering shortfalls and may or may not provide long-term health benefits.

Know before you buy

Shopping for any kind of supplement can be confusing. A staggering array of multivitamins and other supplements crowd the shelves of pharmacies, grocery stores, and specialty stores, and many more are now available over the Internet. Before you buy, it's wise to realize that some of these products may offer much more—or possibly less—than you really need to enhance your health.

Dietary supplements may legally contain vitamins, minerals, herbs, amino acids, enzymes, organ tissues, and a few other substances—in short, practically any ingredient promoted as a way to bolster your diet and, presumably, your health. The FDA does not certify supplements for safety or effectiveness in the same way it monitors drugs. Under the Dietary Supplement Health and Education Act of 1994, the FDA does not have the authority to approve supplements or demand that manufacturers undertake rigorous studies to prove their worth. The FDA doesn't set potency or dosage standards, either.

Manufacturers are left to police themselves. And before a worrisome supplement can be pulled off the market, the FDA has to prove that it creates a significant health risk. This can lead to problems, as demonstrated by a report from ConsumerLab.com, an industry watchdog organization. The organization tested the quality and contents of 27 leading multivitamin and multimineral products sold in the United States and Canada. Almost half of the products did not receive the group's approval. Gummies had the lowest quality of all products tested, often containing far more or far less of listed nutrients than the label claimed. (Some variation in the amount of vitamins and minerals in a product is to be expected because supplements will slowly and naturally degrade over the course of their shelf life; pay attention to expiration dates on the packaging.) Moreover, some tablet products did not disintegrate quickly enough for all nutrients to be absorbed in the gut.

While supplement manufacturers can't legally claim to prevent, treat, or cure specific diseases, they can come pretty close. They are allowed to make "structure-function" claims that sound impressive to most consumers. A product may "build strong teeth"

or "improve memory" or "boost the immune system." Manufacturers can make these assertions without supplying a stitch of proof to any agency. Your cue for healthy skepticism should be the words printed alongside: "This statement has not been evaluated by the Food and Drug Administration."

Certain health claims backed by substantial scientific agreement and not limited to particular brands can appear on supplement bottles. For example, supplement manufacturers can advertise that "calcium helps protect against osteoporosis" and "folic acid may prevent neural tube defects in fetuses," because these statements are borne out by science and have been carefully evaluated (see "Understanding health claims on labels," below).

Advice on choosing a supplement

Buying supplements can raise many questions. Should you choose supplements derived from natural ingredients? Do brand-name supplements have any advantage over less expensive store brands? Are the health claims plausible? Are the suggested dosages safe? The following advice should help answer these questions and guide you as you make your choices.

Consider your particular nutrient needs. Start by checking the label of your multivitamin-multimineral supplement, looking at the recommended amounts listed in Tables 1 and 2 on pages 8 and 11, respectively, and assessing your diet (see "Decoding your diet," page 42). Are you getting too little vitamin D? Need extra calcium? Looking for lutein or other potentially beneficial phytochemicals? Your first line of defense should be through food. Rearrange your diet to include more sources of the nutrients you're lacking. For those nutrients that may be hard to get through food, such as vitamin D and calcium, consider buying separate supplements.

Look for a seal of approval. Choose products that bear the U.S. Pharmacopeia Dietary Supplement Verification Program (USP-DSVP) mark, which indicates that the supplement manufacturer has complied with certain standards. Supplements vetted by the USP-DSVP should contain the ingredients noted on the

Understanding health claims on labels

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Many foods, beverages, vitamin and mineral supplements, and other products tout impressive claims about their potential health benefits. Unlike prescription medications, which must go through a series of safety and efficacy trials before receiving FDA approval, foods and supplements do not routinely undergo the same level of scrutiny. Here are the four types of health claims they make—and what they actually mean.

Nutrient content claims describe the amount of a specific nutrient in a food product—for example, free of saturated fat, high in vitamin C, or low in sugar. However, just because a food is low in saturated fat, that does not stop it from having high levels of sugar, for example.

Structure and function claims describe how dietary components of a food product may affect structures or functions of the body. They tend to be general in nature. For instance, a food with antioxidants may maintain cell integrity, but how does that translate to your overall health?

