chapter 1

WHAT NOURISHES YOU?

Do you need to take vitamin and mineral supplements? Are you eating too much fat and cholesterol? Is much of what you eat unsafe? Are some foods actually *junk foods?* Should you become a vegetarian? If you're confused about what you should eat, you are not alone. This chapter will help you sort out some of these issues as you are introduced to the science of nutrition.

And, as you begin this study of nutrition, keep in mind what nutrition expert Dr. Irwin Rosenberg has written as his "bottom line" for a healthy lifestyle: "Research has shown no better way to slow or even reverse the progress of aging itself and of all the age-related degenerative conditions than through the combination of aerobic and strength-building exercise and a balanced, nutritious diet." Overall, it is clear that the nutritional lifestyles of some (but not all) Americans are out of balance with their physiology.[17] And, since we live longer than our ancestors, preventing the age-related diseases that develop later in life is a more important focus today than in the past.

By optimizing dietary choices, we can strive to bring the goal of a long, healthy life within reach.[26] This is the primary theme not just in this chapter but throughout this entire book.

CHAPTER OUTLINE

Key Chapter Concepts

- A varied diet coupled with regular physical activity contributes to good health.
- Unfortunately, poor nutrition contributes to much of the age-related disease Americans experience.
- Nutrients are classed into six major groups: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, and water. The lipids are especially rich in energy.
- Foods, rather than nutrient supplements, deserve the major focus in diet planning. Nutrition experts especially advocate increasing whole-grain breads and cereal, fruit, and vegetable intake.
- The scientific method is the procedure for testing the validity of possible explanations, called hypotheses. Only after we have much experimental information that supports a specific hypothesis should we embrace a concept and consider adopting the suggested dietary practice.
- There are no “junk” or “bad” foods per se. Focusing on one’s total diet is the best approach for obtaining essential nutrients.
- Because genetic background influences health, family history for disease is important to consider. It is advisable to recognize this relationship and to take appropriate preventive action when possible.

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CHAPTER OPENER PHOTO

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PAGE 8.

Case Scenario

Brendon listens to talk radio as he commutes to school each morning. He hears numerous advertisements for food supplements. Commentators also warn about the dangers of certain lifestyle practices. News briefs discuss the latest breakthroughs, touting new findings regarding both positive and negative health practices. Typical terms he hears are *heart disease, diabetes, colon cancer, obesity, vitamin E, omega-3 fatty acids, cholesterol,* and *creatine phosphate.* These are all topics generally covered in an introductory nutrition class. One advantage of taking such a class is to be able to decipher the health news that one reads in newspapers, hears on the radio, and is exposed to via television.

Start your exploration of nutrition by looking up these terms in the glossary at the back of this book. You will likely find this an interesting task, one that will heighten your awareness of nutrition and, so, help you in your study of nutrition. Also consider adding a few other words you are curious about and look those up as well.

NUTRITION AND YOUR HEALTH

In your lifetime, you will eat about 70,000 meals and 60 tons of food. This opening chapter will take a close look at the general classes of nutrients supplied by this food intake, the role research plays in sorting out which food components are essential for the maintenance of health, and the powerful effect of genetic background in determining both nutrition-related and overall health.

What Actually Is Nutrition?

The Council on Food and Nutrition of the American Medical Association defines *nutrition* as "The science of food, the nutrients and the substances therein, their action, interaction, and balance in relation to health and disease, and the process by which the organism ingests, digests, absorbs, transports, utilizes, and excretes food substances."

Nutrients Come from Food

What is the difference among food, nutrients, and nutrition? Food provides both the energy and the materials needed to build and maintain all body cells. Nutrients are the nourishing substances we must obtain from food. These essential substances are vital for growth and maintenance from infancy to adulthood. For a nutrient to be considered essential, two characteristics are needed. First, its omission from the diet must lead to a decline in certain aspects of human health, such as function of the nervous system. Second, if the omitted nutrient is restored to the diet before permanent damage occurs, those aspects of human health hampered by its absence should regain normal function.[12]

Some nutrients that perform life-sustaining functions can be produced by the body if they are missing from the diet. The essential nature of such nutrients sometimes is not clear-cut. For example, the body requires vitamin D, but the skin is capable of synthesizing its own vitamin D upon receiving sunlight. This reduces the need from dietary sources among people who experience regular sun exposure (see Chapter 9).

Why Study Nutrition?

Nutrition is one key to developing and maintaining a state of health that is optimal for you. In addition, much evidence points to poor diet coupled with a sedentary lifestyle as a **risk factor** for **chronic** diseases that are the leading causes of adult deaths: **heart disease, stroke, hypertension, diabetes,** and some forms of **cancer** (Table 1-1). Together, these disorders account for two-thirds of all deaths in the United States (Table 1-2). Not consuming enough essential **nutrients** in younger years also makes us more likely to suffer consequences of poor nutrition habits in later years, such as bone fractures from the disease **osteoporosis.** Iron-deficiency **anemia** is another possibility. At the same time, taking too much of a nutrient supplement—such as vitamin A, vitamin D, vitamin B-6, calcium, or copper—can be harmful. Another dietary problem, drinking too much alcohol, is associated with **cirrhosis** of the liver, some forms of cancer, accidents, and suicides.

All of these consequences of modern living are partly an "affliction of affluence." Note, however, that these diseases are often preventable.[14] Age fast or age slowly: It is partly your choice. Government scientists have calculated that a poor diet combined with a lack of sufficient physical activity account for 300,000 fatal cases of heart disease, cancer, and diabetes each year. Thus, the combination of poor diet and lack of physical activity is indirectly the second leading cause of death. In addition, **obesity** is considered the second leading cause of preventable death (smoking is the first).

As you gain understanding about your nutritional habits and increase your knowledge about nutrition, you have the opportunity to dramatically reduce your risk for many common health problems.[13] To help U.S. citizens, the federal government provides a web site that can link you to many sites providing health information (http://www.healthfinder.gov).

The major health problems in the United States are largely caused by excessive energy intake and not enough physical activity.

Table 1-1 Glossary Terms to Aid Your Introduction to Nutrition*

anemia Generally refers to a decreased oxygen-carrying capacity of the blood. This can be caused by many factors, such as iron deficiency or blood loss.
body mass index Weight (in kilograms) divided by height squared (in meters). A value of 25 or greater indicates a higher risk for body weight–related health disorders if one is overfat.
cancer A condition characterized by uncontrolled growth of abnormal cells.
cholesterol A waxy lipid found in all body cells; it has a structure containing multiple chemical rings (steroid structure). Cholesterol is found only in foods that contain animal products.
chronic Long-standing, developing over time. When referring to disease, this term indicates that the disease process, once developed, is slow and tends to remain; a good example is heart disease.
cirrhosis A loss of functioning liver cells, which are replaced by nonfunctioning connective tissue. Any substance that poisons liver cells can lead to cirrhosis. The most common cause is a chronic, excessive alcohol intake.
diabetes A disease characterized by high blood glucose (hyperglycemia), resulting from either insufficient or no insulin release by the pancreas or general inability of insulin to act on certain body cells, such as muscle cells.
heart disease A disease characterized by the deposition of fatty material in the blood vessels that serve the heart, often called hardening of the arteries. These deposits restrict blood flow through the heart, which in turn can lead to heart damage and death. Also termed *coronary heart disease* (CHD), as the vessels of the heart are the primary site of disease.
hypertension A condition in which blood pressure remains persistently elevated. Obesity, inactivity, alcohol intake, and salt intake all can contribute to the problem.
kilocalorie (kcal) The heat energy needed to raise the temperature of 1000 g (1 liter) of water 1 degree Celsius. Also written as Calories, with a capital C.
nutrients Chemical substances in food, many of which are essential parts of a diet. Nutrients nourish us by providing energy, materials for building body parts, and factors to regulate necessary chemical processes in the body. The body either can't make these nutrients or can't make them in sufficient amounts for its needs.
obesity A condition characterized by excess body fat, typically defined in clinical settings as a body mass index (BMI) $\geq$ 30.
osteoporosis Decreased bone mass where no obvious causes can be found. This bone loss is related to the effects of aging, genetic background, poor diet, and hormonal effects of postmenopausal status in women.
risk factor A term used frequently when discussing diseases and factors contributing to their development. A risk factor is an aspect of our lives—such as heredity, lifestyle choices (i.e., smoking), or nutritional habits—that may make us more likely to develop a disease.
stroke The loss of body function that results from a blood clot or other change in arteries in the brain that affects blood flow. This in turn causes the death of brain tissue. Also called a *cerebrovascular accident.*

*All bold terms in the book are defined in a glossary, which follows Chapter 20. Many of these key terms are also defined in the chapter margin.

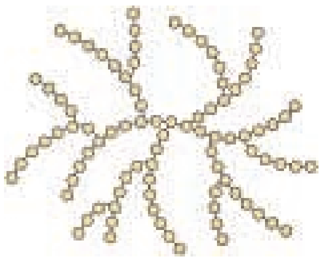
Table 1-2 Ten Leading Causes of Death in the United States

Rank	Cause of Death	Percent of Total Deaths
	All causes	100
1	Heart disease (primarily heart attack)*‡	31
2	Cancer*‡	23
3	Cerebrovascular diseases (stroke)*‡	
4	Chronic obstructive pulmonary diseases and allied conditions (lung diseases)‡	
5	Accidents and adverse effects†	
	Motor vehicle accidents	2
	All other accidents and adverse effects	2
6	Pneumonia and influenza	4
7	Diabetes*	3
8	Suicide†	1
9	Kidney disease*‡	1
10	Liver disease†	1

From Centers for Disease Control and Prevention, *National Vital Statistics Report,* October 7, 1998.
*Causes of death in which diet plays a part
†Causes of death in which excessive alcohol consumption plays a part
‡Causes of death in which tobacco use plays a part

Carbohydrate

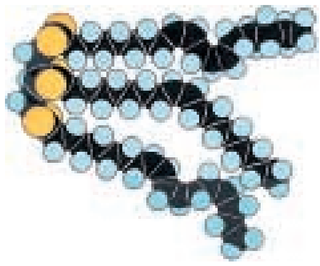
Glycogen
Storage form of carbohydrate in the body



Each yellow circle represents one glucose molecule.

Lipid

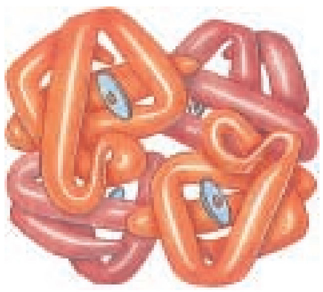
Triglyceride



The black, blue, and yellow circles represent carbon, hydrogen, and oxygen atoms, respectively, in the triglyceride molecule.

