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Nutrition: Everyday Choices

How do you choose what to eat? For most of the world's population, the answer is simple: You eat what you can grow, raise, catch, kill, or purchase. Subsistence is the principal motivator of food consumption: If you don't eat, you die. Historically, the game or crops people could kill or cultivate successfully became staples of their diet. As food production became more sophisticated, a greater array of food choices became available. As people explored and migrated across continents, new foods were discovered: Corn became part of the diet of European settlers in North America, and the potato was brought to the Old World from the New. Today, in our global society, you may literally choose from the world's dinner table.

Biological, social, economic, ecological, and cultural factors as well as personal tastes affect what you choose from this plethora of foods. And what you choose affects how healthy you are. Because the nutrients in the foods you eat form and maintain the structure of your body, you really are what you eat. The challenge is to find a satisfying balance between what you like and what optimizes your health. The choice is yours.

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CHAPTER OUTLINE

1.1 Food Choices and Nutrient Intake

LEARNING OBJECTIVES

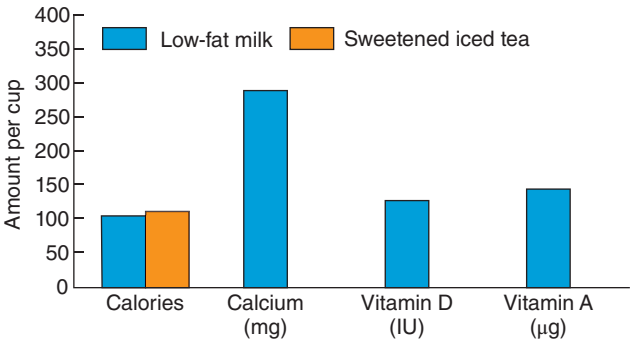
1. **Define** nutrient density.
2. **Compare** fortified foods with dietary supplements as sources of nutrients.
3. **Distinguish** essential nutrients from phytochemicals.
4. **Identify** factors in your food environment that influence your food choices.

What are you going to eat today? Will breakfast be a vegetable omelet or a bowl of sugar-coated cereal? How about lunch—a burger or a bean burrito? The foods we choose determine the **nutrients** we consume. To stay healthy, humans need more than 40 **essential nutrients**. Because the foods we eat vary from day to day, so do the amounts and types of nutrients and the number of **calories** we consume.

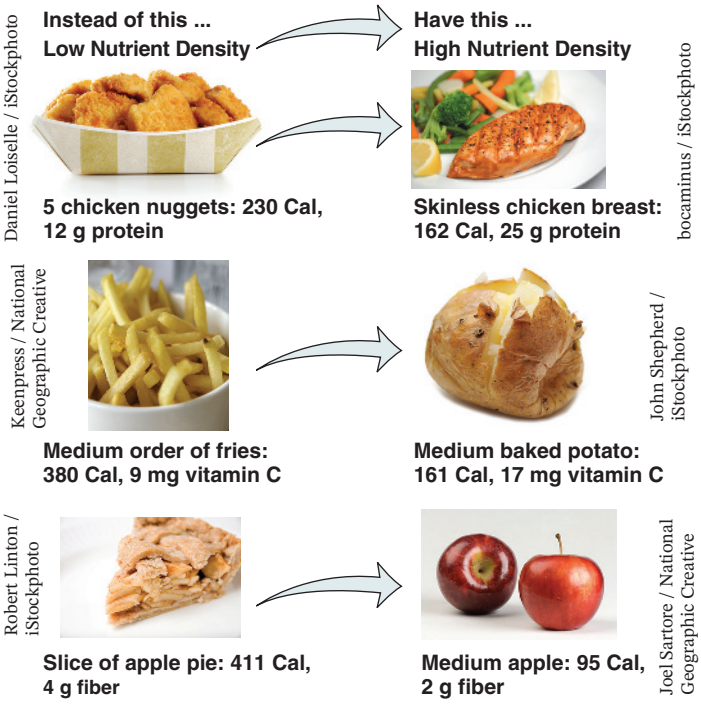
Nutrients from Foods, Fortified Foods, and Supplements

Any food you eat adds some nutrients to your diet, but to make your diet healthy, it is important to choose nutrient-dense foods. Foods with a high **nutrient density** contain more nutrients per calorie than do foods with a lower nutrient density. Foods low in nutrient density are often high in **empty calories**, which are calories that come with few nutrients (**Figure 1.1**).

FIGURE 1.1 Nutrient density Nutrient density is important in choosing a healthy diet. Nutrient-dense foods provide more nutrients in fewer calories.



a. An 8-ounce glass of low-fat milk provides you with about the same number of calories as 8 ounces of bottled iced tea, but the milk also provides calcium, vitamin D, vitamin A, and other nutrients, including protein. The calories in the iced tea are from added sugar.



b. Typically, less processed foods provide more nutrients per calorie. For example, a roasted chicken breast is more nutrient dense than chicken nuggets that are breaded and fried; a baked potato is more nutrient dense than French fries; and apples are more nutrient dense than apple pie.

nutrients Substances in food that provide energy and structure to the body and regulate body processes.

essential nutrient A nutrient that must be consumed in the diet because it cannot be made by the body or cannot be made in sufficient quantities to maintain body functions.

calorie A unit of heat used to express the amount of energy provided by food or expended by the body. We typically use the word "calorie" or "Calorie" to refer to the number of kilocalories; a kilocalorie is technically 1000 calories.

nutrient density A measure of the nutrients provided by a food relative to its calorie content.

Unhealthy fats and added sugars provide empty calories. If a large proportion of your diet consists of foods that are low in nutrient density and high in empty calories, such as soft drinks, chips, and candy, you could have a hard time meeting your nutrient needs without exceeding your calorie needs. By choosing nutrient-dense foods, you can meet all your nutrient needs and have calories left over for occasional treats that are lower in nutrients and higher in calories.

In addition to nutrients that occur naturally in foods, we obtain nutrients from fortified foods. The **fortification** of foods was begun to help eliminate nutrient deficiencies in the population, with the federal government mandating that certain nutrients be added to certain foods. Foods such as milk with added vitamin D, salt with added iodine, and grain products with added B vitamins and iron are examples of this mandated fortification that have been part of the U.S. food supply for decades. These fortification programs have helped prevent deficiency diseases caused by low intakes of vitamin D, iodine, niacin, and iron (**Figure 1.2**).

Discretionary fortification of foods is also now common practice (see Figure 1.2). Vitamins and minerals are routinely added to a variety of foods, including breakfast cereals and snack foods. The amounts and types of nutrients added to these voluntarily fortified foods are at the discretion of the manufacturer. These added nutrients contribute to the diet but are not necessarily designed to address deficiencies and may increase the likelihood of consuming an excess of some nutrients (see *Debate* in Chapter 7).

Dietary supplements are another source of nutrients, but they do not offer all the benefits of food (see Chapters 2 and 7). More than half of U.S. adults take some sort of daily dietary supplement to enhance their nutrient intake.[1] Most supplement use is based on personal preference; only 23% of supplements used are taken at the recommendation of a health professional.[2]

Food Provides More Than Nutrients

In addition to nutrients, food contains substances that, though not essential to life, can be beneficial for health. In plants,

FIGURE 1.2 Fortified foods Each of these foods is fortified. In some foods, like the rice and salt shown in the photo on the left, the nutrients are added to address deficiencies in the population's diet. Other foods have nutrients added to replicate those in a food they replace; for example, reduced-fat milk is fortified with vitamin A to replace the vitamin A that is lost when the fat is removed from whole milk. Some foods, such as those shown in the photo on the right, are fortified with nutrients chosen by the manufacturer as a marketing tool and are not necessarily healthy choices.

Mandated fortification

The fortification of salt with iodine in the 1920's helped eliminate iodine deficiency diseases as a public health problem.

The fortification of milk with vitamin D was begun in the 1930's to combat the vitamin D deficiency disease rickets. Vitamin A is added to low-fat milk because it is low in vitamin A and is used in place of vitamin A-rich whole milk.

Thiamin, riboflavin, niacin, and iron were first added to refined grain products in the 1940's to help prevent deficiencies, and folic acid was added in the 1990's to prevent neural tube defects.

John Ambrose

Discretionary fortification

The vitamins and minerals added to fortified cereals are often highlighted on the label and distract from the large amount of added sugar.

Nutrient-enhanced beverages are often advertised as "energy-enhancing" and "immune-supporting."

Fortified snacks often focus on nutrients that appeal to specific groups, such as athletes.

John Ambrose

fortification The addition of nutrients to foods.

FIGURE 1.3 Foods that are high in phytochemicals[3,4] Fruits, vegetables, and whole grains provide a variety of phytochemicals, such as those highlighted here. Supplements of individual phytochemicals are available, but these supplements do not provide the combinations of nutrients and phytochemicals provided by a diet rich in plant foods.