Qualified health claims describe how particular foods or nutrients affect specific health outcomes and offer greater supportive evidence than structure and function claims. A food or supplement manufacturer must submit a petition to the FDA with sufficient research to support the approval of that qualified health claim. While a qualified health claim must be supported by *some* scientific evidence, it does not necessarily meet the higher standard for *significant* scientific agreement. As a result, qualified health claims must be accompanied by a disclaimer—for example, "Whole grains may reduce the risk of type 2 diabetes, although the FDA has concluded that there is very limited scientific evidence for this claim."

Authorized health claims are a step above qualified health claims and must have *significant* scientific agreement among qualified experts, with publicly available scientific evidence submitted to the FDA to back them up. These claims describe a relationship between a specific food, food component, or nutrient and a disease or health-related condition. For example, "Diets low in sodium may reduce the risk of high blood pressure, a disease associated with many factors."

label in the amounts and strengths stated. The product should dissolve within 30 to 45 minutes so that the nutrients enter your bloodstream, rather than passing through your body intact. It shouldn't contain more than allowable levels of contaminants. Other product safety organizations include ConsumerLab.com, which ranks herbs and supplements based on quality and content, and NSF International, a nonprofit organization that develops standards and certifies products related to public health, safety, and environmental protection.

The U.S. Pharmacopeia Dietary Supplement Verification Program (USP-DSVP) mark

Consider safe levels. Supplements vary widely in the amounts of nutrients they contain, so take a moment to read the label before deciding on a purchase. Much like packaged foods, which have a Nutrition Facts label, all dietary supplements have a Supplement Facts label that lists the DVs of nutrients in a single serving. It also notes the actual amount of each nutrient included. For trace minerals, such as iron, fluoride, and zinc, it's safest not to exceed the DV at all. Some experts even recommend getting these micronutrients only through food. If you take individual supplements (such as extra vitamin D tablets) as well as a multivitamin, be sure to total up the amounts you're getting from every source, including food. Fortified breakfast cereals can bump up your intake of vitamins and minerals considerably. A single serving of certain breakfast cereals can deliver as much as or more than your daily multivitamin. That may not be a problem with vitamin C, but it might pose health risks with iron or vitamin A.

Consider price. Compare active ingredients on the labels, then let price be your guide. Store brands spend less on advertising than nationally known brands and pass on the savings to the consumer.

Ignore marketing gimmicks. It doesn't matter whether vitamin C is derived from organic rose hips or synthesized in large batches in a laboratory; your body will use the resulting product similarly. In fact, your body absorbs certain micronutrients more efficiently in synthetic rather than natural forms. Vitamin K and folic acid are two examples. If you're not sensitive to specific ingredients, such as wheat, rice, or lactose, there's no need to pay more for allergen-free products. "High potency" isn't a plus in cases when more is not better.

Keep it simple! If you feel compelled to take a handful of supplements each day, consider the bigger picture of how to improve or fine-tune your overall diet. Meet with a nutritionist or start with your primary care provider for guidance. You might avoid the need for supplements all together.

Avoid gummy vitamins, unless you cannot swallow pills. Gummies typically contain fewer vitamins and minerals and in lower amounts than multivitamin tablets. Plus you have to take them twice a day, and they have more calories and added sugar.

Don't pay more for unproven extras. Generally, if you're hoping for phytochemical benefits, you'll do better in the produce department than the supplement aisle. There is virtually no evidence that herbs and other nonvitamin ingredients added to supplements are essential for your health. Supplements that list substances such as PABA (para-aminobenzoic acid) and ubiquinone (coenzyme Q_{10}) are trading on good press from research that shows them to be necessary for growth in bacteria or other life forms, rather than substantial evidence from studies in people.

Beware of potentially dangerous interactions. Pay attention to warnings on the label, and tell your doctor and pharmacist what supplements you take (see "Medications and micronutrients," page 46).

Report any serious ill effects. Let your doctor know about any side effects that you attribute to a supplement. He or she may pass along the information to FDA MedWatch, if appropriate. Or you can contact MedWatch directly at 800-FDA-1088 or through the website at www.fda.gov/safety/medwatch. Also inform the manufacturer or distributor and the store where you purchased it.

Resources

Organizations

Academy of Nutrition and Dietetics
120 S. Riverside Plaza, Suite 2000
Chicago, IL 60606
800-877-1600 (toll-free)
www.eatright.org

This national organization of food and nutrition professionals has an extensive consumer website offering information on health, food, and fitness. It includes consumer tips, nutrition fact sheets, and healthy recipes, along with information on how to get the vitamins and minerals you need through healthy food choices.