Protein

Hemoglobin



This protein, found in a red blood cell, is a structure formed of linked amino acids.

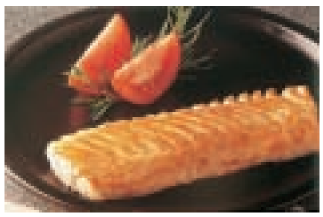


FIGURE 1-1 Two views of carbohydrates, lipids, and proteins—chemical and dietary perspectives.
Illustrations by William Ober.

carbohydrate A compound containing carbon, hydrogen, and oxygen atoms; most are known as sugars, starches, and dietary fibers.

protein Food and body components made of amino acids; proteins contain carbon, hydrogen, oxygen, nitrogen, and sometimes other atoms, in a specific configuration. Proteins contain the form of nitrogen most easily used by the human body.

lipid A compound containing much carbon and hydrogen, little oxygen, and sometimes other atoms. Lipids dissolve in ether or benzene, but not in water, and include fats, oils, and cholesterol.

vitamins Compounds needed in very small amounts in the diet to help regulate and support chemical reactions in the body.

minerals Elements used in the body to promote chemical reactions and to form body structures.

water The universal solvent; chemically, H_2O. The body is composed of about 60% water. Water (fluid) needs are about 8 cups per day; needs are greater if one exercises heavily (see Chapter 14).

CLASSES AND SOURCES OF NUTRIENTS

To begin the study of nutrition, let's start with an overview of the various classes of nutrients. You are probably familiar with the terms **carbohydrates, lipids** (fats and oils), **proteins, vitamins,** and **minerals** (Figure 1-1). These, plus **water,** make up the six classes of nutrients found in food.

Nutrients can then be assigned to three functional categories: (1) those that primarily provide us with energy (typically expressed in **kilocalories [kcal]**); (2) those that are important for growth, development, and maintenance; and (3) those that act to keep body functions running smoothly. Some overlap exists among these groupings. The energy-yielding nutrients make up a major portion of most foods.

Provide Energy	Promote Growth and Development	Regulate Body Processes
Carbohydrates	Proteins	Proteins
Proteins	Lipids	Lipids
Lipids (fats and oils)	Vitamins	Vitamins
	Minerals	Minerals
	Water	Water

Let's now look more closely at these six classes of nutrients.

Carbohydrates

Carbohydrates are composed mainly of the elements carbon, hydrogen, and oxygen. Carbohydrates provide a major source of fuel for the body, on average 4 kcal per gram (kcal/g). Small carbohydrate structures are called sugars or simple sugars. Table sugar (sucrose) is an example. Some simple sugars, such as **glucose,** can link chemically to form large storage carbohydrates, called polysaccharides or complex carbohydrates (see Fig. 1-1). An example of this type of carbohydrate is the **starch** in potatoes.

glucose A six-carbon carbohydrate found in blood and in table sugar bound to fructose; also known as *dextrose,* it is one of the simple sugars.

Aside from enjoying their taste, we need sugars and other carbohydrates in our diets primarily to satisfy the energy needs of body cells. Glucose, which the body can produce from most carbohydrates, is a primary source of energy in most cells. When not enough carbohydrate is eaten to supply sufficient glucose, the body is forced to make glucose from proteins. However, a typical North American diet contains more than enough carbohydrate to prevent this from happening.[28]

Many basic chemistry concepts are reviewed in Appendix B. If you are unfamiliar with chemistry terms, you will find the review quite helpful.

Digestion of some dietary starch begins in the mouth. The digestive process continues in the small intestine until starches break down into single sugar molecules (such as glucose), which are absorbed into the bloodstream (see Chapter 3 for more on digestion). However, the links between the sugar molecules in certain complex carbohydrates cannot be broken down by human digestive processes. These carbohydrates are part of what is called **dietary fiber.** Such dietary fiber passes through the small intestine undigested to provide bulk for the stool (feces), which is formed in the large intestine (colon). Chapter 5 focuses on carbohydrates.

dietary fiber Substances in food (essentially from plants) that are not digested by the processes that take place in the stomach or small intestine. These add bulk to feces.

Lipids

Lipids (mostly fats and oils) are composed of the elements carbon and hydrogen; they contain fewer oxygen atoms than carbohydrates. Because of this difference in composition, lipids yield more energy per gram than carbohydrates—on average, 9 kcal/g. (See Chapter 4 for more details concerning the reason for the high-energy yield of lipids.) Lipids are insoluble in water but dissolve in certain organic solvents (e.g., ether and benzene).

The basic structure of most lipids is the three-carbon glycerol molecule with a fatty acid attached to each of the three carbons (see Fig. 1-1). This form of lipid is generally called a **triglyceride.** Triglycerides are a key energy source for the body and the major form of fat in foods. They are also the major form for energy storage in the body.

triglyceride The major form of lipid in the body and in food. It is composed of three fatty acids bonded to glycerol, an alcohol. May also be called a triacylglycerol, since the form of fatty acid attached exists as an acyl group (see Appendix B).

In this book, the more familiar term, *fats* or *fats and oils,* will generally be used, rather than *lipids* or *triglycerides.* Roughly speaking, fats are lipids that are solid at room temperature, and oils are lipids that are liquid at room temperature.

Most lipids can be separated into two basic types—saturated and unsaturated—based on the chemical structure of their dominant fatty acids. This property determines whether such a lipid is solid or liquid at room temperature. Plant oils tend to contain many unsaturated fatty acids, which makes them liquid. Animal fats are often rich in saturated fatty acids, which makes them solid. Almost all foods contain a variety of saturated and unsaturated fatty acids.

Much attention has been given to saturated fat in the past few years. This is because saturated fat bears a great deal of the responsibility for raising blood cholesterol. High blood cholesterol leads to clogged arteries and, so, can eventually lead to heart disease. For this reason, it is recommended that people limit the amount of saturated fat in their diet.

Certain unsaturated fatty acids are essential nutrients. These key fatty acids that the body can't produce, called essential fatty acids, perform several important functions in the body: they help regulate blood pressure and play a role in the synthesis and repair of vital cell parts. However, we need only about 1 tablespoon of a common vegetable oil (such as the canola or soybean oil found in supermarkets) each day to supply the essential fatty acids. The average American diet supplies about three times the amount of essential fatty acids needed daily.[28] Adding fish in a diet twice a week adds to this benefit derived from the inclusion of vegetable oil. The unique fatty acids in fish complement the healthy aspects of vegetable oil. This will be explained in greater detail in Chapter 6, which focuses on lipids.

Proteins

Like carbohydrates and fats, proteins are composed of the elements carbon, oxygen, and hydrogen. But, unlike the other energy-yielding nutrients, all proteins also contain much nitrogen. Proteins are the main structural material in the body (see Fig. 1-1). For example, proteins constitute a major part of bone and muscle; they are also important components in blood, cell membranes, and immune factors. Furthermore, proteins can also provide energy for the body—on average, 4 kcal/g. Typically, the body uses little protein for that purpose of meeting daily energy needs. Proteins are formed by the linking of **amino acids.** Twenty common amino acids are found in food; nine of these are essential nutrients for adults, and one additional one for infants.

amino acid The building block for proteins containing a central carbon atom with a nitrogen atom and other atoms attached.

Most of us eat about one and a half to two times more protein than the body needs to maintain health.[28] In a healthy person (i.e., no evidence of heart disease, osteoporosis, kidney disease, or diabetes or family history of colon cancer), this amount of extra protein in the diet is generally not harmful—it simply reflects the standard of living and the dietary habits of most Americans. The excess is mostly used for fuel; some may be converted into fat or carbohydrate. Chapter 7 focuses on proteins.

Many health-food stores market protein powders and shakes for bodybuilders and other athletes. As noted in this section, the American diet contains nearly two times the required amount of protein. Thus, these products are unnecessary; diet can suffice.

Three other classes of nutrients are vitamins, minerals, and water. Although vitamins and minerals are vital to good health, they are needed only in small amounts in the diet and provide no direct source of energy for the body.

Uninformed nutrient supplement use can lead to health problems. Chapter 9 will explore the appropriate and safe use of supplements in detail.

Vitamins

Vitamins exhibit a wide variety of chemical structures and can contain the elements carbon, hydrogen, nitrogen, oxygen, phosphorus, sulfur, and others. The main function of vitamins is to enable many chemical reactions to occur in the body. Some of these reactions help release the energy trapped in carbohydrates, lipids, and proteins. Remember, however, that vitamins themselves provide no usable energy for the body.

The 13 vitamins are divided into two groups: four that are fat soluble (vitamins A, D, E, and K) and nine that are water soluble (vitamin C and the B vitamins). The two groups of vitamins often act quite differently. For example, cooking destroys water-soluble vitamins much more readily than it does fat-soluble vitamins. Water-soluble vitamins are also excreted from the body much more readily than are fat-soluble vitamins. Thus, the fat-soluble vitamins, especially vitamins A and D, are much more likely to accumulate in excessive amounts in the body, which then can cause toxicity. The vitamins are the focus of Chapters 9 and 10.

Minerals

The nutrients discussed so far are all **organic** compounds, whereas minerals are structurally very simple, **inorganic** substances, which exist as groups of one or more of the same atoms. These terms, *organic* and *inorganic,* have nothing to do with gardening but are based on simple chemistry concepts.

organic Anything that contains carbon atoms bonded to hydrogen atoms in the chemical structure.

inorganic Anything lacking carbon atoms bonded to hydrogen atoms in the chemical structure.

Minerals typically function as such in the body (Na^+, K^+), or as parts of simple mineral combinations, such as bone mineral [$Ca_{10}(PO_4)_6\ OH_2$]. Because of their simple structure, minerals are not destroyed during cooking, but they can still be lost if they leak into the water used for cooking and then are discarded if that water is not consumed. Although minerals themselves yield no energy as such for the body, they are critical players in nervous system functioning, other cellular processes, water balance, and structural (e.g., skeletal) systems.

The amounts of the 16 or more essential minerals that are required in the diet for good health vary enormously. Thus, they are divided into two groups: major minerals and trace minerals, based on dietary needs. If daily needs are less than 100 mg, the mineral is put in the trace mineral class. The actual dietary requirement for some trace minerals has yet to be determined. Minerals are the focus of Chapters 11 and 12.