Todd Gipstein / National Geographic Creative

these health-promoting substances are called **phytochemicals** (**Figure 1.3**). Although fewer such substances have been identified in animal foods, animal foods also contain substances with health-promoting properties. These are called **zoochemicals**.

Some foods, because of the complex mixtures of nutrients and other chemicals they contain, provide health benefits that extend beyond basic nutrition. Such foods have been termed **functional foods**. The simplest functional foods are unmodified whole foods, such as broccoli and fish, that naturally contain substances that promote health and protect against disease. However, some foods fortified with nutrients or enhanced with phytochemicals or other substances are also classified as functional foods, for example oatmeal with added soy protein, and orange juice with added calcium (**Table 1.1**).[6] Functional foods are also called *nutraceuticals*,

TABLE 1.1 Functional foods provide benefits beyond their nutrients[5]

Food	Potential health benefit
Fruits and vegetables	May reduce the risk of heart disease and various cancers.
Breakfast cereal with added flaxseed	Helps reduce blood cholesterol levels and the overall risk of heart disease and may reduce the risk of certain cancers.
Yogurt (fermented dairy)	May reduce the risk of certain cancers and help control diarrhea.
Garlic	Helps reduce cancer risk and lowers blood cholesterol levels and the overall risk of heart disease.
Oatmeal	Helps reduce blood cholesterol and the risk of heart disease.
Orange juice with added calcium	Helps prevent osteoporosis.
Salmon	Reduces the risk of heart disease.
Green tea	May reduce the risk of certain types of cancer.
Soybeans	May reduce blood cholesterol and heart disease, alleviate menopause symptoms, and reduce the risk of osteoporosis.

phytochemical A substance found in plant foods that is not an essential nutrient but may have health-promoting properties.

functional food A food that has health-promoting properties beyond basic nutritional functions.

from "nutrition" and "pharmaceutical." The terms *functional food* and *nutraceutical* are not defined by the FDA, and therefore their usage varies.

What Determines Food Choices?

Do you eat oranges to boost your vitamin C intake or ice cream to add a little calcium to your diet? Probably not. We need these nutrients to survive, but we generally choose foods for reasons other than the nutrients they contain.

The factors around us that influence what we choose to eat are referred to as our **food environment**. This includes the environmental, sociocultural, and economic factors that affect eating habits and patterns (**Figure 1.4**). It involves factors such as access to grocery stores and restaurants, availability of products and pricing of food in those stores and restaurants, and the acceptability of those foods based on

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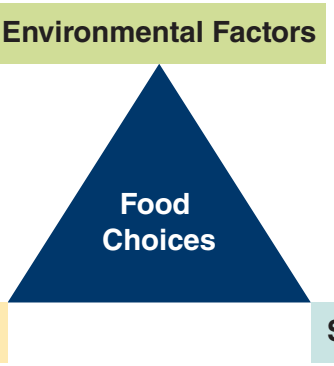
FIGURE 1.4 Our food environment affects what we eat. As seen in these examples, food environment is influenced by our surroundings, as well as by economic and sociocultural factors.

Richard Levine / Alamy Stock Photo

Living in a food desert, where your only convenient shopping option is a small corner market, makes it difficult to choose a varied diet that includes recommended amounts of fresh fruits and vegetables.



Economics affect which foods are available to us. Poverty limits food choices to what is affordable and what is available at food assistance programs or food banks.

In many parts of the world, insects, such as these cicadas and grasshoppers, are considered a treat. But in American culture, insects are considered food contaminants, and most people would refuse to eat them. Food preferences and eating habits learned as part of our familial, cultural, national, and social background are part of our food environment.

SDI Productions / E+ / Getty Images

Kevin Foy / Alamy Stock Photo

food environment The physical, economic, and social factors that affect eating habits and patterns.

our family and cultural traditions. What we choose to eat is also influenced by what we are enticed to eat. Across much of America, fast-food restaurants dominate the landscape, and advertisements for these foods bombard us in the media. The availability, affordability, and familiarity of fast food results in increased consumption.

Food environment can also reduce the consumption of healthy foods. For example, in many inner city and rural areas, supermarkets are scarce, so food choices are limited. An area with limited access to affordable fruits, vegetables, and other foods that make up a healthy diet is referred to as a **food desert** (see Figure 1.4). Farmer's markets improve the food environment by increasing access to fresh locally grown produce.

Food environment also involves social interactions and family and cultural traditions; if we were never exposed to a food as a child, it would not be part of our food environment, and we might be less likely to choose it as an adult (see Figure 1.4). The foods we desire when we are sick, cold, tired, depressed, or lonely depend on what we learned to eat from our family, culture, and friends. What we choose to eat is also affected by our personal convictions, such as environmental consciousness or vegetarianism, as well as our personal preferences for taste, smell, appearance, and texture.

Concept Check

1. **Which** has a higher nutrient density: sugar-sweetened soda or low-fat milk?
2. **Why** are foods fortified?
3. **Why** is it better to meet your vitamin C needs by eating an orange than by taking a dietary supplement?
4. **What** factors determine what you will eat for lunch?

1.2 Nutrients and Their Functions

LEARNING OBJECTIVES

1. **List** the six classes of nutrients.
2. **Discuss** the three functions of nutrients in the body.

There are six classes of nutrients: carbohydrates, lipids, proteins, water, vitamins, and minerals. Carbohydrates, lipids, proteins, and water are considered **macronutrients** because they are needed in large amounts. Vitamins and minerals are referred to as **micronutrients** because they are needed in small amounts. Together, the macronutrients and micronutrients in our diet provide us with energy, contribute to the structure of our bodies, and regulate the biological processes that go on inside us. Each nutrient provides one or more of these functions, but all nutrients together are needed to provide for growth, maintain and repair the body, and support reproduction.

The Six Classes of Nutrients

Carbohydrates, lipids (commonly called fats), and proteins are all **organic compounds** that provide energy to the body. Although we tend to think of each of them as a single nutrient, there are actually many different types of molecules in each of these classes. **Carbohydrates** include starches, sugars, and **fiber** (**Figure 1.5a**). Several types of **lipids** play important roles in our diet and in our health (**Figure 1.5b**). The most recognizable of these are **cholesterol**, **saturated fats**, and **unsaturated fats**. There are thousands of different **proteins** in our bodies and our diets. All proteins are made up of units

organic compound A substance that contains carbon bonded to hydrogen.

carbohydrates A class of nutrients that includes sugars, starches, and fibers. Chemically, they all contain carbon, along with hydrogen and oxygen, in the same proportions as in water (H_2O).

fiber A type of carbohydrate that cannot be broken down by human digestive enzymes.

lipids A class of nutrients, commonly called fats, that includes saturated and unsaturated fats and cholesterol; most do not dissolve in water.

cholesterol A type of lipid that is found in the diet and in the body. High blood levels increase the risk of heart disease.

saturated fat A type of lipid that is most abundant in solid animal fats and is associated with an increased risk of heart disease.

unsaturated fat A type of lipid that is most abundant in plant oils and is associated with a reduced risk of heart disease.

protein A class of nutrients that includes molecules made up of one or more intertwining chains of amino acids.

called **amino acids** that are linked together in different combinations to form different proteins (**Figure 1.5c**).

Water, unlike the other classes of nutrients, is only a single substance. Water makes up about 60% of an adult's body weight. Because we can't store water, the water the body loses must constantly be replaced by water obtained from the diet.

Vitamins are organic molecules that are needed in small amounts to maintain health. There are 13 vitamins, which perform a variety of unique functions in the body, such as regulating energy metabolism, maintaining vision, protecting cell membranes, and helping blood to clot. **Minerals** are **elements** that are essential nutrients needed in small amounts to provide a variety of diverse functions in the body. For example, iron is an element needed for the transport of oxygen in the blood, calcium is an element important in keeping bones strong. We consume vitamins and minerals

FIGURE 1.5 Carbohydrates, lipids, and proteins Varying combinations of carbohydrates, lipids, and proteins provide the energy in the foods we eat.

a. Some high-carbohydrate foods, such as rice, pasta, and bread, contain mostly starch; some, such as berries, kidney beans, and broccoli, are high in fiber; and others, such as cookies, cakes, and carbonated beverages, are high in empty calories from added sugars.

Jeffrey Coolidge / Getty Images

Charles D. Winters / Science Source

b. High-fat plant foods such as vegetable oils, avocados, olives, and nuts are high in healthy unsaturated fats. High-fat animal foods such as cream, butter, meat, and whole milk are sources of cholesterol and are high in saturated fat, which increases the risk of heart disease.

Jeffrey Coolidge / Getty Images, Inc.

c. The proteins we obtain from animal foods, such as meat, fish, and eggs, better match our amino acid needs than do most individual plant proteins, such as those in grains, nuts, and beans. However, when plant sources of protein are combined, they can provide all the amino acids we need.

in almost all the foods we eat. Some are natural sources: Oranges contain vitamin C, milk provides calcium, and carrots give us vitamin A. Other foods are fortified with vitamins and minerals; a serving of fortified breakfast cereal often has 100% of the recommended intake of many vitamins and minerals. Dietary supplements are another source of vitamins and minerals for some people.

