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 afford. Fundamentally, 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 agriculture and food production became more sophisticated, a greater array of food choices became available. Colonization and exploitation of native peoples introduced new foods to the colonizers: Corn became part of the diet of European settlers in North America, for instance, and the potato was brought to the Old World from the New. Today, in a cosmopolitan, global society, one may literally choose from the world’s dinner table.

The implications of food choices are significant not only because what you eat affects your health but also because what you like affects what you choose to eat.
Hundreds of millions of people enjoy eating insects, raw fish, horses, and even dogs, while hundreds of millions of others abhor pork, beef, shellfish, dairy products, and even chocolate! Most of us enjoy the sweet and avoid the bitter, yet some of us choose the zip of the bitter or the bite of the zesty.

Because the nutrients in the food we eat form and maintain the structure of our bodies, we really are what we eat. The challenge is to find a satisfying balance between what we like and what optimizes our health. The choice is ours.
Nutrient density • Figure 1.1

<table>
<thead>
<tr>
<th>Calories (mg)</th>
<th>Vitamin D (IU)</th>
<th>Vitamin A (µg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-fat milk</td>
<td>Sweetened iced tea</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>200</td>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
</tbody>
</table>

a. Nutrient density is important in choosing a healthy diet. For example, low-fat milk provides about the same number of calories per cup as bottled iced tea, but it also provides calcium, vitamin D, vitamin A, and other nutrients, including protein.

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

CHAPTER 1 Nutrition: Everyday Choices

LEARNING OBJECTIVES

1. Define nutrient density.
2. Compare fortified foods and dietary supplements.
3. Distinguish essential nutrients from phytochemicals.
4. Identify the factors that determine food choices.
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 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.

Recently, however, voluntary fortification of foods has become common practice. Vitamins and minerals are routinely added to breakfast cereals and a variety of 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.

**Dietary supplements** are another source of nutrients; about half of U.S. adults take some sort of daily dietary supplement. Supplements provide nutrients but do not offer all the benefits of food (see Chapters 2 and 7).

**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, these health-promoting substances are called **phytochemicals** (Figure 1.2). Although fewer such substances have been identified in animal foods, animal foods also contain substances with health-promoting properties. These are called **zoochemicals**.

**Foods that are high in phytochemicals • Figure 1.2**

Fruits, vegetables, and whole grains provide a variety of phytochemicals, such as those highlighted here. Supplements of individual phytochemicals are available, but there is little evidence that they provide the health benefits obtained from foods that are high in phytochemicals.¹

Garlic, broccoli, and onions provide sulfur-containing phytochemicals that help protect us from some forms of cancer by inactivating carcinogens or stimulating the body’s natural defenses.²,³

Yellow-orange fruits and vegetables, such as peaches, apricots, carrots, and cantaloupe, as well as leafy greens, are rich in carotenoids, which are phytochemicals that may prevent oxygen from damaging our cells.⁷

Soybeans are a source of phytoestrogens, hormone-like compounds found in plants that may reduce the risk of certain types of cancer and cause small reductions in blood cholesterol.⁴,⁵,⁶

Purple grapes, berries, and onions provide red, purple, and pale yellow pigments called flavonoids, which prevent oxygen damage and may reduce the risk of cancer and heart disease.⁸,⁹
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, but some foods fortified with nutrients or enhanced with phytochemicals or other substances are also classified as functional foods (Table 1.1). These modified foods, such as water with...
added vitamins, oatmeal with added soy protein, and orange juice with added calcium, have also been called designer foods or nutraceuticals. As food manufacturers cash in on the concept that “health sells,” the line between what is a dietary supplement and what is a food has become blurred.

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. Sometimes we choose a food simply because it is put in front of us; often our choices also depend on what we have learned to eat, what is socially acceptable in our cultural heritage or religion, what we think is healthy, or what our personal convictions—such as environmental consciousness or vegetarianism—demand. Tradition and values may dictate what foods we consider appropriate,

but individual preferences for taste, smell, appearance, and texture affect which foods we actually consume. All these factors are involved in food choices because food does more than meet our physiological requirements. It also provides sensory pleasure and helps meet our social and emotional needs (Figure 1.3).