CRITICAL THINKING

Believing that supplements provide the nutrition her body needs, Janice regularly takes numerous supplements while paying relatively little attention to daily food choices. How would you explain to her that this practice may lead to health problems?

For suggested answers to the Critical Thinking questions in this and every chapter, turn to the back of the book.)

Water

Water is the sixth class of nutrients. Although sometimes overlooked as a nutrient, water (chemically, H_2O) has numerous vital functions in the body. It acts as a **solvent** and lubricant, as a medium for transporting nutrients and waste, and as a medium for temperature regulation and chemical processes. For these reasons, and because the human body is approximately 60% water, we require about 2 liters (L)—equivalent to 2000 g or 8 cups—of water and fluids containing water every day.

Water is not only available from the obvious sources, but it is also the major component in some foods, such as many fruits and vegetables (e.g., lettuce, grapes, and melons). The body even makes some water as a by-product of **metabolism.** Water is examined in detail in Chapter 11.

solvent A substance that other substances dissolve in.

metabolism Chemical processes in the body by which energy is provided in useful forms and vital activities are sustained.

NUTRIENT COMPOSITION OF DIETS AND THE HUMAN BODY

The quantities of the various nutrients that people consume vary widely, and the nutrient amounts present in different foods also vary a great deal. The total daily intake of protein, fat, and carbohydrate amounts to about 500 g. In contrast, the typical daily mineral intake totals about 20 g, and the daily vitamin intake totals less than 300 mg. Although each day we require nearly a gram of some minerals, such as calcium and phosphorus, we need only a few milligrams or less of other minerals. For example, we need about 15 mg of zinc per day, which is just a few specks of the mineral.

Figure 1-2 contrasts the relative concentrations of all the major classes of nutrients in a lean man and a lean woman with the composition of both a cooked steak and a cooked stalk of broccoli. Note how the nutrient composition of the body differs from the nutritional profiles of the foods we eat. This is because growth, development, and later maintenance of the human body are directed by the genetic material inside the cell nucleus.[23] This genetic blueprint determines how each cell uses the essential nutrients to perform body functions. These nutrients can come from a variety of sources. Cells are not concerned whether available amino acids come from animal or plant sources. The carbohydrate glucose can come from sugars or starches. Thus, you really aren't what you eat. Rather, what you eat provides cells with basic materials to function according to the directions supplied by the genetic material **(genes)** housed in the cell (see the Nutrition Perspective at the end of this chapter).

genes The hereditary material on chromosomes that makes up DNA. Genes provide the blueprints for the production of cell proteins.

Alcoholic beverages are calorie rich, but alcohol is not a nutrient per se.

ENERGY SOURCES AND USES

We obtain the energy we need to perform body functions and do work from carbohydrates, fats, and proteins. Foods generally provide more than one energy source.

Vegetable oil is an exception; it is 100% fat. **Alcohol** is also a source of energy for some of us, supplying about 7 kcal/g. It is not considered a nutrient, however,

alcohol Ethyl alcohol (CH_3CH_2OH).

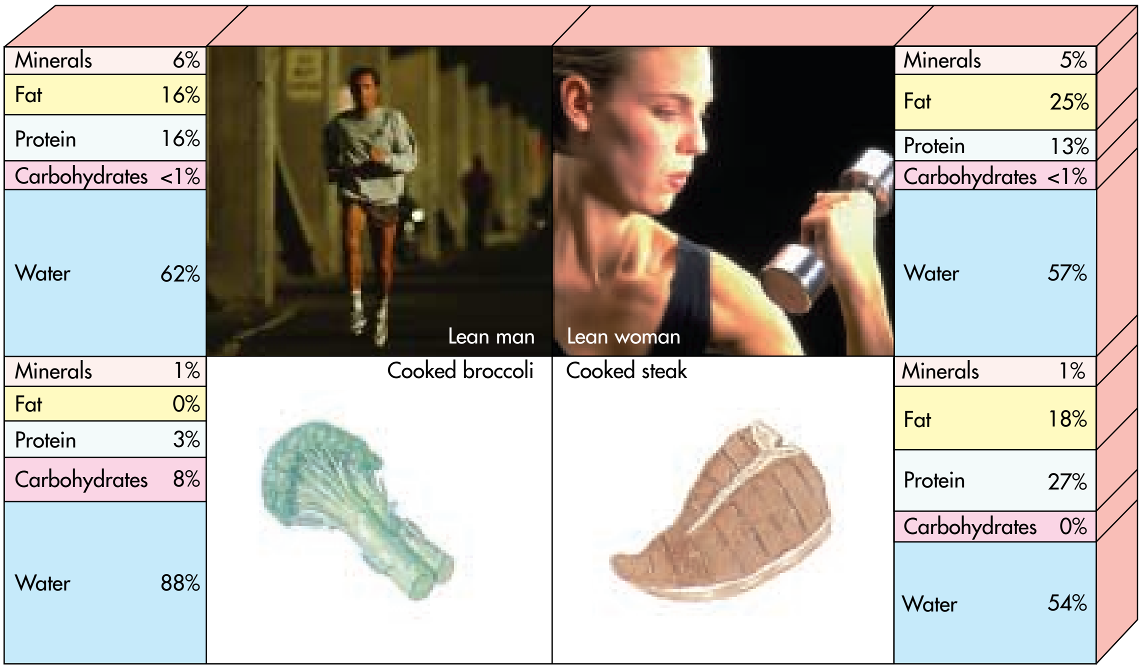


FIGURE 1-2 You aren't what you eat. The proportions of nutrients in the human body do not match those found in typical foods—animal or vegetable.

because it has no required function. Still, alcoholic beverages—generally also rich in carbohydrate—are typically a contributor of energy to the diet of adults.[28]

The body transforms the energy trapped in carbohydrate, protein, and fat (and alcohol) into other forms of energy in order to

- Build new compounds
- Perform muscular movements
- Promote nerve transmissions
- Maintain **ion** balance within cells

Chapter 4 describes how that energy is released from chemical bonds and then used by body cells to support the processes just described.

You have likely noticed on food labels that the energy in food is often expressed in terms of calories. Technically, a calorie is the amount of heat energy it takes to raise the temperature of 1 g of water 1 degree Celsius (1°C, centigrade scale). Because a calorie is such a tiny measure of heat, food energy is more accurately expressed in terms of the kilocalorie (kcal), which equals 1000 calories. A kcal is the amount of heat energy it takes to raise the temperature of 1000 g (1 L) of water 1°C. The term *kilocalorie* and its abbreviation *kcal* are used throughout this book. In everyday life, the word *calorie* is often used loosely to mean *kilocalorie*. The values given on food labels in calories are actually in kilocalories (Fig. 1-3). A suggested intake of 2000 calories per day on a food label is really 2000 kcal.

Carbohydrates, proteins, lipids, and alcohol provide the body with differing amounts of energy. Use the 4-9-4 estimates for carbohydrate, fat, and protein introduced over the last few pages to determine energy content of a food. Consider a typical deluxe hamburger sandwich:

Carbohydrate	39 grams × 4 = 156 kcal
Fat	32 grams × 9 = 288 kcal
Protein	30 grams × 4 = 120 kcal
Total	564 kcal

Note also that the 4-9-4 estimates have been adjusted for (1) **digestibility** and (2) substances not available for energy use. Such substances include waxes and some fibrous parts of plants. The energy values are then rounded to whole numbers.

ion An atom with an unequal number of electrons and protons. Negative ions have more electrons than protons; positive ions have more protons than electrons.

In many scientific journals, the kilojoule (kJ), rather than the kilocalorie, is used to express the energy content of food. A kilojoule is the amount of work needed to move 1 kilogram for 1 meter with the force of 1 newton. Since heat and work are just two forms of energy, measurements expressed in terms of kilocalories (a heat measure) are interchangeable with measurements expressed in terms of kilojoules (a work measure): 1 kcal = 4.18 kJ.

digestibility Corresponds to the proportion of food substances eaten that can be broken down into individual nutrients in the intestinal tract for absorption into the body.

Nutrition Facts

Serving Size 1 slice (36g) — Servings Per Container 19

Amount Per Serving

Calories 80 — Calories from Fat 10

	% Daily Value*		% Daily Value*
Total Fat 1g	**2%**	**Total Carbohydrate** 15g	**5%**
Saturated Fat 0g	**0%**	Dietary Fiber 2g	**8%**
Cholesterol 0mg	**0%**	Sugars less than 1g	
Sodium 200mg	**8%**	**Protein** 3g	

Vitamin A 0% Vitamin C 0% Calcium 0% Iron 4%

*Percent Daily Values (DV) are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

		2,000	2,500
Calories:		2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

INGREDIENTS: WHOLE WHEAT, WATER, ENRICHED WHEAT FLOUR [FLOUR, MALTED BARLEY, NIACIN, REDUCED IRON, THIAMINE MONONITRATE (VITAMIN B1) AND RIBOFLAVIN (VITAMIN B2)], CORN SYRUP, PARTIALLY HYDROGENATED COTTONSEED, OIL, SALT, YEAST.

HONEY WHEAT BREAD

FIGURE 1-3 Use the nutrient values on the Nutrition Facts label to calculate energy content of a food. A serving of this food contains 81 kcal ([15 × 4] + [3 × 4] + [1 × 9] = 81). The label lists 80, suggesting that the energy value was rounded down.

You can also use the 4-9-4 estimates to determine what portion of total energy intake is contributed by the various energy-yielding nutrients. Assume that one day you consume 290 g of carbohydrates, 60 g of fat, and 70 g of protein. This consumption yields a total of 1980 kcal ([290 × 4] + [60 × 9] + [70 × 4] = 1980). The percentage of your total energy intake derived from each nutrient can then be determined:

$$\text{\% of kcal as carbohydrate} = (290 \times 4) \div 1980 = 0.586 \text{ or } 59\%$$
$$\text{\% of kcal as fat} = (\ 60 \times 9) \div 1980 = 0.273 \text{ or } 27\%$$
$$\text{\% of kcal as protein} = (\ 70 \times 4) \div 1980 = 0.141 \text{ or } 14\%$$

Check your calculations by adding the percentages together. Do they total 100?

CONCEPT CHECK

Food contains vital nutrients that are essential for good health: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, and water. Nutrients have three general functions in the body: (1) to provide materials for building and maintaining the body; (2) to act as regulators for key metabolic reactions; and (3) to participate in metabolic reactions that provide the energy necessary to sustain life. A common unit of measurement for this energy is the kilocalorie (kcal).