What Nutrients Do

Nutrients are involved in providing energy, forming body structures, and regulating physiological processes (**Figure 1.6**). Carbohydrates, lipids, and proteins are often referred to as **energy-yielding nutrients**; they provide energy that can be measured in calories. The calories people talk about and see

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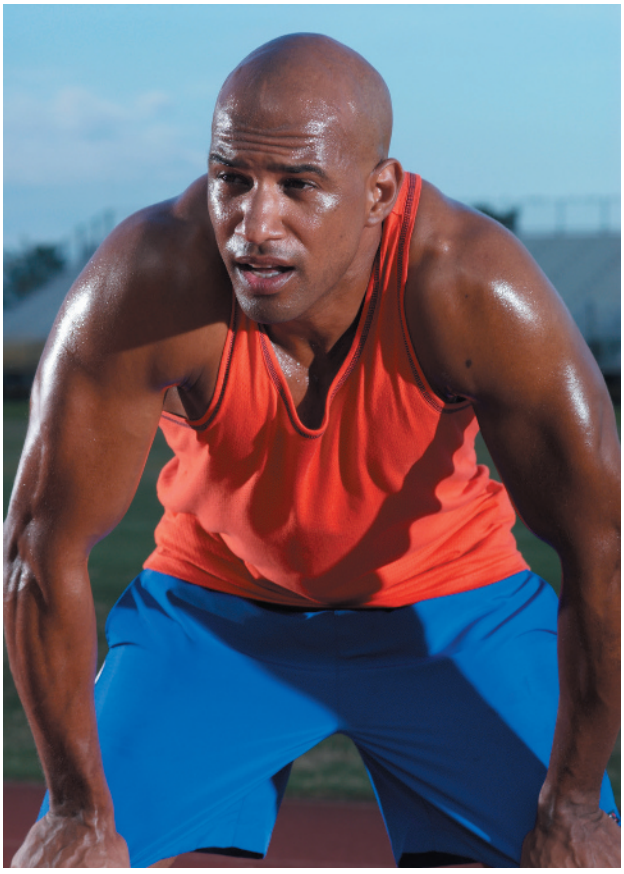
FIGURE 1.6 Nutrient functions The nutrients we consume in our diet provide energy, form body structures, and regulate body processes.

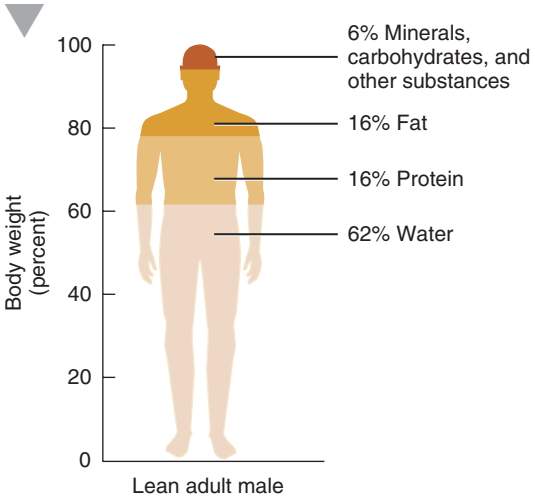
Skip Brown / National Geographic Creative

Energy Whether riding a bike through the fall foliage, walking to the mailbox, or gardening, physical activity is fueled by the carbohydrates, fat, and protein in the food we eat.

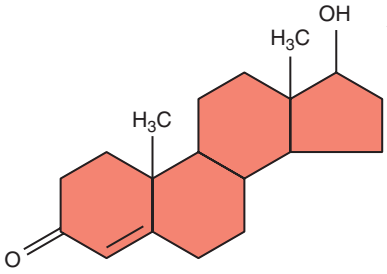


Wendy Hope / Stockbyte / Getty Images

Structure Proteins, lipids, carbohydrates, minerals, and water all contribute to the shape and structure of our bodies.



Regulation Water helps regulate body temperature. When body temperature increases, sweat is produced, cooling the body as it evaporates from the skin.



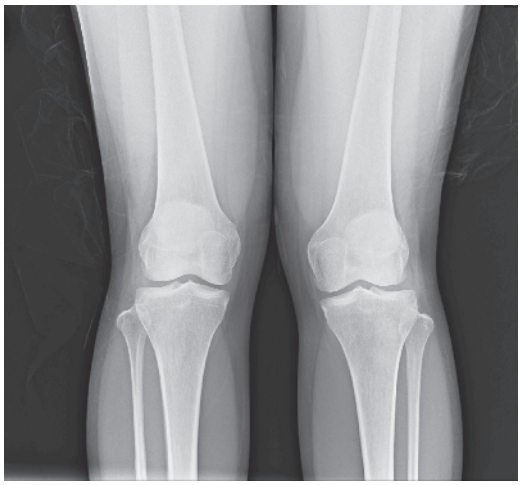
Regulation Lipids, such as the hormone testosterone, illustrated here, help regulate body processes. Testosterone is made from cholesterol. In men, it stimulates sperm production and the development of secondary sex characteristics, such as body and facial hair, a deep voice, and increased muscle mass.

(continues)

FIGURE 1.6 *(continued)*

GrapeImages / E+ / Getty Images

Energy The fat stored in our bodies acts as an energy reserve for when intake is less than needs.



rattanachot kasa / 123RF

Structure Calcium, along with phosphorus and a few other minerals, form the structure of our bones.

listed on food labels are actually **kilocalories** (abbreviated kcalorie or kcal), units of 1000 calories. When spelled with a capital *C*, Calorie means kilocalorie. Carbohydrates provide 4 Calories/gram; they are the most immediate source of energy for the body. Lipids also help fuel our activities and are the major form of stored energy in the body. One gram of fat provides 9 Calories. Protein can supply 4 Calories/gram but is not the body's first choice for meeting energy needs because protein has other roles that take priority. Alcohol, though it is not a nutrient because it is not needed for life, provides about 7 Calories/gram. Water, vitamins, and minerals do not provide energy (calories).

With the exception of vitamins, all the classes of nutrients are involved in forming and maintaining the body's structure. Fat deposited under the skin contributes to our body shape, for instance, and proteins form the ligaments and tendons that hold our bones together and attach our muscles to our bones. Minerals harden bone. Proteins and water make up the structure of the muscles, which help define our body contours, and proteins and carbohydrates form the cartilage that cushions our joints. On a smaller scale, lipids, proteins, and water form the structure of individual cells. Lipids and proteins make up the membranes that surround each cell, and water and dissolved substances fill the cells and the spaces around them.

All six classes of nutrients play important roles in regulating body processes. Keeping body temperature, blood pressure, blood sugar level, and hundreds of other parameters relatively constant involves thousands of chemical reactions and physiological processes. Proteins, vitamins, and minerals are regulatory nutrients that help control how quickly chemical reactions take place throughout the body. Lipids and proteins are needed to make regulatory molecules called **hormones** that stimulate or inhibit various body processes. Water helps regulate body temperature, as well as lubricate surfaces, and transport materials throughout the body.

Figure 1.6 illustrates some of the ways various nutrients are involved in providing energy, forming body structures, and regulating physiological processes.

Concept Check

1. **Which** classes of nutrients provide energy?
2. **What** are the three overall functions that nutrients provide?

1.3 Nutrition in Health and Disease

LEARNING OBJECTIVES

1. **Describe** the causes of malnutrition.
2. **Explain** ways in which nutrient intake can affect health in both the short term and the long term.
3. **Discuss** how the genes you inherit affect the impact your diet has on your health.

What we eat has an enormous impact on how healthy we are now and how likely we are to develop chronic diseases such as heart disease, obesity, and diabetes. Consuming either too much or too little of one or more nutrients or energy will result in **malnutrition**. Malnutrition includes both

malnutrition A condition resulting from an energy or nutrient intake either below (undernutrition) or above (overnutrition) that which is optimal.

FIGURE 1.7 Undernutrition Nutrient deficiencies may be mild enough to cause no obvious symptoms or severe enough to cause debilitating illness and death.

Rich Reid / National Geographic Image Collection / Alamy Stock Photo

a. Even though this child looks normal and healthy, she has low iron stores. If the iron content of her diet is not increased, she will eventually develop iron deficiency anemia. Mild nutrient deficiencies like hers may go unnoticed because the symptoms either are not immediately apparent or are nonspecific. Two common nonspecific symptoms of iron depletion are fatigue and decreased ability to fight infection.

W.E. Garrett / National Geographic Creative

b. The symptoms of starvation, the most obvious form of undernutrition, occur gradually over time when the energy provided by the diet is too low to meet the body's needs. Body tissues are broken down to provide the energy to support vital functions, resulting in loss of body fat and wasting of muscles.

undernutrition, which is due to a deficiency of energy or nutrients, and **overnutrition**, which occurs when there is an excess of energy or nutrients. Both undernutrition and overnutrition can affect your health not just today but 20, 30, or 40 years from now. The impact of your diet on your health is also affected by your genetic makeup.