CONCEPT CHECK

1. Which has a higher nutrient density: a soda or a glass of 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 which foods you eat at a family picnic?

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Food preferences and eating habits are learned as part of an individual’s family, cultural, national, and social background. In many parts of the world, insects, such as these palm beetle larvae, are considered a delicacy, but in U.S. culture, insects are considered food contaminants, and most people would refuse to eat them.

For an adolescent, stopping for pizza after school may be part of being accepted by his or her peers. Food is the centerpiece of everyday social interactions. We meet friends for dinner or a cup of coffee. The family dinner table is a focal point for communication, where experiences of the day are shared.

Often people’s attitudes about what foods they think are good for them or are good for the environment affect what they choose. For example, you may choose organic produce because you are concerned about exposure to pesticides or green tea to increase your intake of cancer-fighting antioxidants.
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, and proteins are all organic compounds that provide energy to the body (Figure 1.4). Although we tend to think of each as a single nutrient, there are actually many different types of molecules in each of these classes. Carbohydrates include starches, sugars, and fiber (Figure 1.4a). Several types of lipids play important roles in nutrition (Figure 1.4b). The most familiar 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 called amino acids that are linked together in different combinations to form different proteins (Figure 1.4c).

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. In the body, water acts as a lubricant, a transport fluid, and a regulator of body temperature.

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 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; fortified breakfast cereals often have 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

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 listed on food labels are actually kilocalories (abbreviated kcal 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...
Nutrients and Their Functions

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 found in grains, nuts, and beans. However, when plant sources of protein are combined, they can provide all the amino acids we need.

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 added sugar. High-fiber, low-sugar foods have a higher nutrient density than do low-fiber, high-sugar foods.

b. High-fat plant foods such as vegetable oils, avocados, olives, and nuts have no cholesterol and are high in unsaturated fat, so they don’t increase the risk of heart disease. High-fat animal foods such as cream, butter, meat, and whole milk are high in saturated fat and cholesterol; a diet high in these increases the risk of heart disease.

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 found in grains, nuts, and beans. However, when plant sources of protein are combined, they can provide all the amino acids we need.
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, although 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. Protein and water make up the structure of the muscles, which help define our body contours, and protein 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.

**CONCEPT CHECK**

1. **Which** classes of nutrients provide energy?
2. **What** three nutrient functions help ensure normal growth, maintenance of body structure and functions, and reproduction?

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**Nutrition in Health and Disease**

**LEARNING OBJECTIVES**

1. **Describe** the different types 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.

**Undernutrition and Overnutrition**

**Undernutrition** occurs when intake doesn’t meet the body’s needs (Figure 1.6). The more severe the deficiency, the more dramatic the symptoms. 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, occurs after years of consuming a calcium-deficient diet.

**malnutrition** A condition resulting from an energy or nutrient intake either above or below that which is optimal.

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**Undernutrition • Figure 1.6**

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.

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.
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 B₆ 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 68% of adults are overweight or obese (Figure 1.7a). 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. It has been estimated that about 15% of all deaths in the United States can be attributed to poor diet and sedentary lifestyle (Figure 1.7b).

**Diet-Gene Interactions**

Diet 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 (Figure 1.8). Your genetic makeup determines the impact a certain nutrient will have on you. For example, some people inherit a combination of genes that

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**Overnutrition • Figure 1.7**

a. Obesity is a form of overnutrition that 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 who are getting fatter. An estimated 17% of U.S. children and adolescents, ages 2 to 19 years, are obese.

b. The top three causes of death in the United States are nutrition related. They are all thought to be exacerbated by obesity.

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**Interpreting Data**

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

- a. 5%
- b. 10%
- c. 50%
- d. 90%
Choosing a Healthy Diet

LEARNING OBJECTIVES

1. Explain why it is important to eat a variety of foods.
2. Describe how 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. Such a healthy diet is rich in whole grains, fruits, and vegetables; high in fiber; moderate in fat, sugar, and sodium; and low in unhealthy fats (saturated fat, cholesterol, and trans fat). In short, a healthy diet is based on variety.

nutritional genomics or nutrigenomics The study of how diet affects our genes and how individual genetic variation can affect the impact of nutrients or other food components on health.