INTEREST IN THE FIELD OF NUTRITION HAS A LONG HISTORY

The field that we call nutrition evolved primarily out of the fields of physiology, chemistry, and medicine.[12] Our interest in the relationship between food and the maintenance of health has a long history, beginning some 2400 years ago in Greece, during the time of Hippocrates. The Bible even contains references to the importance of certain foods, such as beans, for maintaining health.

The science of nutrition began in the 1600s in Europe. A British physician, Sydenham, in 1674 showed that iron filings in wine can be used to treat anemia. In the 1740s, a British naval surgeon, Lind, found that the consumption of citrus fruits—lemons and limes—cures the disease scurvy in sailors. Between 1770 and

1794, Lavoisier and Laplace in France discovered that certain carbon-containing compounds are the source of energy for body functions. Adding to this observation, in 1816 German scientist Magendie showed that dogs fed only carbohydrate and fat lost much body protein and died within a few weeks.

By 1830, it was known that foods contain three major constituents: proteins, carbohydrates, and fats. By 1850, at least six mineral elements—calcium, phosphorous, sodium, potassium, chloride, and iron—had been established as essential for the diets of higher animals. Nutrition as a scientific discipline was born. Scientists realized that components in foods, some of which are present in very small amounts, contribute to health.

During the 1880s, a Japanese physician, Takaki, showed that a common disease of sailors, called beriberi, can be treated with evaporated milk and meat. Later research in the Dutch East Indies by both Eijkman and Grijns showed that the same disease is associated with the use of refined rice, whereas use of the whole rice grain does not show the same problem. By 1901, it was assumed that refined rice lacks an essential nutrient (later called water-soluble B and then eventually found to be the vitamin thiamin), which was present in the whole-grain product.

In the 1890s, Rubner in Germany and Atwater in the United States established the energy (kcal) content of protein, carbohydrate, and fat. This research also quantified human energy output, showing that, on average, we expend about 2000 to 3000 kcal/day, with some variation at both ends of the range.

In 1906, the amino acid tryptophan was shown to be essential for mice by Willcock and Hopkins in Britain. By 1913, Osborne and Mendel in the United States had shown that food proteins are quite different in terms of their amino acid content.

The year 1912 was a banner year—the term *vitamin* was coined by Polish scientist Funk at this time to describe certain compounds present in very small amounts in foods that promote health. *Vita* came from the Latin for "life," and *amin* came from the term for nitrogen bonded to carbon (technically, called an amine). The *e* was dropped from *amine* to form *amin* in the 1920s, when it was shown that some vitamins do not contain nitrogen. Later, in 1913, American researchers McCollum and Davis showed that butterfat contains a protective dietary factor; this was called fat-soluble A.

By 1915, nutrition experts knew that six minerals, four amino acids, and three vitamins—A, B (later shown to be a group of vitamins), and the anti-scurvy factor (later shown to be ascorbic acid, which we also call vitamin C)—are essential nutrients. By 1918, the importance of consuming a wide variety of foods in order to consume an adequate quantity of nutrients had become a focus in dietary advice given throughout the United States and Europe.

From the 1920s to today, nutrition research has been a key part of the intense scientific inquiry that characterized the twentieth century. **Recommended Dietary Allowances** (RDAs) for nutrients were first published in the United States in 1943 in response to growing recognition of the poor nutritional health of many Americans. All known vitamins had been characterized by 1949. The research on vitamins such as thiamin, vitamin K, vitamin C, and vitamin B-12 even led to Nobel prizes such as for Eijkman, Dam, and Szent-Gyorgyi. By 1950, some 35 nutrients had been shown to be necessary to maintain human health. Today we know that the minimum diet for humans must contain about 45 essential nutrients in order to maintain health (Table 1-3).

In the 1950s, British researchers Watson and Crick described the structure of genetic material in cells, DNA. Today the Human Genome Project is extending that work by deciphering the human DNA code. This should help us understand the genetic effects on individual health status, as well as the possible genetic differences that lead to differences in human nutritional needs (see the Nutrition Perspective at the end of this chapter).

In 1968, Dudrick in the United States was able to support the nutrient needs of dogs using only intravenous feedings of purified nutrients. Soon after, it was shown

The vitamin-like compound choline plays essential roles in the body but is not listed under the vitamin category at this time. Rough estimates of human needs for this water-soluble compound recently have been set (see the inside cover of the text). Note, however, that body synthesis suffices during many stages of life (see Chapter 10 for details).

Table 1-3 Essential Nutrients in the Human Diet and Their Classes*

Energy-Yielding Nutrients

Carbohydrate	Fat (Lipids)†	Protein (Amino Acids)	Water
Glucose‡ (or a carbohydrate that yields glucose)	Linoleic acid (omega-6)	Histidine	Water
	α-Linolenic acid (omega-3)	Isoleucine	
		Leucine	
		Lysine	
		Methionine	
		Phenylalanine	
		Threonine	
		Tryptophan	
		Valine	

Vitamins		Minerals		
Water-Soluble	**Fat-Soluble**	**Major**	**Trace**	**Some Questionable Varieties**
Thiamin	A	Calcium	Chromium	Arsenic
Riboflavin	D§	Chloride	Copper	Boron
Niacin	E	Magnesium	Fluoride‖	Cadmium
Pantothenic acid	K	Phosphorus	Iodide	
Biotin		Potassium	Iron	
B-6		Sodium	Manganese	Nickel
B-12		Sulfur	Molybdenum	Silicon
Folate			Selenium	Tin
C			Zinc	Vanadium

*This table includes nutrients that the current *Dietary Reference Intakes* and related publications list for humans. Some disagreement exists over the questionable and certain other minerals not listed. Dietary fiber could be added to the list of essential substances, but it is not a nutrient (see Chapter 5). Alcohol is a source of calories but is not a nutrient per se.

†The lipids listed are needed only in slight amounts, about 2% of total energy needs (see Chapter 6).

‡To prevent ketosis and thus the muscle loss that would occur if protein were used to synthesize carbohydrate (see Chapter 5)

§Sunshine on the skin also allows the body to make vitamin D for itself (see Chapter 9).

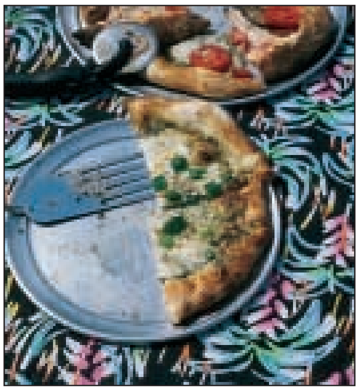
‖Primarily for dental health (see Chapter 12)

that this is also possible for humans. Thus, we had evidence that meeting the needs for nutrients known to be essential at that time sufficed to maintain health.

Over the past 30 years, interest in nutrition has grown. Health-conscious consumers are especially interested in the topic. Government policymakers stepped up their interest after the 1970 White House conference on food, nutrition, and health. Following this, more and more research supported the role of nutrition in the maintenance of health, as well as showed a link between poor nutrition (both inadequate and excessive intakes) and various health problems. And we have made much progress in the field of nutrition, but work needs to be done, and nutrition problems still plague peoples around the world.[9] In fact, the Worldwatch Institute estimates that the number of overweight people now equals the number of undernourished people in the world; each group contains roughly 1.2 billion people.

Current State of the American Diet

Humans derive energy mostly from carbohydrates, fats, and proteins. If we ignore alcohol, American adults consume about 16% of their kcal as proteins, 50% as



A market research firm surveyed the eating habits of people in 2000 American households. The top meal choice was pizza, followed by ham sandwich, hot dog, peanut butter and jelly sandwich, steak, macaroni and cheese, turkey sandwich, cheese sandwich, hamburger on a bun, and spaghetti.

carbohydrates, and 33% as fats. These percentages are estimates and vary slightly from year to year and from person to person. As a rough estimate, changing to a 10 to 15%, 55 to 60%, and 25 to 30% distribution of calories from protein, carbohydrate, and fat, respectively, is widely advocated. This advice contributes to a lower fat intake, a change that can lead to many health benefits (see Chapters 6 and 13).[2] Note that recommendations for different distributions of calories among protein, carbohydrate, and fat come and go in the popular press. The pros and cons of these patterns, such as the 45%, 15%, 40% pattern of carbohydrate, protein, and fat calories in the popular book *Syndrome X,* authored by Dr. Gerald Reaven and colleagues, will be reviewed in future chapters.

Animal sources supply about two-thirds of protein intake for most Americans; plant sources supply only about one-third. In many other parts of the world, it is just the opposite: plant proteins—from rice, beans, corn, and other vegetables—dominate protein intake. About half the carbohydrate in American diets comes from simple sugars; the other half comes from starches (such as in pastas, breads, and potatoes). About 60% of our dietary fat comes from animal sources and 40% from vegetable sources.[17]

Assessing the Current American Diet

Information about the American diet comes from large surveys designed to find out what and when people eat.[30] Results from these surveys and other studies, such as the Continuing Survey of Food Intakes of Individuals by the United States Department of Agriculture (USDA), show that we eat a wide variety of foods. Many people are meeting their nutrient needs; some are not. Chapter 2 will look at this situation in more detail. For now, note that studies show that some of us should choose more foods that are rich in iron, calcium, vitamin A, various B vitamins, vitamin C, zinc, and dietary fiber.[28] Many experts also recommend that we pay more attention to balancing energy intake with need. An excess intake of energy is usually tied to an overindulgence in sugar, fat, and alcoholic beverages. African-Americans may need to pay special attention to the amount of sodium (**salt** is a mixture of sodium and chloride) and alcohol in their diets. This is because they have a greater chance of developing hypertension than do other ethnic groups in America, and these substances are two of the many factors linked to that health problem. Actually, a careful look at sodium and alcohol intake—along with saturated and total fat and total energy intake—is a useful task for all adults.[15]

salt Generally refers to a compound of sodium and chloride in a 40:60 ratio.

On a per-person basis, Americans consumed roughly 18 pounds of butter and 270 pounds of whole milk per year in the 1920s and 1930s, whereas today we consume less than 5 pounds of butter and 111 pounds of whole milk, often substituting margarine and low-fat or nonfat milk. Therefore, progress is being made in reducing key sources of saturated fat and cholesterol in our diets.[17]

Still, our overall population is getting fatter, probably due to an increasingly sedentary lifestyle with no decrease in total energy intake. Many Americans, thus, would benefit from a more helpful balance of foods in their diets—greater moderation in the intake of some foods is needed, such as sugared soft drinks and fried foods, while increasing the variety of other foods, such as fruits and vegetables. Few adults currently meet the "five-a-day" minimum recommendation for total servings of vegetables and fruits, even though, when interviewed, 70% of the people said these are an important part of a diet.[9]

Today soft drinks are more popular than milk, although not as beneficial to the diet. Soft drinks account for on average 10% of the energy intake of teenagers and, in turn, contribute to generally poor calcium intakes in this age group.