Undernutrition and Overnutrition

Undernutrition occurs when intake doesn't meet the body's needs: The more severe the deficiency, the more dramatic the symptoms (**Figure 1.7**). Some nutrient deficiencies occur quickly. Dehydration, a deficiency of water, can cause symptoms in a matter of hours. Drinking water can relieve the headache, fatigue, and dizziness caused by dehydration almost as rapidly as these symptoms appeared. Other nutritional deficiencies may take much longer to become evident. Symptoms of scurvy, a disease caused by a deficiency of vitamin C, appear after months of deficient intake; **osteoporosis**, a condition in which the bones become weak and break easily, may result after years of consuming a calcium-deficient diet.

We typically think of malnutrition as undernutrition, but overnutrition, an excess intake of nutrients or calories, is also a concern. An overdose of iron can cause liver failure, for example, and too much vitamin B_6 can cause nerve damage. These nutrient toxicities usually result from taking large doses of vitamin and mineral supplements because foods generally do not contain high enough concentrations of nutrients to be toxic. However, chronic overconsumption of calories and certain nutrients from foods can also cause health problems. The typical U.S. diet, which provides more calories than are needed, has resulted in an epidemic of obesity in which more than 40% of adults have obesity (**Figure 1.8a**).[7] Diets that are high in sodium contribute to high blood pressure; an excess intake of saturated fat contributes to heart disease; and a dietary pattern that is high in red meat and saturated fat and low in fruits, vegetables, and fiber may increase the risk of certain cancers.[8] Diseases related to a poor diet are the leading causes of death in the United States, exceeding deaths related to smoking or alcohol consumption (**Figure 1.8b**).[9]

Diet–Gene Interactions

What you eat affects your health, but diet alone does not determine whether you will develop a particular disease. Each of us inherits a unique combination of **genes**. Some of these genes affect your risk of developing chronic diseases, such as heart disease, cancer, high blood pressure, and diabetes, but their impact is affected by what you eat. Your genetic makeup determines the impact a certain nutrient will have on you. For example, some people inherit a combination of genes that makes their blood pressure sensitive to sodium intake. When these individuals consume even an average amount of sodium, they may develop high blood pressure (see Chapter 8). Others inherit genes that allow them to consume more sodium without much of a rise in blood pressure. Those whose genes dictate a significant rise in blood pressure with a high-sodium diet can reduce their blood pressure, and the complications associated with high blood pressure, by eating a diet that is low in sodium.

Our increasing understanding of human genetics has given rise to the discipline of **nutritional genomics**, which explores the interaction between human genes, nutrition, and health (**Figure 1.9**).[12] It encompasses both the effects that the genes people inherit have on how their diet affects health (**nutrigenetics**) and the effects the nutrients and other food components they consume have on gene activity

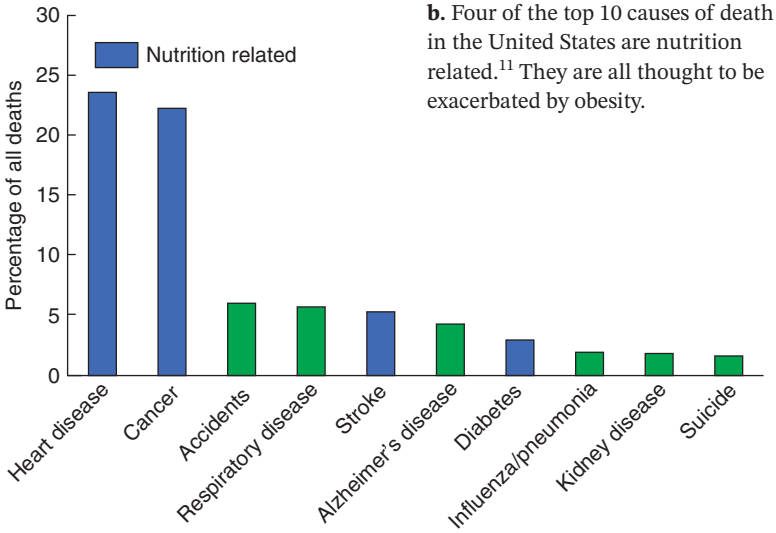
genes Units of a larger molecule called DNA that are responsible for inherited traits.

nutritional genomics The study of how our genes affect the impact of nutrients or other food components on health (nutrigenetics) and how nutrients affect the activity of our genes (nutrigenomics).

FIGURE 1.8 Overnutrition Obesity is a form of overnutrition that increases the risk of a variety of other nutrition-related chronic diseases that contribute to death.

Karan Kapoor / Getty Images

a. Obesity occurs when energy intake surpasses energy expenditure over a long period, causing the accumulation of an excessive amount of body fat. Adults are not the only ones whose weight is affecting their health; 18.5% of U.S. children and adolescents, ages 2 to 19 years, are obese.[10]



b. Four of the top 10 causes of death in the United States are nutrition related.[11] They are all thought to be exacerbated by obesity.

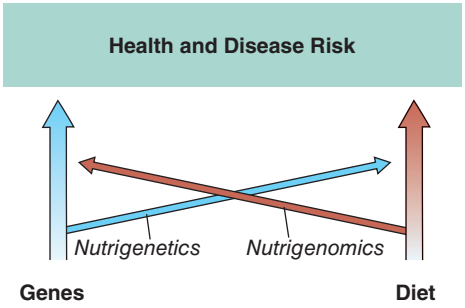
Interpret the Data

Based on this graph showing the leading causes of death in the United States, about what percentage of all deaths are due to nutrition-related diseases?

a. 5% **c. 50%**

b. 10% **d. 90%**

FIGURE 1.9 Nutritional genomics Both the genes you inherit and your dietary choices directly affect your health and disease risk. There is also interplay between these factors such that your genes, through nutrigenetics, influence how your diet affects your health, and your diet, through nutrigenomics, affects how your genes impact your health.



zhijian Huang / iStockphoto

The genes you inherit affect your tendency to develop nutrition-related chronic diseases such as heart disease and diabetes.

Tom Grill / Corbis / Getty Images

The diet you consume affects your risk of developing nutrition-related chronic diseases.

Think Critically

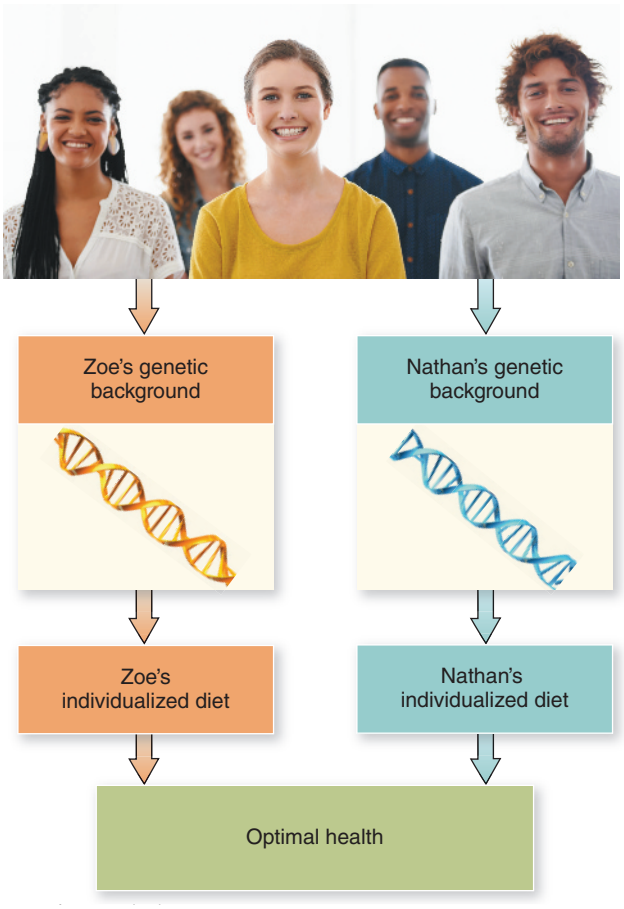
Can you become obese even if both of your parents are thin?

Debate

Do DNA-Based Diets Improve Health Outcomes?

The risk of developing chronic diseases such as diabetes and heart disease is affected by the genes we inherit and the lifestyle we lead. If a genetic analysis could identify your risk and the best diet to reduce that risk, would you be willing to change your diet?

Current nutrition recommendations are designed for the majority of healthy people but are not optimum for everyone. Nutritional genomics suggests that we can reduce our disease risk by tailoring our diet to our individual genetic makeup (see figure).[13,14] Although millions of people send samples to DNA-testing companies every year,[15] currently only a few of these companies provide customers with a personalized diet based on their genes.[16,17] Can these "DNA-based diets" deliver accurate recommendations?