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?
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 high-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. Making varied choices both from the different food groups and 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 diet, as long as your diet throughout the day or week provides enough of all the nutrients you need without excesses of any. When you choose a food that is lacking in fiber, for example, balance it with one that provides lots of fiber. When you choose a food that is very high in fat, balance that choice with a low-fat one.

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 1.9).

**Balance calories in with calories out • Figure 1.9**

To keep your weight stable, you need to burn the same number of calories as you consume. Extra calories consumed during the day can be balanced by increasing the calories you burn in physical activity.

If you have a Big Mac for lunch instead of a smaller plain burger, you will have to increase your energy expenditure by 300 Calories.

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

If you have a grande Mocha Frappuccino instead of a regular iced coffee, you will have to increase your energy expenditure by 370 Calories.

You could do this by jogging for about 30 minutes.

Ask Yourself

If you add a daily grande Mocha Frappuccino to your usual diet and do not increase your activity, what will happen to your weight?
WHAT SHOULD I EAT?
A Healthy Diet

Eat a variety of foods
• Mix up your snacks by having salsa and chips one day and fruit, nuts, or a granola bar 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. Have fish one day and beef the next—or skip the meat and have beans.

Balance your choices
• Going out to dinner? Have a salad for lunch.
• Add a vegetable instead of pepperoni to your pizza.
• When you have cookies for a snack, have fruit for dessert.
• Had soda with lunch? Have low-fat milk with dinner.

Practice moderation
• Push back from the table before you are stuffed and go for a walk.
• Reduce your portions by using a smaller bowl.
• Skip the seconds or split your restaurant meal with a friend.
• If you eat some extra fries, take some extra steps.

Practice Moderation
Moderation means not overdoing it—not having too many calories, too much fat, too much sugar, too much salt, or too much alcohol. Choosing moderately 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 (see What Should I Eat?).

The fact that more than 68% of adult Americans are overweight or obese demonstrates that we have not been practicing moderation when it comes to calorie intake. One of the main culprits is likely the size of our food portions. The sandwiches, soft drinks, and French fry orders served in fast-food restaurants today are two to five times larger than what they were 40 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. Moderation makes it easier to balance your diet and allows you to enjoy a greater variety of foods.

CONCEPT CHECK
1. Why is variety in a diet important?
2. How might you balance the 400-Calorie cinnamon roll you had for a morning snack with your lunch choice?
3. What is the connection between obesity and moderation in a diet?

Evaluating Nutrition Information
LEARNING OBJECTIVES
1. Explain 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 correct and update previous knowledge 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 1.10). 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.

The scientific method • Figure 1.10

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 Caucasian Americans who eat the same diet. Result: The Japanese people who eat the U.S. diet have the same higher incidence of colon cancer as Caucasian Americans.

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.

5 If experimental results do not support the hypothesis, a new hypothesis can be formulated. As new information becomes available, even a theory that has been accepted by the scientific community for years can be proved wrong.

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

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.
**How Scientists Study Nutrition**

Many different types of experiments 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 experiments evaluate the affect of a particular dietary change on health. Some of these experiments study humans, others use animals; some look at whole populations, others study just a few individuals; and some use just cells or molecules (Figure 1.11). For any nutrition study to provide reliable information, it must collect quantifiable data from the right experimental population, use proper experimental controls, and interpret the data accurately.

Reliable data can be quantified, meaning that they 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.

For an experiment to answer the right question, scientists must study the appropriate group of people. For an experiment to determine whether a treatment does or does not have an effect, it must include enough subjects. For example, if a dietary supplement claims to increase bone strength in older women, it must be tested in older women and include enough subjects to demonstrate that the supplement 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 for four weeks 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 when the supplement is taken.

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.

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 muscle strength, the control group would consist of individuals of similar age, gender, and ability, eating similar diets and following similar workout regimens as individuals in the experimental group. Instead of the supplement, the control subjects would consume a **placebo**, a fake product that is identical in appearance to the dietary supplement.