Improving Our Diets

Our cultural diversity, varied cuisines, and generally high nutritional status should be points of pride for Americans. Today we can choose from a tremendous variety of food products, the result of continual innovation by food manufacturers.

During the past hundred years, the United States has led the world in creating new food products (Table 1-4). From toaster pastries to microwave popcorn, the

TABLE 1-4 Years When Common American Foods Were Introduced

1875—Chocolate milk	1950—Sugar Corn Pops
1876—Heinz ketchup	1951—Duncan Hines cake mix
1891—Fig Newtons	1952—Kellogg's Sugar Frosted Flakes
1896—Tootsie Rolls	1953—Sugar Smacks, frozen pizza
1897—Jell-O	1956—Jif peanut butter
1897—Grape-Nuts	1957—Sweet 'n Low
1898—Graham crackers	1958—Tang
1907—Hershey's Kisses	1960—Instant potatoes
1912—Life Savers, Oreos	1963—Tab
1913—Fruit cocktail	1965—Shake 'n Bake
1916—All-Bran	1966—Cool Whip
1921—Mounds, Wonder bread	1968—Pringles, Care Free sugarless gum
1923—Milky Way, Sanka decaffeinated coffee	1976—Country Time lemonade
1927—Kool-Aid	1981—TCBY frozen yogurt
1928—Rice Krispies, Velveeta	1984—Diet Coke (with aspartame)
1930—Birds Eye frozen foods	1986—Pop Secret microwave popcorn
1930—Snickers, chocolate chip cookies	1987—Minute Maid calcium-fortified orange juice
1932—3 Musketeers, Fritos corn chips	1995—Hellman's (Best Foods) low-fat mayonnaise
1934—Ritz crackers, Bisquick	1996—Fat-free Pringle's potato chips (with Olestra)
1937—Spam, Kraft macaroni and cheese	1996—Vitamin-fortified fruit juice
1941—Cheerios, M&M's	1998—Vitamin-fortified vegetable juice
1944—Hawaiian Punch	1999—Margarine with Benechol (to lower blood cholesterol), chocolate candies fortified with vitamins and calcium
1946—Minute Rice, frozen orange juice, instant coffee	

Modified from Staten V: *Can you trust a tomato in January?* New York, 1993, Simon & Schuster, and from other sources.

variety of food products in a typical supermarket is nearly limitless. Even astronauts in space have their unique food product: a plastic bag containing the nutritional equivalent of an entree, two side dishes, and a beverage, which is kneaded for several minutes and then squeezed into the mouth.

Today we are eating more breakfast cereals, pizza, pasta entrees, stir-fried meat and vegetables served on rice, salads, tacos, burritos, and fajitas than ever before.[24] Sales of whole milk are down, whereas in the same time period sales of nonfat and 1% low-fat milk have increased. Consumption of frozen vegetables, rather than canned vegetables, is also on the rise. Still, soft drinks are more popular than milk, although not as beneficial to the diet. Overall, many of these recent diet changes are advantageous; some are not.[17]

The fast-paced life for some of us requires eating on the run. What we choose should be as important as how fast it is served.

Americans currently live longer than ever before, and many enjoy better general health. Many also have more money, more diverse food and lifestyle choices to consider, and more time to relax and enjoy life. The nutritional consequences of these trends are not fully known. Deaths from heart disease and strokes, for example, have dropped dramatically since the late 1960s, partly because of better medical care and diets. Still, if affluence leads to sedentary lifestyles and high intakes of fat, sodium, and alcohol, it can lead to problems.[4] Because of better technology and greater choices, we can have a much better diet today than ever before—if we know what choices to make.

The goal of this book is to help you find the best path to good nutrition. There are no "junk" or bad foods, but some foods provide relatively few nutrients in comparison with energy content and, thus, contribute to less nutritious food habits. One's overall diet is the proper focus in a nutritional evaluation. Chapter 2 will emphasize this point and show you how to balance your diet. As you reexamine your nutritional goals, remember that your health is partly your responsibility (Table 1-5).[5]

TABLE 1-5 Recommendations for Health Promotion and Disease Prevention: What We Can Expect from Adequate Nutrition and Good Health Habits[1, 4, 6, 16, 18]

Diet

Eating enough essential nutrients and meeting energy needs help prevent
- Birth defects and low birth weight in pregnancy
- Stunted growth and poor resistance to disease in infancy and childhood
- Poor resistance to disease in adulthood
- Deficiency diseases, such as cretinism (lack of iodide), scurvy (lack of vitamin C), and anemia (lack of iron, folate, or other nutrients)

Eating enough calcium helps
- Build bone mass in childhood and adolescence
- Prevent some adult bone loss, especially among older individuals

Obtaining adequate intake of fluoride and moderating sugar intake helps prevent
- Dental caries

Eating enough dietary fiber helps prevent
- Digestive problems, such as constipation and some intestinal problems

Eating enough vitamin A and related plant carotenoids may help reduce
- Susceptibility to some cancers
- Degeneration of the retina (intake of carotenoids in green and orange vegetables, specifically)

Moderating energy intake helps prevent
- Obesity and related diseases, such as type 2 diabetes, hypertension, cancer, and heart disease

Limiting intake of sodium helps prevent
- Hypertension and related diseases of the heart and kidney in susceptible people

Moderating intake of total fat, saturated fat, and cholesterol helps prevent
- Heart disease

Moderating intake of essential nutrients when taking vitamin and mineral supplements, if practiced, prevents
- Most chances for nutrient toxicities

Physical Activity

Adequate, regular physical activity (a minimum of 30 minutes per day) helps prevent
- Obesity
- Type 2 diabetes
- Heart disease
- Some adult bone loss
- Loss of muscle tone

Lifestyle

Minimizing alcohol intake (no more than one to two drinks per day) helps prevent
- Liver disease
- Fetal alcohol syndrome
- Accidents

Not smoking cigarettes or cigars helps prevent
- Lung cancer, other lung disease, and kidney and heart disease

In addition, minimum use of medication, no illicit drug use, adequate sleep (7–8 hours), adequate fluid intake (about 8 cups per day) and a reduction in stress provide a more complete approach to good nutrition and health. Finally, consultation with health-care professionals on a regular basis is as important as early diagnosis is especially useful for controlling the damaging effects of many diseases. Overall, prevention of disease is an important investment of your time.

TABLE 1-6 A Sample of Nutrition-Related Objectives from *Healthy People 2010*

	Target	Current Estimate
Increase the proportion of adults who are at a healthy weight (defined as a body mass index between 18.5 and 25).	60%	42%
Reduce the proportion of adults who are obese (body mass index of 30 or more).	15%	23%
Reduce the proportion of children and adolescents who are overweight or obese.	5%	10%
Increase the proportion of persons age 2 years and older who consume at least two daily servings of fruit.	75%	28%
Increase the proportion of persons age 2 years and older who consume at least three daily servings of vegetables, with at least one-third being dark green or deep yellow vegetables.	50%	3%
Increase the proportion of persons age 2 years and older who consume at least six daily servings of grain products, with at least three being whole grains (e.g., whole wheat bread and oatmeal).	50%	7%
Increase the proportion of persons age 2 years and older who consume less than 10% of calories from saturated fat.	75%	36%
Increase the proportion of persons 2 years and older who consume no more than 30% of calories from fat.	75%	33%
Increase the proportion of persons age 2 years and older who consume 2400 mg or less of sodium daily.	65%	21%
Increase the proportion of persons age 2 years and older who meet dietary recommendations for calcium (see inside cover of this book).	75%	46%
Reduce iron deficiency among young children and females of childbearing age.	6%	10%

Note: Related objectives include those addressing osteoporosis, various forms of cancer, diabetes prevention and treatment, food allergies, heart disease and stroke, low birth weight, nutrition during pregnancy, breastfeeding, eating disorders, physical activity, and alcohol use (see later chapters).

Health Objectives for the United States for the Year 2010, Including Numerous Nutrition Objectives

Health promotion and disease prevention have been public health strategies in the United States since the late 1970s. One part of this strategy is *Healthy People 2010*, a report issued in 2000 by the U.S. Department of Health and Human Services' Public Health Service. This report consists of national health promotion and disease prevention objectives for the nation for the year 2010 and assigns each of the objectives to appropriate federal agencies to address. Many nutrition-related objectives are part of the overall plan (Table 1-6).[13]

The main objectives of *Healthy People 2010* are to promote healthful lifestyles and to reduce preventable death and disability in all Americans. Minority groups, in particular, are the focus of *Healthy People 2010* programs, as overall health status currently lags in these population groups, especially with respect to hypertension, diabetes, and obesity.[20]

Regular physical activity complements a healthy diet; practice both each day.

The following Internet sites have resources for both patients and professionals on the *Healthy People* program:

Healthy People initiative:
www.health.gov/healthypeople
www.health.gov/partnerships
Healthy People data:
www.cdc.gov/nchs/hphome.htm
Office of Disease Prevention and Health Promotion:
odphp.osophs.dhhs.gov/

CONCEPT CHECK

Surveys in the United States show that we generally have a variety of food available to us. However, some of us could improve our diets by focusing on rich food sources of iron, calcium, vitamin A, various B vitamins, vitamin C, zinc, and dietary fiber. In addition, many of us should reduce our consumption of energy, sugar, protein, fat, sodium, and alcoholic beverages. These recommendations are consistent with an overall goal to attain and maintain good health.

USING SCIENTIFIC RESEARCH TO DETERMINE NUTRIENT NEEDS

People certainly are interested in nutrition (see the Expert Opinion by Dr. Finn). How do we know what we know about nutrition? How has this knowledge been gained? In a word, research. Like other sciences, the research that underpins nutrition has developed through the use of the *scientific method,* a procedure for testing designed to detect and eliminate error. The first step is the observation of a natural phenomenon. Scientists then suggest possible explanations, called **hypotheses,** about its cause. Distinguishing a true cause-and-effect relationship from mere coincidence can be difficult.[25] For instance, earlier in the past century, many patients in mental hospitals suffered from the disease *pellagra,* which suggested a possible relationship between mental illness and this disease. In time, it became clear that this supposed connection was simply coincidental; the real culprit was the poor diet common in mental institutions at that time.

hypotheses "Educated guesses" by a scientist to explain a phenomenon.