PeopleImages / E+ / Getty Images

The genetics of nutrition-related diseases are complicated, and some argue that it will be years before the science catches up with the promises of genetic testing. This is exemplified by a study that looked at whether variations in three genes that affect carbohydrate and fat metabolism could predict whether subjects would lose more weight on a low-fat or low-carbohydrate diet. The study found no difference in weight loss based on diet or genetic variation.[18] Although this study examined only three genes among the dozens of genes and gene interactions that play a role in weight loss, it suggests that we do not yet have the knowledge to prescribe an optimal personalized weight-loss diet based on our genes.

We may not yet have the technology to provide complete DNA-based nutrition prescriptions, but someday we probably will. Will this approach improve individual or public health?[14] In many cases, DNA-based advice is no different from general recommendations. For example, if your DNA increases your risk of developing heart disease, you could decrease your risk by limiting saturated fat and increasing fiber intake. But even if you don't have this genetic variant, healthy diet recommendations tell us to reduce our saturated fat and increase our fiber intake.

Those who advocate personalized diets point out that people often do not follow general dietary guidance and may be more likely to stick to individualized recommendations. One study found that personalized nutrition advice resulted in greater dietary improvements than general recommendations,[19] but not all studies support this finding. A meta-analysis (a study that combines the results of many studies) examining whether awareness of one's genetic risk influenced diet or other risk-reducing behaviors found that it had no effect.[20] For example, telling people that they had an increased genetic risk for diabetes did not motivate them to improve their diet or increase their activity. Perhaps the priority for public health dollars should not be to fine-tune diet prescriptions but rather to find out what will motivate people to change their diets and live healthier lives.

In the future, we may be filling our plates based on our genes. This could mean planning an individual plate for each person at the table. Will eating these personalized diets make us healthier than following general nutrition recommendations? Will personalized diets limit the pleasure we get from food and change the cultural and social roles that food plays in our lives?

Think Critically

If genetic testing determines that you are unlikely to become obese, does this mean that you can eat as much as you want without worrying about weight gain? Why or why not?

(**nutrigenomics**). Research in these areas has led to the development of the concept of "personalized nutrition." The goal of personalized nutrition is to prescribe a diet based on the genes an individual has inherited in order to prevent, moderate, or cure chronic disease. We know that certain dietary patterns can reduce the risk of many chronic diseases, but it is not clear whether personalized diets based on genetic analysis have the potential to improve individual or public health (see *Debate: Do DNA-Based Diets Improve Health Outcomes?*).

Concept Check

1. **What** causes malnutrition?
2. **How** can your diet today affect your health 20 years from now?
3. **Why** might the diet that optimizes health be different for different people?

1.4 Choosing a Healthy Diet

LEARNING OBJECTIVES

1. **List** three reasons it is important to eat a variety of foods.
2. **Explain** why you can sometimes eat foods that are low in nutrient density and still have a healthy diet.
3. **Discuss** how dietary moderation can reduce the risk of chronic disease.

A healthy diet is one that provides the right number of calories to keep your weight in the desirable range; the proper balance of carbohydrates, proteins, and fat; plenty of water; and sufficient but not excessive amounts of vitamins and minerals. This healthy diet is rich in whole grains, fruits, and vegetables; high in fiber; and low in added sugars, sodium, and unhealthy fats. In short, a healthy diet is based on variety, balance, and moderation (see *What Should I Eat*?).

Eat a Variety of Foods

In nutrition, choosing a variety of foods is important because no single food can provide all the nutrients the body needs for optimal health. *Variety* means choosing foods from different food groups—vegetables, grains, fruits, dairy products, and protein foods. Some of these foods are rich in vitamins and phytochemicals, others are rich in protein and minerals, and all are important.

Variety also means choosing diverse foods from within each food group. Different vegetables provide different nutrients. Potatoes, for example, are the only vegetable in many Americans' diets. Potatoes provide vitamin C but are low in vitamin A. If potatoes are your only vegetable, it is unlikely that you will meet your nutrient needs. If instead you have a salad, potatoes, and broccoli, you will be getting plenty of vitamins C and A, as well as many other vitamins and minerals. Choosing from all the food groups and making varied choices from within each food group is also important because nutrients and other food components interact. Such interactions may be positive, enhancing nutrient utilization, or negative, inhibiting nutrient availability. Variety averages out these interactions. Some foods may also contain toxic substances. Eating a variety of foods reduces the risk that you will consume enough of any one toxin to be harmful. For example, tuna may contain traces of mercury, but as long as you don't eat tuna too often, you are unlikely to consume a toxic amount.

Variety involves choosing different foods not only each day but also each week and throughout the year. If you had apples and grapes today, for example, have blueberries and cantaloupe tomorrow. If you can't find tasty tomatoes in December, replace them with a winter vegetable such as squash.

Balance Your Choices

Choosing a healthy diet is a balancing act. Healthy eating doesn't mean giving up your favorite foods. There is no such thing as a good food or a bad food—only healthy diets and unhealthy diets. Any food can be part of a healthy dietary pattern, as long as your intake throughout the day or week provides enough of all the nutrients you need without excesses of any. When you choose a food that is low in nutrient density, balance it with one that is high in nutrient density. For example, when you choose chips for a snack, choose fruit for dessert.

A balanced diet also balances the calories you take in with the calories you burn in your daily activities so that your body weight stays in the healthy range (**Figure 1.10**).

What Should I Eat?

Variety, Balance, and Moderation

Eat a variety of foods

- Mix up your snacks. For example, have salsa and chips one day and fruit, yogurt, or nuts another day.
- Add almonds and diced apples to your salad.
- Try a new vegetable or fruit each week. Tired of carrots? Try jicama.
- Vary your protein sources. Eat fish one day and beef the next—or skip the meat and have beans.

Balance choices to assure nutrient density

- Going out to dinner? Have a salad for lunch.
- If you eat some extra fries, take some extra steps.
- When you have cookies for a snack, have fruit for dessert.
- If you had salty chips with lunch, snack on carrots before dinner.

Choose moderate portions

- Push back from the table before you are stuffed and go for a walk.
- Reduce your portions by using a smaller bowl.
- Next time you go out for ice cream, get one scoop instead of two.
- Split your restaurant meal with a friend.

Use iProfile to calculate the calories in your favorite fast-food meal.

FIGURE 1.10 Balance calories in with calories out To keep your weight stable, you need to burn the same number of calories as you consume. Consuming extra calories during the day can be balanced by increasing the calories you burn in physical activity. You may be surprised how much activity is needed to burn off extra calories.

If you grab 4 potato chips and pop them in your mouth, you will need to burn about 30 extra Calories to maintain your weight.

John Ambrose

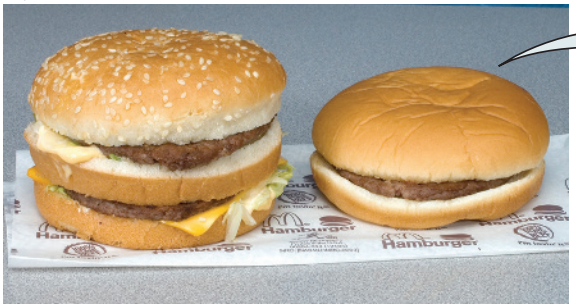
You can do this by doing jumping jacks for 3 minutes.

Mirage_studio / Shutterstock

You could do this by playing golf for about an hour, carrying your own clubs.

Andy Washnik

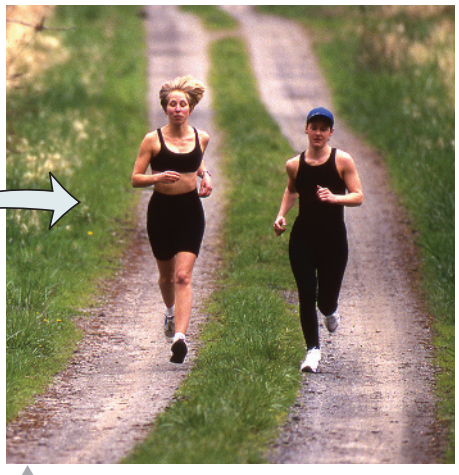
Choosing a Big Mac over a smaller burger means you will need to increase your energy expenditure by 300 Calories to maintain your weight.



Andy Washnik

Andy Washnik

Choosing a grande Mocha Frappuccino over a regular iced coffee means you will need to increase your energy expenditure by 350 Calories to maintain your weight.



Kate Thompson / National Geographic Creative

You could do this by jogging for about 30 minutes.

Ask Yourself

If you add a daily grande Mocha Frappuccino to your usual diet, how many minutes of jumping jacks would you need to do to burn off the extra calories?

Practice Moderation

Moderation means not overdoing it—not having too many calories, too much saturated fat, too much sugar, too much salt, or too much alcohol. Choosing moderate amounts will help you maintain a healthy weight and prevent some of the chronic diseases, such as heart disease and cancer, that are on the rise in the U.S. population.