When an experiment has been completed, the results must be interpreted. Accurate interpretation 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 American Dietetic Association*, *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* and the *Harvard Health Letter*, 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 health care 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**.
a. Epidemiological studies
Epidemiological studies of populations around the world explore the impact of nutrition on health. If you were to measure saturated fat intake and the incidence of heart attacks in populations around the world, you might get a graph that looks like this one. It indicates that a high percentage of calories from saturated fat in a population is associated with an increased incidence of heart attacks. However, epidemiology does not determine cause-and-effect relationships—it just identifies patterns. Therefore, it cannot determine whether the higher incidence of heart attacks is caused by the high intake of saturated fat.

b. Clinical trials
The observations and hypotheses that arise from epidemiology can be tested using clinical trials. Nutrition clinical trials are studies that explore the health effects of altering people's diets—for instance, the possible effects of eliminating meat on blood cholesterol levels.

c. Animal studies
Ideally, studies of human nutrition should be done with human subjects. However, 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 are a good model for studying heart disease, but even the best animal model is not the same as a human, and care must be taken when extrapolating animal results to humans.

d. Biochemistry and molecular biology
Laboratory-based techniques can be used to study nutrient functions in the body. For example, 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 regulate our genes.
Behind the Claims

This product must be amazing! It will increase your muscle strength, decrease your body fat, and boost your drive and motivation. This is what consumers see. The claims sound great, but a scientist looking at the same ad may have some concerns.

First of all, the claims about muscle strength and motivation are testimonials based on individuals’ feelings and impressions, and these are not objective measures.

A scientist would also question whether the research evidence supports the claim that the product increases lean body mass and decreases body fat. The study measured the amount of lean tissue and fat tissue in weightlifters before and four weeks after they began consuming the POWER BOOST drink. The measures used provide quantifiable, repeatable data. The results report a gain of 5.2 lb of lean tissue and a loss of 4.5 lb of fat tissue in weightlifters taking POWER BOOST. This looks convincing, but the results for the control group are not reported in the ad. When the results for the experimental group are compared to those for the control group, a different picture emerges. This comparison (see graph) shows that the control group gained almost as much lean mass and lost slightly more fat mass than the group taking POWER BOOST.

Power Boost

4 out of 5 users report:

“It increased my muscle strength.”

“It pumped up my drive and motivation!”

POWER BOOST

Years of research were needed to develop this special nutritional formulation. Just mix with water and drink one shake with every meal or snack.

In a university study, 25 experienced weightlifters consumed one POWER BOOST shake at meals and snacks, 5 times a day for 4 weeks.

Lean body mass and fat mass were measured by underwater weighing before the study began and after 4 weeks of training while taking POWER BOOST.

RESULTS

The weightlifters gained an average of 5.2 lbs of lean muscle and lost 4.5 pounds of unwanted fat.

Think Critically

Based on the information in the graph, explain why you would or would not recommend this product.
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). 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.

Let’s now look at questions that can help you evaluate any piece of 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 (Figure 1.12), but government recommendations regarding healthy dietary practices and information disseminated by universities generally are. 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 or anyone else. These individuals’ results are not compared to those for a control group or subjected to scientific evaluation. Therefore, it cannot be assumed that similar results will occur in other people.

Individual testimonies are not proof • Figure 1.12

Weight-loss product advertisements commonly show before-and-after photos of people who have successfully lost weight using the product. The success of such individuals is not a guarantee that the product they used will produce the same results for you or anyone else. These individuals’ results are not compared to those for a control group or subjected to scientific evaluation. Therefore, it cannot be assumed that similar results will occur in other people.
The Issue: Poor dietary habits in the United States have resulted in a largely unfit, unhealthy nation. Should we as individuals take responsibility for our diet and health, or should the government intervene?

The typical U.S. diet is not as healthy as it could be. Our lack of discretion has contributed to our high rates of obesity, diabetes, high blood pressure, and heart disease. This is not only the concern of the individuals whose lives it affects but also the government. The dollar cost to our health care system is huge; half of the $147 billion per year the United States spends on obesity comes from government-funded Medicare and Medicaid. Government concern is not just financial. The fact that almost one in four applicants to the military is rejected for being overweight is suggested to be a threat to national security and military readiness.