To test hypotheses and eliminate coincidental explanations, scientists perform controlled scientific **experiments.** The data gathered from these experiments may either support or refute each hypothesis (Fig. 1-4). If the results of many experiments support a hypothesis, the hypothesis becomes generally accepted by scientists and can be called a **theory** (such as the theory of gravity). Very often, the results from one experiment suggest a new set of questions to be answered.

experiments Tests made to examine the validity of a hypothesis.

theory An explanation for a phenomenon that has numerous lines of evidence to support it.

The scientific method requires a skeptical attitude. Scientists must not accept proposed hypotheses and theories until they are supported by considerable evidence, and they must reject those that fail to pass critical analyses. Likewise, students should adopt a healthy skepticism and be critical of many current ideas about nutrition.[3, 31]

A recent example of this need for skepticism involves stomach **ulcers.** Not so many years ago, "everyone knew" that stomach ulcers were caused by a stressful lifestyle and a poor diet. Then, in 1983, an Australian physician, Marshall, reported in a respected medical journal that ulcers are usually caused by a common microorganism called *Helicobacter pylori.* Furthermore, he stated that a cure is possible using antibiotics. At first, other physicians were skeptical about this finding and continued to prescribe medications that reduce stomach acid. But, as more studies were published, and patients were cured of ulcers using antibiotics, the medical profession eventually accepted the findings, and today, ulcers are managed for the most part by medications that destroy the pathogen. Overall, we can expect that scientific discoveries will always be subject to challenge and change.

ulcer Erosion of the tissue lining, usually in the stomach (gastric ulcer) or the upper small intestine (duodenal ulcer). These are generally referred to as peptic ulcers.

Generating Hypotheses

Historical events have provided clues to important relationships in nutrition science. In the fifteenth and sixteenth centuries, for example, many European sailors on the long voyages to the Americas developed the disease scurvy. The sailors ate few fruits and vegetables, and eventually a British naval surgeon, Lind, as noted earlier,

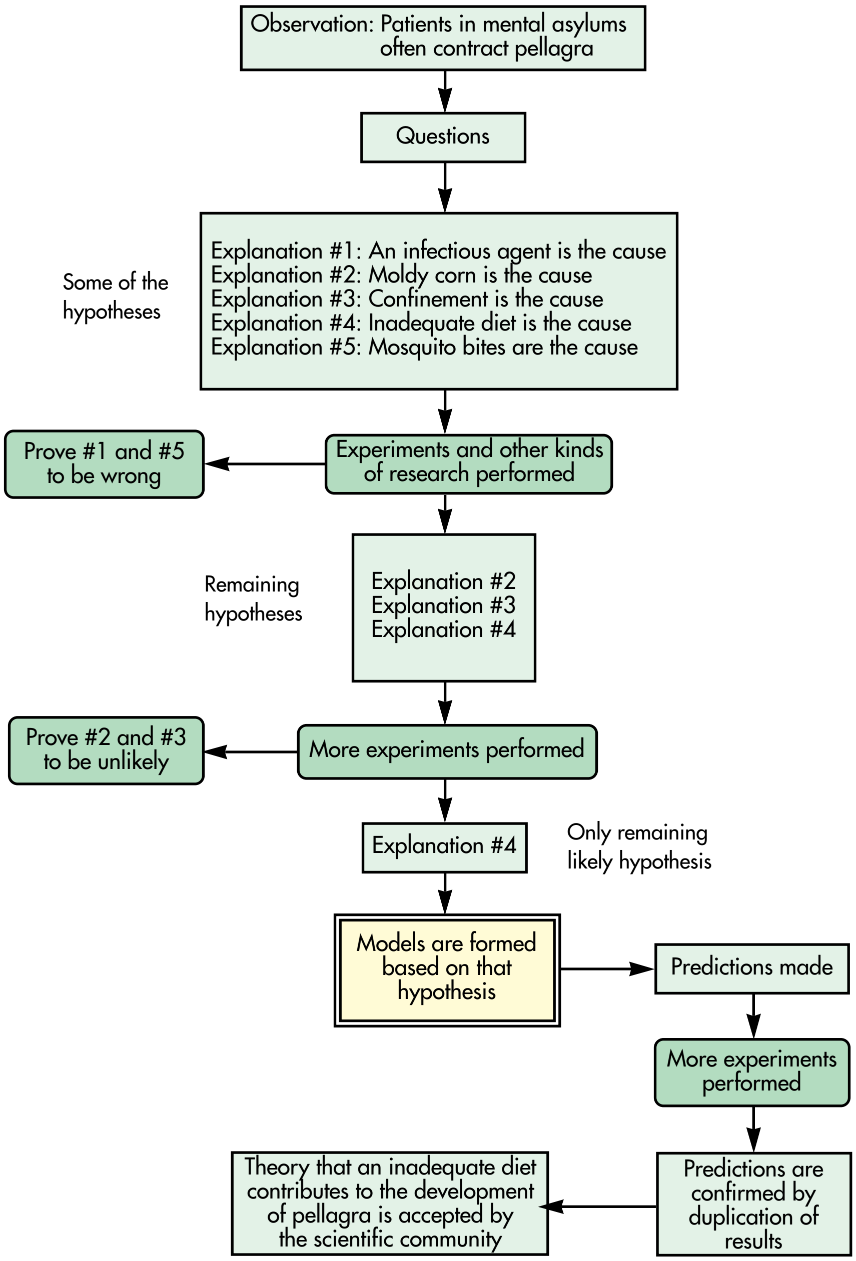


FIGURE 1-4 From question to theory—the process of science applied to nutrition. Only after careful and thorough analysis and repeated experimentation should a research finding influence our food choices, such as the need to consume the vitamin niacin to prevent the development of pellagra.

discovered that lime juice prevents or cures the scurvy. After this, sailors were given a ration of lime juice, earning them the nickname "limeys." This simple practice ensured a healthy workforce for the British navy and helped it dominate the seas worldwide. About 200 years later, scientists identified vitamin C, the nutrient present in fruits and vegetables that prevents scurvy.[12]

In a related approach to using historical observation, scientists establish nutritional hypotheses by studying the dietary and disease patterns among various populations in today's world. If one group tends to develop a certain disease but another group does not, scientists can speculate about the role diet plays in this difference. The study of diseases in populations is called **epidemiology.**

An example of this approach occurred in the 1920s, in the United States, when Goldberger noticed that prisoners in jail—but not their jailers—suffered from pellagra. He reasoned that, if pellagra were an **infectious disease,** both populations

epidemiology The study of how disease rates vary among different population groups. For example, the rate of stomach cancer in Japan could be compared with that in Germany.

infectious disease Any disease caused by invasion of the body by microorganisms, such as bacteria, fungi, or viruses.

would suffer from it. Since this was not the case, he concluded that pellagra is probably caused by a dietary deficiency.

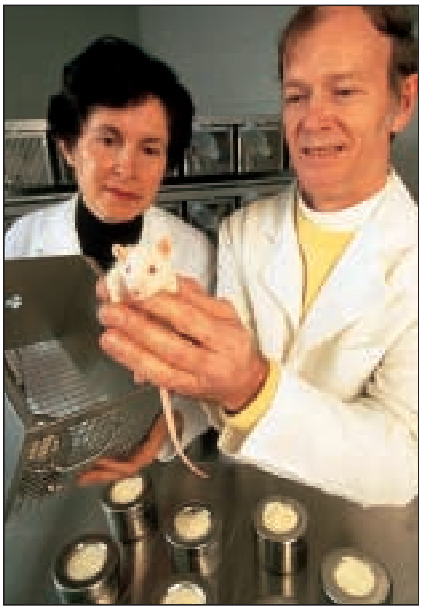
Historical and epidemiological findings can suggest hypotheses about the role of diet in various health problems. To prove the role of particular dietary components, however, requires controlled experiments. For instance, once the high incidence of pellagra in mental institutions during the 1920s was linked to poor diet, various foods were given to patients who had the disease. These experiments showed that yeast and high-protein foods could cure these patients if the disease was not in its final stage, indicating that pellagra results from a deficiency of some nutrient present in these foods. Eventually, this nutrient was found to be the B vitamin called niacin.[12]

CRITICAL THINKING

For thousands of years, early humans consumed a diet rich in vegetable products and low in animal products. These diets were generally lower in fat and higher in dietary fiber than modern diets. Do the differences in human diets throughout history necessarily tell us which diet is better—that of early humans or of modern humans? If not, what is a more reliable way to pursue this question of potential diet superiority?

Laboratory Animal Experiments

When scientists cannot test their hypotheses by experiments with humans, they often use animals. Much of what we know about human nutritional needs and functions has been generated from animal experiments. Still, human experiments are the most convincing to scientists. In the 1930s, scientists showed that a pellagra-like disease seen in dogs, called *blacktongue,* is cured by nicotinic acid. Only when nicotinic acid actually cured the disease in humans were scientists convinced that nicotinic acid, later identified as the vitamin niacin, was the critical dietary factor.



Research using laboratory animals contributes to our nutrition knowledge.

Today, we know that low doses of the mineral fluoride can stimulate growth in rats. However, we still do not know whether this is true for humans, because it is not practical to control the fluoride intake of humans accurately enough to answer the question. Thus, fluoride might stimulate growth in humans, but real proof is lacking.

In addition, the use of humans in certain types of experiments is considered unethical. Although some people argue that animal experiments are also unethical, most people believe that the careful, humane use of animals is an acceptable alternative to using human subjects. For example, most people would think it is reasonable to feed rats a low-copper diet to study the importance of this mineral in the formation of blood vessels. Almost universally, however, people would object to a similar study in infants.

The use of animal experiments to study the role of nutrition in certain human diseases depends on the availability of an **animal model**—a disease in laboratory animals that closely mimics a particular human disease. If no animal model is available and human experiments are ruled out, scientific knowledge often cannot advance beyond what can be learned from epidemiological studies.

animal model Study of disease in animals that duplicates human disease. This can be used to understand more about human disease.

double-blind study An experimental design in which neither the participants nor the researchers are aware of each participant's assignment (test or placebo) or the outcome of the study until it is completed. An independent third party holds the code and the data until the study has been completed.

control group Participants in an experiment who are not given the treatment being tested.