The fact that Americans are gaining weight suggests that we have not been practicing moderation when it comes to calorie intake.[21] Larger food portions are one factor contributing to our increasing intake. The sandwiches, soft drinks, and

Thinking It Through

A Case Study on Choosing a Healthy Diet

For many college students, their freshman year is the first time they are making all their own food choices, and they don't always make the best ones. Learning to apply the principles of variety, balance, and moderation can help improve these choices.

Maya doesn't really know how to choose a healthy diet, so she picks what is familiar, inexpensive, and saves her time. Every day for breakfast she eats the same cereal, a glass of apple juice, and coffee.

Suggest ways that Maya could increase the variety in her breakfast while still keeping her food choices inexpensive and quick.

Your answer:

For lunch Maya has fast food—usually a burger and fries. She knows this is not the most nutrient-dense choice, but she is always in a hurry, rushing between school and work. The drive-thru often seems like the best option.

Suggest some fast and easy lunch choices that would be more nutrient dense than Maya's current lunch choice.

Your answer:

Suggest some snacks that would add variety and help to balance Maya's repetitious breakfast and lunch.

Your answer:

Maya has gained a few pounds and is worried that she will become a victim of the "freshman 15"—the 15 or so pounds frequently gained by college students during the first year away from home. She thinks her weight gain is due to the dinner that she eats in the college dining hall. Her evening meal plan is "all-you-can-eat," so she piles food on her plate and always takes a dessert to get the most for her money.

Suggest two changes that Maya could make to moderate her dinner choices.

Your answer:

It is Mexican night at the dining hall. Maya knows that beans are a healthy choice, so she takes two beef and bean burritos as shown in the photo.

Joshua Resnick / 123 RF

How does Maya's Mexican dinner stack up in terms of variety, balance, and moderation?

Your answer:

Check your answers in Appendix L.

French fry orders served in fast-food restaurants today are two to five times larger than what they were 50 years ago. The sizes of the snacks and meals we eat at home have also increased. As these portion sizes have grown, so has the amount we eat—and so has our weight.[22] Moderation makes it easier to balance your diet and allows you to enjoy a greater variety of foods (see *Thinking It Through*).

Concept Check

1. **Why** is variety in a diet important?
2. **What** could you have for lunch to balance a breakfast that doesn't include any fruits or vegetables?
3. **Why** does moderation allow more variety in your diet?

1.5 Evaluating Nutrition Information

LEARNING OBJECTIVES

1. **List** the steps of the scientific method and give an example of how it is used in nutrition.
2. **Discuss** three different types of experiments used to study nutrition.
3. **Describe** the components of a sound scientific experiment.
4. **Distinguish** between reliable and unreliable nutrition information.

We are bombarded with nutrition information almost every day. The evening news, the morning papers, and the World Wide Web continually offer us tantalizing tidbits of nutrition advice. Food and nutrition information that used to take professionals years to disseminate now travels with lightning speed, reaching millions of people within hours or days. Much of this information is reliable, but some can be misleading. In order to choose a healthy diet, we need to be able to sort out the useful material in this flood of information.

The Science Behind Nutrition

Like all other sciences, the science of nutrition is constantly evolving. As new discoveries provide clues to the right combination of nutrients needed for optimal health, new nutritional principles and recommendations are developed. Sometimes established beliefs and concepts give way to new information. Understanding the process of science can help consumers understand the nutrition information they encounter.

The systematic, unbiased approach that allows any science to acquire new knowledge and continuously revise and update our understanding based on new information is the **scientific method**. The scientific method involves making observations of natural events, formulating **hypotheses** to explain these events, designing and performing experiments to test these hypotheses, and developing **theories** that explain the observed phenomenon based on the results of many studies (**Figure 1.11**). In nutrition, the scientific method is used to develop nutrient recommendations, understand the functions of nutrients, and learn about the role of nutrition in promoting health and preventing disease.

How Scientists Study Nutrition

Many different types of studies are used to expand our knowledge of nutrition. Some make observations about relationships between diet and health; these are based on the science of **epidemiology**. Other types of studies evaluate the effect of a particular dietary change on health. Some of these use human subjects, others use animals; some look at whole populations, others study just a few individuals; and some use just cells or molecules (**Figure 1.12**).

A sound nutrition experiment examines the right experimental population, collects quantifiable data, includes proper

PROCESS DIAGRAM

FIGURE 1.11 The scientific method The scientific method is a process used to ask and answer scientific questions through observation and experimentation.

1 The first step of the scientific method is to make an observation and ask questions about that observation.

Observation
More people get colon cancer in the United States than in Japan.

2 The next step is to propose an explanation for this observation. This proposed explanation is called a hypothesis.

Hypothesis
The lower incidence of colon cancer in Japan than in the United States is due to differences in the diet.

3 Once a hypothesis has been proposed, experiments like this one are designed to test it. To generate reliable theories, the experiments done to test hypotheses must produce consistent, quantifiable results and must be interpreted accurately.

Experiment
Compare the incidence of colon cancer of Japanese people who move to the United States and consume a typical U.S. diet with the American population as a whole. **Result:** The Japanese people who eat the U.S. diet have the same higher incidence of colon cancer as the general population.

4 If the results from repeated experiments support the hypothesis, a scientific theory can be developed. A single experiment is not enough to develop a theory; rather, repeated experiments showing the same conclusion are needed to develop a sound theory.

Courtesy Lori Smolin

5 If experimental results do not support the hypothesis, a new hypothesis can be formulated.

Theory
The U.S. diet contributes to the development of colon cancer.

6 As new information becomes available, even a theory that has been accepted by the scientific community for years can be proved wrong.

Think Critically

A scientist has hypothesized that the difference in the incidence of colon cancer in Japan and the United States is due to differences in the genetic makeup of the populations. Based on the results of the experiment described in this illustration, explain why this hypothesis is not supported.

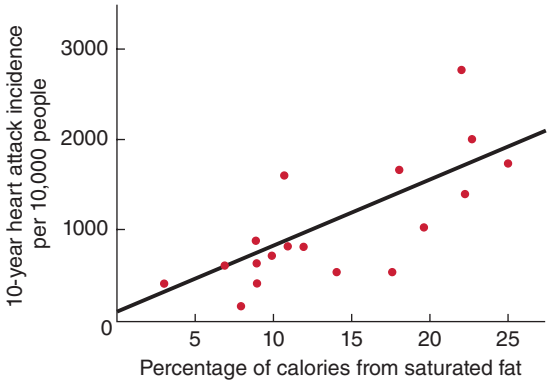
hypothesis A proposed explanation for an observation or a scientific problem that can be tested through experimentation.

theory A formal explanation of an observed phenomenon made after a hypothesis has been tested and supported through extensive experimentation.

epidemiology The branch of science that studies health and disease trends and patterns in populations.

NUTRITION INSIGHT

FIGURE 1.12 Types of nutrition studies Scientists use a variety of methods to expand our understanding of nutrition.



a. Epidemiological studies Comparing saturated fat intake to the incidence of heart attacks in different populations indicates that diets with a high percentage of calories from saturated fat are associated with an increased incidence of heart attacks.

Think Critically

Does this graph indicate that a high intake of saturated fat causes heart attacks? Explain your answer.

Epidemiology does not determine cause-and-effect relationships; it just identifies patterns, which can be used to generate hypotheses. Many kinds of experiments can be used to test hypotheses generated through epidemiology.

Dmytro / 123 RF

b. Clinical trials In nutrition, studies called clinical trials explore the health effects of altering people's diets—for instance, the possible effects of reducing saturated fat intake on blood cholesterol levels.

Greg Dale / National Geographic Creative

c. Biochemistry and molecular biology Biochemistry can be used to study the chemical reactions that provide energy or synthesize molecules, such as cholesterol, and molecular biology can be used to study how nutrients interact with our genes.

kickers / Getty Images

d. Animal studies Because studying humans is costly, time-consuming, inconvenient for the subjects, and in some cases impossible for ethical reasons, many studies are done using animals. Guinea pigs provide a good model for studying heart disease. However, even the best animal model is not the same as a human, and care must be taken when extrapolating animal results to humans.

experimental controls, and interprets the data accurately. The experimental population must be chosen to answer a specific question. For example, if a dietary supplement claims to increase bone strength in older women, a study to test this should use older women as subjects. For an experiment to determine whether a treatment does or does not have an effect, it must include enough subjects to demonstrate that the treatment causes the effect to occur more frequently than it would by chance. The number of subjects needed depends on how likely an effect is to occur without the treatment. For example, if weight training without a muscle-building supplement causes an increase in muscle mass, a large number of experimental subjects may be needed to demonstrate that there is a greater increase in muscle mass with the treatment—in this case, the muscle-building supplement. Results from studies with only a few subjects may not be able to distinguish effects that occur due to chance and should therefore be interpreted with caution.

Data collected in experiments must be quantifiable—that is, data must include parameters that can be measured reliably and repeatedly, such as body weight or blood pressure. Individual testimonies or opinions alone are not quantifiable, objective measures.