So, who is responsible for our unhealthy diet, and who should be responsible for changing what we eat? Proponents of more government involvement in our food choices suggest that our food environment is the cause of our unhealthy eating habits. Obesity expert Kelly Brownell believes that environment plays a more powerful role in determining food choices than does personal irresponsibility. Brownell and other proponents of government intervention argue that the government should treat our noxious food environment like any other public health hazard.

Americans want the personal freedom to choose what they eat, but that has not stopped people from blaming fast-food for their health problems.

(See Debate: How involved should the government be in your food choices?). 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 American Dietetic Association and the American Medical Association are also reliable sources of nutrition information.

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 “nutrition counselors” may provide accurate information, these terms are not legally defined and are used by a wide range of people, from college professors with doctoral degrees from reputable universities to health food store clerks with no formal training.

One reliable source of nutrition information is registered dietitians (RDs). An RD is a nutrition professional who has earned a four-year college degree in a nutrition-related field and has met established criteria for certification to provide nutrition education and counseling.

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 in newspapers and magazines and on television may also be biased or exaggerated because it is designed to help sell magazines or boost ratings, 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).
health threat and develop programs to keep us safe and healthy. Just as government regulations help to ensure that our food is not contaminated with harmful bacteria, laws could ensure that what you order at a restaurant will not contribute to heart disease or cancer. Unfortunately, unlike bacteria, individual foods are difficult to classify as healthy or unhealthy. Almost all food has some nutritional benefits, and the arguments as to what is a “junk food” and what we should add or subtract from our diets are ongoing. However, many people believe there are things that could be done to ensure healthier choices.

One option to encourage healthier choices suggested by proponents of government intervention is to tax junk food, making it more expensive, and increase subsidies for fruits and vegetables, making them less expensive. Other suggestions include zoning restrictions to keep fast-food restaurants away from schools and child-care facilities and limitations on the types of foods that can be advertised on children’s television. All these ideas have pros and cons, and none will absolve individuals of the responsibility for getting more exercise and making healthier food choices.

Opponents of government involvement believe it is an infringement on personal freedom and suggest that individuals need to take responsibility for their actions. They propose that the food industry work with the public to make healthier food more available and affordable. Many food companies have already responded to the need for a better diet; General Mills and Kellogg’s offer whole-grain cereals. And the giant food retailer Wal-Mart has announced a major campaign to make healthy food more affordable.

Our current food environment makes unhealthy eating easy. Opportunities for fatty, salty, and sweet foods are available 24/7, and the portions offered are often massive. To preserve our public health, the United States needs to change the way it eats. This change could be driven by government regulations and taxes, it could come from changes in the food industry, or it could come from individuals taking more responsibility for their choices and their health. A synergy of policy intervention, industry cooperation, and personal efforts is likely needed to solve the crisis.

Think critically: If someone eats fast-food daily and becomes obese, is that person to blame for eating the food, or is the restaurant to blame for not informing the person of the health risks?

Results may be misinterpreted in order to sell products • Figure 1.13

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.
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.

CONCEPT CHECK

1. What is the difference between a hypothesis and a theory?
2. How is epidemiology used to study nutrition?
3. Why are control groups important in any scientific experiment?
4. Why is information in advertisements likely to be exaggerated or inaccurate?

Summary

1 Food Choices and Nutrient Intake  4

- 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.

Nutrient density • Figure 1.1a

- 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 by many factors other than nutrition, including food availability; what we learn to eat from family, culture, and traditions; personal tastes; and what we think we should eat to maintain health.

2 Nutrients and Their Functions   8

- 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, forming and maintaining the structure of our bodies. All six classes of nutrients help regulate body processes. The energy, structure, and regulation provided
The diet you consume can affect your genetic predisposition for developing a variety of chronic diseases.