Human Experiments

Various experimental approaches are used to test research hypotheses in humans, including case-control and double-blind studies.[31]

Case-Control Study

In a case-control study, individuals who have the condition in question, such as lung cancer, are compared with individuals who do not have the condition. Comparisons are made only between groups that are matched for other major characteristics (e.g., age, race, and gender) not under study. This type of study may identify factors other than the disease in question, such as fruit and vegetable intake, that differ between the two groups, thus providing researchers with clues about the cause, progression, and prevention of the disease.

Double-Blind Study

An important approach for more definitive testing of hypotheses is the **double-blind study,** in which a group of participants—the experimental group—follows a specific protocol (e.g., consuming a certain food or nutrient), and participants in a corresponding **control group** conform to their normal habits. People are randomly assigned to each group, such as by the flip of a coin. Scientists then observe the experimental group over time to see if there is any effect that is not found in the control group. Sometimes individuals are used as their own control: First they are observed for a period of time, and then they are treated and their responses noted.

Two features of a double-blind study help reduce the introduction of bias (prejudice), which can easily affect the outcome of an experiment. First, neither the participants nor the researchers know which individuals are in the experimental group and which are in the control group. Second, the expected effects of the experimental protocol are not disclosed to the participants or researchers until after the entire study is completed. This approach reduces the possibility that researchers may see the change they want to see in the participants to prove a certain "pet" hypothesis, even though such a change did not actually occur. This approach also reduces the chance that the persons participating begin to feel better simply because they are involved in a research study or are receiving a new treatment, a phenomenon called the *placebo effect.*

Derived from the Latin word ***placebo,*** meaning "I shall please," the placebo effect cannot be explained by pharmacological or other direct physical action. It may instead be linked to a simple reduction in stress and anxiety. At least one-third of all patients show improvement after receiving a placebo (generally in the form of a fake medicine). Thus, it is critical to make allowances for the placebo effect in research studies.

In a double-blind experiment, the control group often receives a sugar pill or other placebo to camouflage who is in which group and thereby eliminate the bias introduced by the placebo effect. During the course of the experiment, neither the researchers nor the participants know who is getting the real treatment and who is getting a placebo. Sometimes only a single-blind protocol is possible, in which either the participants or the researchers are kept in the dark. Either way, now it is up to the experimental treatment—not just the practice of both groups taking a pill—to show an effect, if one is possible.

Drug studies lend themselves to double-blind protocols because it is often easy to substitute a placebo for the drug. However, food studies often cannot be placebo controlled. For example, disguising a diet high in fruits and vegetables from one low in them is difficult. In such a study, the experimenters should try to ensure that the results from blood assays or other measurements are not revealed until the end of the study. In addition, the results should be kept from the participants until the end of the study. These precautions can eliminate much potential bias. The more bias that is controlled in an experiment, the more confidence we can have in the results.

A recent example illustrates the need to test hypotheses based on epidemiological observations in double-blind studies. Epidemiologists using primarily case-control studies found that smokers who regularly consumed fruits and vegetables had a lower risk for lung cancer than smokers who ate few fruits and vegetables. Some scientists proposed that beta-carotene, a pigment present in many fruits and vegetables, could reduce the damage that tobacco smoke creates in the lungs. This hypothesis helped fuel sales of supplements of beta-carotene.

However, in double-blind studies involving heavy smokers, the risk of lung cancer was found to be higher for those who took beta-carotene than for those who did not. Some investigators criticized this research, arguing that the beta-carotene was given too late in the smokers' lives to be of much use, but even these critics did not suspect that the substance would increase cancer risk. Soon after these results were reported, the federal agency supporting two other large ongoing studies that employed beta-carotene supplements called a halt to the research, stating that these supplements are ineffective in preventing both lung cancer and heart disease.

Overall, health and nutrition advice provided by grandparents, parents, friends, and other well-meaning individuals can't be verified unless it is put to the ultimate scientific test—blinded studies. Until that is done, we can't be sure that the substance or procedure in question is truly effective.[3, 31] One reason for this is the power of the placebo effect. In addition, many common symptoms, such as sneezing, lower back

Before researchers conduct any research process using humans (or laboratory animals), they must first obtain approval from the Human Use (or Animal Use) Committee at their university or company. The committee determines if the experimental protocol is valid and assesses the risks and benefits of the potential therapy to the subject and, when appropriate, society at large. In human studies, the committee insists that a document depicting the risks and benefits of the study be developed, which the participants must receive and sign. The process is called *informed consent,* meaning the participant knows what he or she is expected to do in the research study and the associated risks.

placebo Generally a fake medicine used to disguise the roles of participants in an experiment; if fake surgery is performed, it is called a *sham operation.*

Recently major nutrition organizations put together ten red flags that they consider signals for poor nutrition advice:

1. Recommendations that promise a quick fix
2. Dire warnings of dangers from a single product or regimen
3. Claims that sound too good to be true
4. Simplistic conclusions drawn from a complex study
5. Recommendations based on a single study
6. Dramatic statements that are refuted by reputable scientific organizations
7. Lists of "good" and "bad" foods
8. Recommendations made to help sell a product
9. Recommendations based on studies published without peer review
10. Recommendations from studies that ignore differences among individuals or groups

Expert Opinion

How to Find Reliable Nutrition Information

Susan Calvert Finn, Ph.D., R.D., FADA

Life in the Information Age is never boring! Everywhere we turn, there is more to know and new ways to learn. With 150,000 books published in the United States every year, hundreds of thousands of Web sites and more than 10,000 periodicals—plus radio, television, CDs, fax and e-mail—we are bombarded with facts and figures. No wonder so many of us suffer from information anxiety!

But just because we have easy access to an abundance of information doesn't mean that all the "facts" we encounter are correct. Ironically, the easier and more fun information retrieval becomes, the more difficult our role as responsible consumers becomes. Nowhere is this irony more prevalent than in the nutrition and health arena.

According to The American Dietetic Association's Nutrition and You: Trends 2000, almost 50% of Americans look to television as their major source of nutrition information. And, not surprisingly, HealthFocus research reveals that approximately seven in 10 shoppers believe it is hard to follow the experts' advice because they keep changing their minds! Indeed, almost daily consumers are asked to judge the reliability of nutrition reports and studies that often seem contradictory. We are told that our diets should contain low fat, no fat, some fat. We've been advised to drink wine and to avoid wine. The virtues of fiber, phytochemicals and functional foods are extolled and refuted (see Chapter 2 for details). We've witnessed a resurgence in alternative health therapies, often promoted with little science to back them up. "Experts" advise gimmicks and gadgets, pills and potions. As the traveling medicine men of the nineteenth century liked to say, whatever is being sold is good for what ails you.

Our fascination with youth and our desire to stay vital, alert, and mobile as we age have propelled the field of nutritional health into a multibillion dollar business. In the Food Marketing Institute's (FMI) 1999 Trends in the United States, 95% of respondents said that nutrition is very or somewhat important when they shop for food. FMI's 1999 Shopping for Health survey revealed that half of all grocery shoppers actively seek information about health and nutrition. And as the HealthFocus 1999 Trend Report reveals, 80% of shoppers want to eat healthy foods more often. Despite this active interest in nutrition, however, close to 40% of HealthFocus survey respondents admit to being confused about what they should eat to stay healthy.

Finding Accurate Nutrition Information

With a number of potential pitfalls in your path, where and how do you find legitimate nutrition experts—trained professionals who offer valid diagnoses and prescribe safe and effective nutritional therapies? A number of avenues are available. If you have access to an accredited university, you may be able to obtain current and authoritative information from faculty members, particularly those who teach nutrition, dietetics, health, or medicine. Similarly, many hospital dietetics departments can be valuable references.

Most public, private and school libraries offer Web access to and stock nutrition books by experts on topics you may be researching. But be aware that appearing on the World Wide Web or in print does not necessarily make information credible. With all sources, it is essential to authenticate the background and training of the practitioner before accepting the material. A string of initials after a name does not automatically mean that the person is qualified. Even a legitimate

pain, and headache, go away within a month or so without any treatment, reflecting the natural course of the underlying diseases. When people say, "I get fewer colds now that I take vitamin C," they overlook the fact that many cold symptoms disappear quickly with no treatment; the apparent curative effect of vitamin C or any other remedy is often coincidental rather than causal to the natural healing process.

All consumers need to become more sophisticated about science, its accepted standards of evidence, and its current limitations. Failure to do so leads many to a frantic pursuit of fraudulent remedies. To ignore science is to follow an inferior path—the road of hard knocks. Those who follow this road learn about the dangers of various health practices primarily from the experiences of those harmed by them.

degree may be misleading. A Ph.D. in mathematics, for example, is irrelevant to nutrition.

It also is important to look out for danger signals, which include an overemphasis on "magic" pills or "unique" apparatuses; heavy reliance on testimonials from people you don't know, or who may not even exist; departure from established and legitimate medical practices; and performance of strange procedures, such as hair analysis or eye color tests.

As more and more consumers assume greater responsibility for their health and well-being, self-care communities and health-related web sites are becoming standard fare on the internet. In the year 2000, there were more than 25,000 (and counting) health-related web sites. Many of these online sources are credible; many are not. To protect yourself from erroneous information, stick with web sites sponsored by well-known health entities such as the American Heart Association, the American Dietetic Association or the National Institutes of Health. In addition, Tufts University School of Nutrition Science and Policy rates nutrition-related sites for accuracy and usability. Tufts has evaluated many of the most commonly visited sites. Check it out at: http://navigator.tufts.edu.

THE REGISTERED DIETITIAN

The most dependable source for up-to-date, accurate nutrition data is a registered dietitian (R.D.). There are more than 70,000 registered dietitians in the United States; they can be identified by the credential R.D. after their names. Registered dietitians are health-care professionals who are rigorously trained in a single specialty—nutrition science. Their goal is to promote health and fight illnesses by fostering the practice of proper nutrition. R.D.s are the most reliable disseminators of information and educational materials on food and nutrition. An R.D. analyzes each patient's situation, taking into account such factors as medical history, lifestyle, and eating habits, and tailors specific regimens to meet those unique needs. Because R.D.s do not make medical diagnoses, the patient is encouraged to consult a physician regularly.

What is it about registered dietitians that make them so qualified? An R.D. has both theoretical and practical experience, including a bachelor's degree in food and nutrition from an accredited university plus a thorough and extensive professional internship under expert supervision. R.D.s also must pass a comprehensive examination. Tough continuing education and recertification standards ensure that R.D.s keep up-to-date with the profession's science base.

Many states have enacted some form of statutory regulation of registered dietitians (certification or licensing). Unfortunately, in those states without regulation, anyone with little or no training, experience, a license, or specific qualifications can call himself or herself a dietitian or nutritionist.