American Cancer Society (ACS)
3380 Chastain Meadows Parkway NW
Kennesaw, GA 30144
800-227-2345 (toll-free)
www.cancer.org

This website of this pre-eminent cancer organization offers a wealth of information on cancer risk, treatment, and research. Go to the "Stay Healthy" tab, then click on "Eat Healthy and Get Active" to find the ACS recommendations for healthy eating and exercise that can help reduce cancer risk.

American Heart Association (AHA)
7272 Greenville Ave.
Dallas, TX 75231
800-242-8721 (toll-free)
www.heart.org/en/healthy-living

Under the AHA website's "Healthy for Good" listing, you'll find a wealth of articles and quizzes on healthy eating at home and in restaurants, along with simple heart-healthy recipes.

ConsumerLab.com
333 Mamaroneck Ave.
White Plains, NY 10605
914-722-9149
https://www.consumerlab.com

If you're looking for comprehensive reviews of herbs and supplements, this subscription service offers sound advice with rankings and grades—sort of a *Consumer Reports* for supplements. It provides in-depth information about products, recalls, and warnings.

Food and Drug Administration (FDA)
10903 New Hampshire Ave.
Silver Spring, MD 20993
888-463-6332
www.fda.gov/food

The food section of the FDA's website is your go-to site for information on dietary supplements. The website and toll-free hotline offer information, including warnings and recalls, about dietary supplements and other products. You can also report problems with foods and supplements via the website.

National Academies of Sciences, Engineering, and Medicine
500 Fifth St. NW
Washington, DC 20001
202-334-2000
www.nationalacademies.org

This is the umbrella group that includes the Health and Medicine Division (formerly called the Institute of Medicine, or IOM), which oversees guidelines for nutrient intakes. You can purchase reports on a variety of nutrition topics or read them for free online.

National Center for Complementary and Integrative Health
9000 Rockville Pike
Bethesda, MD 20892
888-644-6226 (toll-free)
www.nccih.nih.gov

Part of the National Institutes of Health, this government agency is a great resource if you're looking for publications and research on dietary supplements, including herbal medicines. You can speak to an information specialist from 10:00 a.m. to 4 p.m. ET, Monday through Friday (except federal holidays), or request information by filling out the online comment form or sending an email to info@nccih.nih.gov.

U.S. Department of Health and Human Services
Office of Disease Prevention and Health Promotion
1101 Wootton Parkway, Suite 420
Rockville, MD 20852
https://health.gov

This consumer website from the U.S. Department of Health and Human Services offers information on various aspects of a healthy lifestyle. Go to "Food and Nutrition," then "Current Dietary Guidelines," for the most recent version of the Dietary Guidelines.

Publications

The following publications provide additional information about topics in this report. To order, call 877-649-9457 (toll-free), or go online to www.health.harvard.edu.

The Benefits of Probiotics
W. Allan Walker, M.D., Medical Editor
(Harvard Medical School, 2020)

This digital publication reviews the scientific evidence for probiotics. It catalogs the different strains and species and what they're helpful for, and explains ways to get more probiotics in your diet.

The Harvard Medical School 6-Week Plan for Healthy Eating
Teresa Fung, Sc.D., R.D., L.D.N., and Kathy McManus, M.S., R.D., L.D.N., Nutrition Editors
(Harvard Medical School, 2019)

Knowing what you ought to eat and actually doing it are two different things. This Special Health Report from Harvard Medical School walks you through a set of weekly changes that will help you transform your diet in healthy ways, one step at a time.

Healthy Eating: Strategies, tips, and recipes to help you make better food choices
Teresa Fung, Sc.D., R.D., L.D.N., Faculty Editor, and Sharon Palmer, R.D.N., Nutrition Editor
(Harvard Medical School, 2019)

This report explains how to choose the right foods for maximum health. It includes information on healthy snacking, meal planning, trimming salt, restaurant survival strategies, and finding hidden sources of sugar. Includes 23 recipes.

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Cognitive Fitness
COPD
Core Workout
Depression
Diabetes
Diabetes & Diet
Diet Review
Energy/Fatigue
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Foot Care
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