**Nutrient functions • Figure 1.5b**

- 16% Minerals, carbohydrates, and other substances
- 16% Protein
- 62% Water

**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 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.

**Balance calories in with calories out • Figure 1.9**

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

**Nutrition in Health and Disease • 11**

- Your diet affects your health. The foods you choose contain the nutrients needed to keep you alive and healthy and prevent malnutrition. 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.
Evaluating Nutrition Information

• Nutrition uses the scientific method to study the relationships among food, nutrients, and health. The scientific method, illustrated here, 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.

The scientific method • Figure 1.10

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

<table>
<thead>
<tr>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>More people get colon cancer in the United States than in Japan.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>The lower incidence of colon cancer in Japan than in the United States is due to differences in the diet.</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compare the incidence of colon cancer of Japanese people who move to the United States and consume a typical U.S. diet with Caucasian Americans who eat the same diet. Result: The Japanese people who eat the U.S. diet have the same higher incidence of colon cancer as Caucasian Americans.</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>The U.S. diet contributes to the development of colon cancer.</td>
</tr>
</tbody>
</table>

5. If experimental results do not support the hypothesis, a new hypothesis can be formulated. 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 8
• calorie 4
• carbohydrates 8
• cholesterol 8
• control group 18
• designer food or nutraceutical 7
• dietary supplement 5
• element 8
• energy-yielding nutrient 8
• epidemiology 18
• essential nutrient 4
• evidence-based practice 18
• experimental group 18
• fiber 8
• fortification 5
• functional food 6
• genes 12
• hormone 11
• hypothesis 17
• kilocalorie 8
• lipids 8
• macronutrient 8
• malnutrition 11
• micronutrient 8
• mineral 8
• nutrient density 4
• nutrient 4
• nutritional genomics or nutrigenomics 13
• organic compound 8
• osteoporosis 11
• overnutrition 12
• peer-review process 18
• phytochemical 5
• placebo 18
• protein 8
• saturated fat 8
• scientific method 17
• theory 17
• undernutrition 11
• unsaturated fat 8
• variable 18
• vitamin 8
• zoochemical 5
Critical and Creative Thinking Questions

1. Zach eats in the dorm cafeteria. He has a banana and a glass of orange juice for breakfast and potatoes or corn for dinner every day, but he doesn’t eat any other fruits or vegetables. How could his choices be improved? Why is such an improvement important?

2. A typical fast-food meal consists of a cheeseburger, French fries, and a soft drink. Use iProfile or the Nutrient Composition of Foods booklet to calculate the calories in this meal. How long would a person of your gender, height, and weight need to jog to burn off the calories in this meal?

3. A NASA space probe finds life on a distant planet. An analysis of the food supply for these organisms reveals three classes of nutrients, which NASA names vital A, nutrion, and essential S. The table below shows the amounts of these nutrients in the food supply and the amounts in the organisms’ bodies. Based on these data, predict whether each nutrient provides energy, structure, or regulation for these organisms. Explain your answers.

<table>
<thead>
<tr>
<th>Nutrient class</th>
<th>Amount in the food supply</th>
<th>Amount in the body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital A</td>
<td>65%</td>
<td>Less than 1%</td>
</tr>
<tr>
<td>Nutrion</td>
<td>15%</td>
<td>45%</td>
</tr>
<tr>
<td>Essential S</td>
<td>Less than 1%</td>
<td>Less than 1%</td>
</tr>
</tbody>
</table>

4. Which type of malnutrition—overnutrition or undernutrition—is most common in the United States today? Why?

5. A nutrition student observes that people who skip breakfast tend to be overweight more often than people who eat breakfast every day. He hypothesizes that people who skip breakfast get hungry later in the day and overeat, actually consuming more total calories in a day than people who eat breakfast. Propose an experiment that might be used to test this hypothesis.

6. Look up an advertisement for a dietary supplement on the Internet. What nutrients does the supplement contain? Does it contain substances that are not nutrients? Do you think this dietary supplement is worth the money? Why or why not?
What is happening in this picture?

Instead of playing basketball and hide-and-seek like American kids a generation ago, this boy is sitting in front of the television snacking and playing video games.

Self-Test

(Check your answers in Appendix K.)