In order to know whether what is being tested has an effect, one must compare it with something. A **control group** acts as a standard of comparison for the factor, or **variable**, being studied. A control group is treated in the same way as the **experimental group** except that the control group does not receive the treatment being tested. For example, in a study examining the effect of a dietary supplement on weight loss, the control group would consist of individuals of similar age, gender, height, weight, and body composition, eating similar diets and following similar activity patterns as individuals in the experimental group. While the experimental group would consume the supplement, the control subjects would consume a **placebo**, a harmless, inactive substance that is identical in appearance to the dietary supplement.

When an experiment has been completed, the results must be interpreted. Accurately interpreting results is just as important as conducting a study carefully. If a study conducted on a large group of young women indicates that a change in diet reduces breast cancer risk later in life, the results of that study cannot be used to claim that the same effect will occur if older women make a similar dietary change. Likewise, if the study looks only at the connection between a change in diet and breast cancer, the findings can't be used to claim a reduced risk for other cancers.

One way to ensure that the results of experiments are interpreted correctly is to have them reviewed by experts in the field who did not take part in the study being evaluated. Such a **peer-review process** is used in determining whether experimental results should be published in scientific journals. The reviewing scientists must agree that the experiments were conducted properly and that the results were interpreted appropriately. Nutrition articles that have undergone peer review can be found in many journals, including *The American Journal of Clinical Nutrition*, *The Journal of Nutrition*, *The Journal of the Academy of Nutrition and Dietetics*, *The New England Journal of Medicine*, and *The International Journal of Sport Nutrition*. Newsletters from reputable institutions, such as the *Tufts Health and Nutrition Letter*, the *Harvard Health Letter*, and *Nutrition Action Healthletter* are also reliable sources of nutrition and health information. The information in these newsletters comes from peer-reviewed articles but is written for a consumer audience.

Recommendations and policies regarding nutrition and healthcare practices are made by compiling the evidence from the wealth of well-controlled, peer-reviewed studies that are available. This is referred to as **evidence-based practice**.

Judging for Yourself

Not everything you hear is accurate. Because much of the nutrition information we encounter is intended to sell products, that information may be embellished to make it more appealing. Understanding the principles scientists use to perform nutrition studies can help consumers judge the nutrition information they encounter in their daily lives (see *What a Scientist Sees: Behind the Claims*). Some things that may tip you off to misinformation are claims that sound too good to be true, information from unreliable sources, information intended to sell a product, and information that is new or untested. The following questions can help you evaluate the validity of any nutrition information you encounter.

Does it make sense? Some claims are too outrageous to be true. For example, if a product claims to increase your muscle size without any exercise or decrease your weight without a change in diet, common sense should tell you that the claim is too good to be true. In contrast, an article that tells you that adding exercise to your daily routine will help you lose weight and increase your stamina is not so outrageous.

What's the source? If a claim seems reasonable, find out where it came from. Personal testimonies are not a reliable source of information. These individual success stories are not subjected to scientific evaluation, and therefore it cannot be assumed that similar results will occur in other people. Claims based on well-controlled research studies can provide reliable, reproducible results as long as the data is interpreted correctly.

Government recommendations regarding healthy dietary practices and information disseminated by universities generally are reliable information sources. Government recommendations are developed by committees of scientists who interpret the latest well-conducted research studies and use their conclusions to develop recommendations for the population as a whole. The information is designed to improve the health of the population. Information that comes from universities is supported by research studies that are well scrutinized and published in peer-reviewed journals. Many universities also provide information that targets the general public. Not-for-profit organizations such as the Academy of Nutrition and Dietetics and the American Medical Association are also reliable sources of nutrition information.

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control group In a scientific experiment, the group of participants used as a basis of comparison. They are similar to the participants in the experimental group but do not receive the treatment being tested.

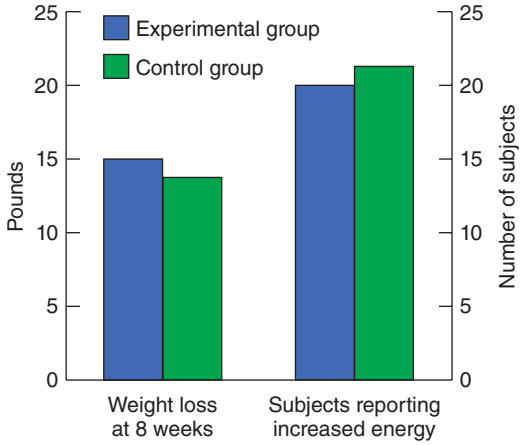
experimental group In a scientific experiment, the group of participants who undergo the treatment being tested.

What a Scientist Sees

Behind the Claims

Consumers who want to slim down may think this product looks amazing. It will allow them to lose weight and to increase their energy level! However, a scientist looking at the same ad may have some concerns. First of all, the testimonial about weight loss is based on Janet's experience, and not everyone will have the same weight-loss result. And, although she claims to have more energy than ever, Janet is basing this statement on her feelings and not objective measures.

A scientist would want to carefully examine the research study to see if the data supports the claim that the product promotes weight loss. A review of the full study shows that it involved 50 overweight subjects. Half of them consumed a reduced-calorie diet along with one SlimEazzy tablet per day. The other half ate the same reduced-calorie diet but took a placebo instead of SlimEazzy. Body weight was measured at the beginning of the study and after 8 weeks of the diet. As seen in the graph, both the control and experimental groups lost weight. The amount lost in the experimental group is slightly greater, but statistical analysis found that the difference was insignificant. The implication that taking the supplement helped subjects to lose 15 pounds is misleading because those taking the placebo lost a similar amount of weight. The ad also claims that the supplement energizes you but does not tell you that a comparable energizing effect occurred in those not taking the supplement; when interviewed, 20 of 25 subjects in the experimental group said they felt energized, and 21 subjects in the control groups said they felt energized (see graph).



Think Critically

Do you think the claims made in the ad are supported by the information in the graph? Explain why you would or would not recommend this product.

If you are looking at an article in print or posted on a Web site, checking the author's credentials can help you evaluate the credibility of the information. Where does the author work? Does this person have a degree in nutrition or medicine? Although "nutritionists" and "health coaches" may provide accurate information, these terms are not legally defined and can be used by individuals with no formal nutrition or medical training.

One reliable source of nutrition information is a registered dietitian (RD), also called a registered dietitian nutritionist (RDN). RD/RDNs are nutrition professionals who are certified to provide nutrition education and counseling. To obtain certification, an RD/RDN must earn a four-year college degree that includes coursework approved by the Academy of Nutrition and Dietetics, complete a supervised internship, and pass a national exam.

Is it selling something? If a person or company will profit from the information presented, be wary. Advertisements are designed to increase product sales, and the company stands to profit if you believe the claims that are made. Information presented online, in newspapers and magazines, and on television may also be biased or exaggerated because it is designed to help boost sales, not necessarily to promote health and well-being. Even a well-designed, carefully executed study published in a peer-reviewed journal can be a source of misinformation if its results have been interpreted incorrectly or exaggerated (**Figure 1.13**).

Has it stood the test of time? Often the results of new scientific studies are on the news the same day they are presented at a meeting or published in a peer-reviewed journal. However, a single study cannot serve as a basis for a reliable theory. Results need to be reproduced and supported numerous times before they can be used as a foundation for nutrition recommendations.

Headlines based on a single study should therefore be viewed skeptically. The information may be accurate, but there is no way to know because there has not been enough time to repeat the work and reaffirm the conclusions. If, for example, someone has found the secret to easy weight loss, you will undoubtedly encounter this information again at some later time if the finding is valid. If the finding is not valid, it will fade away with all the other weight-loss concoctions that have come and gone.

FIGURE 1.13 Results may be misinterpreted in order to sell products These rats, which were given large doses of vitamin E, lived longer than rats that consumed less vitamin E. Does this mean that dietary supplements of vitamin E will increase longevity in people? Not necessarily. The results of animal studies can't always be extrapolated to humans, but they are often the basis of claims in ads for dietary supplements.

Joel Sartore / National Geographic Image Collection

Concept Check

1. **What** is the difference between a hypothesis and a theory?
2. **How** is an epidemiologic study different from a clinical trial?
3. **Why** are control groups important in any scientific experiment?
4. **Why** are personal testimonies not a source of reliable nutrition information?

What Is Happening in This Picture?

This modest display of fruits and vegetables is typical of what is available in an inner city corner store. These stores usually also offer an abundance of candy, chips, beverages, and other snack foods along with a small selection of staples such as eggs, milk, pasta, bread, and canned goods. For some people, this is their only shopping option close to home.

Think Critically

1. If your fruit and vegetable intake was limited to those in the photo, how would it affect the variety, balance, and moderation in your diet?
2. Suggest two reasons why this store offers so few options for fresh produce.
3. Propose a community initiative that would help increase the availability of fruits and vegetables in an urban setting.

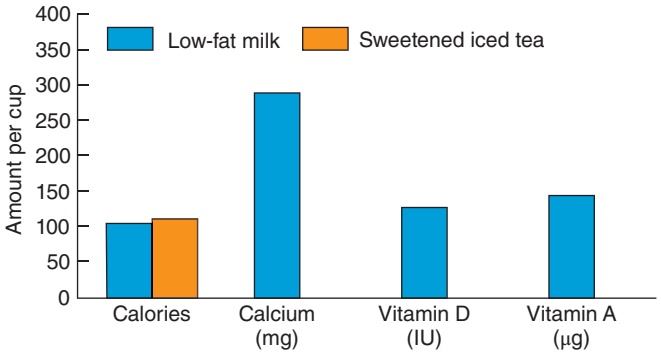
John Ambrose

Summary

1 Food Choices and Nutrient Intake 2

- The foods you choose determine which **nutrients** you consume. Choosing foods that are high in **nutrient density** allows you to obtain more nutrients in fewer calories, as shown in this graph. Fortified foods, or foods to which nutrients have been added, and **dietary supplements** can also contribute nutrients to the diet.

Figure 1.1a Nutrient density

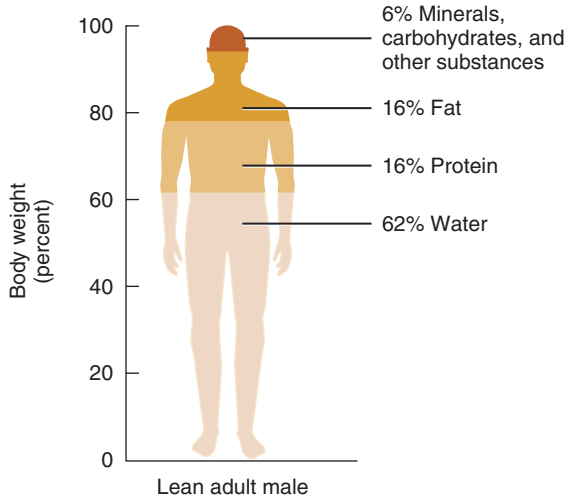


- Food contains not only nutrients but also nonnutritive substances, such as **phytochemicals**, that may provide additional health benefits. Foods that provide health benefits beyond basic nutrition are called **functional foods**. Some foods are naturally functional, and others are made functional through **fortification**.
- The food choices we make are affected not just by personal taste but by our **food environment**, which includes the environmental, sociocultural, and economic factors that affect our eating habits and patterns. What foods are available in our community, what foods are advertised, how much food costs, and what we learn to eat from family, culture, and traditions are all part of our food environment.

2 Nutrients and Their Functions 6

- Nutrients are grouped into six classes. **Carbohydrates**, **lipids**, **proteins**, and water are referred to as **macronutrients** because they are needed in large amounts. **Vitamins** and **minerals** are **micronutrients** because they are needed in small amounts to maintain health.
- Carbohydrates, lipids, and proteins are nutrients that provide energy, typically measured in **calories**. Lipids, proteins, carbohydrates, minerals, and water perform structural roles, as shown in the following illustration, forming and maintaining the structure of our bodies. All six classes of nutrients help regulate body processes. The energy, structure, and regulation provided by nutrients are needed for growth, maintenance and repair of the body, and reproduction.

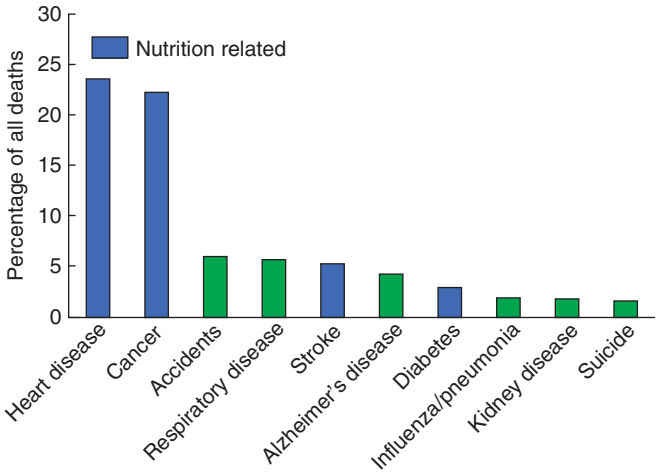
Figure 1.6b Nutrient functions



3 Nutrition in Health and Disease 9

- Your diet affects your health. The foods you choose contain the nutrients needed to keep you alive and healthy and prevent **malnutrition**, which includes both **undernutrition** and **overnutrition**. Undernutrition results from consuming too few calories and/or too few nutrients. Overnutrition can result from a toxic dose of a nutrient or from a chronic excess of nutrients or calories, which over time contributes to chronic diseases, such as those shown in this graph.

Figure 1.8b Overnutrition



- Your genetic makeup and the diet you consume interact to affect your health risks. **Nutritional genomics** studies how the genes you inherit affect the impact of diet on health and how the diet you choose affects the activity of your genes.

4 Choosing a Healthy Diet 13

- A healthy diet includes a variety of nutrient-dense foods from the different food groups as well as a variety of foods from

within each group. Variety is important to ensure that nutrient needs are met because different foods provide different nutrients and health-promoting substances as well as a variety of tastes.

- Balance means mixing and matching foods and meals in order to obtain enough of the nutrients you need and not too much of the ones that can potentially harm your health. Extra calories you consume during the day can be balanced by increasing the calories you burn in physical activity, as shown.

Figure 1.10 Balance calories in with calories out

John Ambrose

Mirage_studio / Shutterstock.com

- Moderation means not ingesting too many calories or too much saturated fat, sugar, salt, or alcohol. Eating moderate portions helps you maintain a healthy weight and helps prevent chronic diseases such as heart disease, diabetes, and cancer.

5 Evaluating Nutrition Information 15

- Nutrition uses the **scientific method** to study the relationships among food, nutrients, and health. The scientific method, illustrated below, involves observing and questioning natural events, formulating **hypotheses** to explain these events, designing and performing experiments to test the hypotheses, and developing **theories** that explain the observed phenomena based on the experimental results.
- To be valid, a nutrition experiment must provide quantifiable measurements, study the right type and number of subjects, and use appropriate **control groups**. When a study has been completed, the results must be interpreted fairly and accurately. The **peer-review process** ensures that studies published in professional journals adhere to a high standard of experimental design and interpretation of results.
- Not all the nutrition information we encounter is accurate. The first step in deciding whether a nutritional claim is valid is to ask whether the claim makes sense. If it sounds too good to be true, it probably is. It is also important to determine whether the information came from a reliable source, whether it is trying to sell a product, and whether it has been confirmed by multiple studies.

Figure 1.11 The scientific method

1 The first step of the scientific method is to make an observation and ask questions about that observation.

Observation
More people get colon cancer in the United States than in Japan.

2 The next step is to propose an explanation for this observation. This proposed explanation is called a hypothesis.

Hypothesis
The lower incidence of colon cancer in Japan than in the United States is due to differences in the diet.

3 Once a hypothesis has been proposed, experiments like this one are designed to test it. To generate reliable theories, the experiments done to test hypotheses must produce consistent, quantifiable results and must be interpreted accurately.

Experiment
Compare the incidence of colon cancer of Japanese people who move to the United States and consume a typical U.S. diet with the American population as a whole. **Result:** The Japanese people who eat the U.S. diet have the same higher incidence of colon cancer as the general population.

4 If the results from repeated experiments support the hypothesis, a scientific theory can be developed. A single experiment is not enough to develop a theory; rather, repeated experiments showing the same conclusion are needed to develop a sound theory.

Courtesy Lori Smolin

5 If experimental results do not support the hypothesis, a new hypothesis can be formulated.

Theory
The U.S. diet contributes to the development of colon cancer.

6 As new information becomes available, even a theory that has been accepted by the scientific community for years can be proved wrong.

Key Terms

- amino acid 7
- calorie 2
- carbohydrates 6
- cholesterol 6
- control group 18
- dietary supplement 3
- element 7
- empty calories 2
- energy-yielding nutrient 8
- epidemiology 16
- essential nutrient 2
- evidence-based practice 18
- experimental group 18
- fiber 6
- food desert 6
- food environment 5
- fortification 3
- functional food 4
- genes 10
- hormone 9
- hypothesis 16
- kilocalorie 9
- lipids 6
- macronutrient 6
- malnutrition 9
- micronutrient 6
- mineral 7
- nutrient density 2
- nutrients 2
- nutrigenetics 10
- nutrigenomics 12
- nutritional genomics 10
- organic compound 6
- osteoporosis 10
- overnutrition 10
- peer-review process 18
- phytochemical 4
- placebo 18
- protein 6
- saturated fat 6
- scientific method 16
- theory 16
- undernutrition 10
- unsaturated fat 6
- variable 18
- vitamin 7
- zoochemical 4