1. True or false: If you choose a high-fat, high-salt fast-food lunch, your nutrient intake for the day cannot meet the recommendations for a healthy diet.
   a. True  
   b. False

2. Which of these foods has the lowest nutrient density?
   a. an orange  
   b. strawberry yogurt  
   c. whole-wheat bread  
   d. orange soda

3. This graph indicates that __________.

4. Which group consists only of nutrients that are classified as energy-yielding nutrients?
   a. vitamins and minerals  
   b. carbohydrates, lipids, and proteins  
   c. lipids, carbohydrates, proteins, and water  
   d. carbohydrates and vitamins

5. Which group consists only of nutrients that are considered micronutrients?
   a. protein and water  
   b. carbohydrates, lipids, and proteins  
   c. vitamins and minerals  
   d. minerals and water

6. Which nutrient class provides the most calories per gram?
   a. carbohydrates  
   b. proteins  
   c. lipids  
   d. vitamins

7. Based on this illustration, which nutrient class makes up the greatest proportion of body weight?
   a. protein  
   b. carbohydrate  
   c. fat  
   d. water

Think Critically

1. What impact do you think this lifestyle change has had on the balance between food intake and activity?
2. How have video games impacted the incidence of childhood obesity?
3. Do you think active video games (such as Wii games) will help American children increase their activity level?

100
80
60
40
20
0

Lean adult male

Body weight (percent)

6% Minerals, carbohydrates, and other substances
16% Fat
16% Protein
62% Water

Calories
Calcium (mg)
Vitamin D (IU)
Vitamin A (μg)

amount per cup

Low-fat milk
Sweetened iced tea

a. low-fat milk contains more calcium per calorie than iced tea
b. low-fat milk is a poor source of calcium
c. iced tea is more nutrient dense than milk
d. low-fat milk has less vitamin D per calorie than iced tea

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8. Which of these statements about essential nutrients is false?
   a. If you do not get enough of them in your diet, your body will synthesize enough to meet its needs.
   b. If you do not get enough of them in your diet, deficiency symptoms will eventually appear.
   c. Some of them provide energy.
   d. Some of them provide structure.

9. Why is it better to obtain your vitamins and minerals from foods than from dietary supplements?
   a. Dietary supplements are more likely to contain toxic amounts of nutrients.
   b. Foods provide a greater variety of phytochemicals and zoochemicals.
   c. Foods provide pleasurable tastes and aromas.
   d. All of the above are correct.

10. Which of these factors can limit the availability of food?
    a. socioeconomic status
    b. health status
    c. living conditions
    d. All of the above are correct.

11. A diet that follows the principles of variety, balance, and moderation __________.
    a. can include all kinds of foods
    b. includes only foods that have high nutrient density
    c. includes exactly the right amount of each nutrient each day
    d. includes only unprocessed foods

12. Which of these sources would be most likely to exaggerate the beneficial effects of a dietary supplement?
    a. a government publication
    b. a dietitian’s recommendations
    c. a pamphlet published by the supplement manufacturer
    d. a peer-reviewed article in a scientific journal

13. When the scientific method is used, a hypothesis is first proposed and then tested through experimentation. Which of the following hypotheses can be tested by means of experiments that use a quantifiable measure?
    a. Iron supplements increase feelings of vitality.
    b. A high vitamin E intake makes you feel younger.
    c. Eating an apple a day will lower blood cholesterol.
    d. B vitamin supplements give you an energy boost.

14. The information in this graph was collected in an epidemiological study. Which of the following statements is true?

   ![Graph showing 10-year heart attack incidence per 10,000 people vs. Percentage of calories from saturated fat]
   a. A diet that is high in saturated fat causes heart disease.
   b. A higher incidence of heart attacks is associated with a higher intake of saturated fat.
   c. People who lower their intake of saturated fat will have fewer heart attacks.
   d. Moving to a country with less heart disease will lower your intake of saturated fat.

15. In a scientific experiment, a group that is identical to the experimental group in every way except that its members do not receive the treatment being tested is called __________.
    a. a control group
    b. a placebo
    c. a variable
    d. an alternative group

Review your Chapter Planner on the chapter opener and check off your completed work.