As you seek nutrition information, you would do well to remember these two guidelines. Availability doesn't mean accuracy. Abundance doesn't mean reliability. A good measure of common sense, sound research and thorough verification of references and credentials will ensure that you have chosen an accurate and reliable source of information. The benefits you will receive are well worth the extra effort required to secure their advice.

Susan Calvert Finn is the director of nutrition and health services for Ross Products Division, Abbott Laboratories, a leading research facility and manufacturer of scientifically formulated nutritional products. She is a past president of the American Dietetic Association, author of The American Dietetic Association Guide to Women's Nutrition for Healthy Living *(Perigee 1997), and co-author of* The Real Life Nutrition Book *(Penguin Books 1992).*

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Medical science does not ignore novel approaches to disease prevention and cure. Anecdotes and personal experiences are important clues to fruitful experimentation, but they are not credible evidence.[3]

Peer Review of Experimental Results

Once an experiment is complete, scientists summarize the findings and publish the results in scientific journals. At the end of each chapter in this book, many reports are listed, describing important experiments that have been published in scientific journals. Generally, before articles are published in scientific journals, they are

Careful research contributes to nutrition knowledge, more so than personal experience.

critically reviewed by other scientists familiar with the subject. The objective of this peer review is to ensure that only high-quality research findings are published. This is an important step because most scientific research in this country is funded by the federal government, nonprofit foundations, drug companies, and other private industries. All these funding sources can have strong expectations about the research outcomes. In theory, the scientists conducting these research studies will be fair in evaluating their results and will not be influenced by the funding agency. Peer review helps ensure that the researchers are as objective as possible. This then helps ensure that results published in peer-reviewed journals, such as the *American Journal of Clinical Nutrition*, the *New England Journal of Medicine*, and the *Journal of the American Dietetic Association*, are much more reliable than those found in popular magazines or promoted on television talk shows. Unfortunately, reputable journals are not the main sources for the information presented in the popular media, and claims are seldom scrutinized by competent researchers for accuracy and scientific validity.[3, 1] The Expert Opinion by Dr. Susan Calvert Finn discusses these concepts in more detail.

Follow-Up Studies

Even if an acceptable protocol has been followed and the results of a study have been accepted by the scientific community, one experiment is never enough to prove a particular hypothesis or provide a basis for nutritional recommendations. Rather, the results obtained in one laboratory must be confirmed by experiments conducted in other laboratories. Only then can we really trust and use the results. The more lines of evidence available to support an idea, the more likely it is to be true (Figure 1-5). It is important to avoid rushing to accept new ideas as fact or incorporating them into your health habits until they are proved by several lines of evidence.

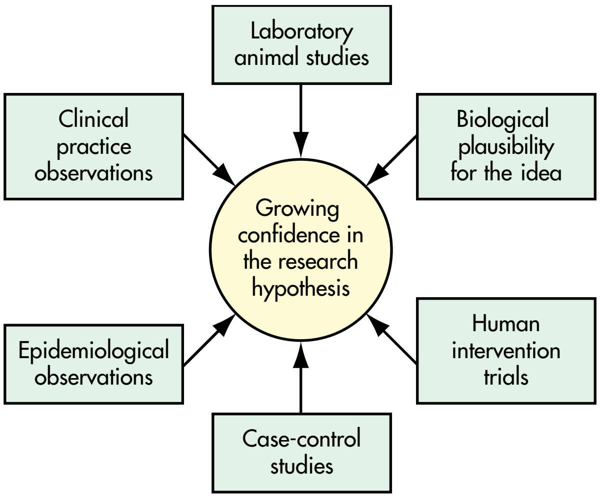


FIGURE 1-5 Data from a variety of sources can come together to support a research hypothesis. For example, epidemiological studies show that type 2 diabetes is characteristically found in obese populations, compared with leaner populations. Physicians notice in **clinical practice** that type 2 diabetes is much more likely in their obese patients, compared with their leaner patients. Laboratory animal studies show that overfeeding that eventually leads to obesity often leads to the development of type 2 diabetes. Case-control studies show that obese patients are much more likely to have type 2 diabetes than the leaner comparison group that is matched for other characteristics. Finally, **human intervention trials** show that weight loss can correct type 2 diabetes in many people. Laboratory researchers also show that the enlarged fat cells associated with obesity are much less responsive to the hormonal signals involved in blood glucose regulation (see Chapter 5). All these lines of data come together with **biological plausibility** from various laboratory studies to support the research hypothesis that obesity can lead to type 2 diabetes.

CONCEPT CHECK

The scientific method is the procedure for testing the validity of possible explanations, called hypotheses. Experiments are conducted to either support or refute a specific hypothesis. Once we have much experimental information that supports a specific hypothesis, it then can be called a theory. Ideally, experiments are conducted in a blinded fashion, where the subjects and researchers (preferably both) do not find out the results of an experiment until after the experiment is completed. This reduces bias in the results and minimizes the placebo effect. All of us need to be skeptical of new ideas in the nutrition field. We should wait until many lines of experimental evidence support a concept for adopting any suggested dietary practice.

SUMMARY

1. Nutrition is the study of the food substances vital for health and the study of how the body uses these substances to promote and support growth, maintenance, and reproduction of cells. Research in the field has been especially vigorous from the past century to present times.
2. Nutrients in foods fall into six classes: (1) carbohydrates, (2) lipids (mostly fats and oils), (3) proteins, (4) vitamins, (5) minerals, and (6) water. The first three, along with alcohol, provide energy for the body to use.
3. The body transforms the energy contained in carbohydrate, protein, and fat into other forms of energy, which allow the body to function. Fat provides, on average, 9 kcal/g, whereas protein and carbohydrate each provides, on average, 4 kcal/g. Vitamins, minerals, and water do not supply energy to the body but are essential for proper body function.
4. A basic plan for health promotion and disease prevention includes eating a varied diet, performing regular physical activity, not smoking, not abusing nutrient supplements (if used), getting adequate fluid and sleep, limiting alcohol intake (if consumed), and limiting or coping with stress.
5. The focus of nutrition planning should be on food, not primarily on dietary supplements. The focus on foods to supply nutrient needs avoids the possibility of severe nutrient imbalances.
6. Results from large nutrition surveys in the United States suggest that some of us need to concentrate on consuming foods that supply more vitamin A, certain B vitamins, calcium, iron, zinc, and dietary fiber.
7. There are no true "junk" or "bad" foods. The focus should be on balancing a total diet by choosing many nutritious foods.
8. The scientific method is the procedure for testing the validity of possible explanations, called hypotheses. Experiments are conducted to either support or refute a specific hypothesis. Once we have much experimental information that supports a specific hypothesis, it then can be called a theory. All of us need to be skeptical of new ideas in the nutrition field, waiting until many lines of experimental evidence support a concept before adopting any suggested dietary practice.

STUDY QUESTIONS

1. Name one chronic disease associated with poor nutrition habits. Now list a few corresponding risk factors.
2. Explain the concept of energy as it relates to foods. What are the fuel (energy) values used for a gram of carbohydrate, fat, protein, and alcohol?
3. Identify three ways that water is used in the body.
4. Wendy's Big Bacon Classic contains 44 g carbohydrate, 36 g fat, and 37 g protein. Calculate the percentage of energy derived from fat.
5. Describe the two types of fat and explain why the differences are important in terms of overall health.
6. According to national nutrition surveys, which nutrients tend to be underconsumed by many adult Americans? Why is this the case?
7. List four health objectives for the United States for the Year 2010. How would you rate yourself in each area? Why?
8. List one food habit you should work on to improve your health. Indicate why and list three actions to take.
9. What nutrition-related disease is common in your family? What step(s) could you take at this point to minimize your risk?
10. List one nutrition claim you have heard recently that sounds too good to be true. What do you suspect is the motive of the person providing the advice?

ANNOTATED REFERENCES

1. Achievements in Public Health, 1900–1999: Changes in the public health system. *Journal of the American Medical Association* 283:735, 2000.

   Improvements cited as major advances in health promotion over the past century are safer and healthier foods, healthier mothers and babies, fluoridation of drinking water, and recognition of tobacco use as a health hazard.

2. ADA Reports: Position of the American Dietetic Association and dietitians of Canada: Women's health and nutrition. *Journal of the American Dietetic Association* 99:738, 1999.

   Chronic diseases that particularly affect women are reviewed, providing advice on prevention and treatment, such as daily physical activity and regular screening for chronic disease.

3. Blumenthal SJ: A top woman doctor tells how to get past the hype to the truth. *American Health,* p. 36, January/February 1998.

   The assistant U.S. surgeon general provides advice on how to interpret research findings that appear in the media, such as who paid for the study and whether the findings are supported by previous studies.

4. Breslow L: From disease prevention to health promotion. *Journal of the American Medical Association* 281:1030, 1999.

   Current concepts of health promotion are discussed, including goals such as increasing moderate daily physical activity and reducing excessive alcohol use as important health preventive measures.

5. Checkup for the new millennium. *Consumer Reports on Health,* p. 1, December 1999.

   A checklist of both healthy habits and not-so-healthy habits is given, along with suggested changes in habits to maximize wellness. The focus is on a balanced diet, maintaining a healthy weight, and performing regular physical activity.

6. Chidley E: Smoking: Butt in to help your clients kick the habit. *Today's Dietitian,* p. 35, January 2000.

   Risks of smoking are discussed, along with current therapies that can help smokers break the habit. Physicians now more than ever can prescribe effective medical approaches that aid success.

7. Collins FS: Shattuck lecture—Medical and societal consequences of the human genome project. *The New England Journal of Medicine* 341:28, 1999.

   The current human genome project and the many anticipated applications are discussed. This will lead to a better understanding of the personal health risks each individual faces.

8. Eisen A, Weber BL: Prophylactic mastectomy—the price of fear, *The New England Journal of Medicine* 340:137, 1999.

   Issues surrounding this radical procedure for reducing breast cancer in women at very high risk are reviewed. The procedure is effective, but the psychological effects also need to be considered.

9. Frazao E: High costs of poor eating patterns in United States. *CNI Nutrition Week,* p. 4, June 18, 1999.

   The many chronic diseases associated with the poor dietary and lifestyle habits seen in some Americans are discussed. Although genetics plays an important role in an individual's risk for chronic disease, environmental factors are also significant.

10. Garber J: A 40-year-old woman with a strong family history of breast cancer. *Journal of the American Medical Association* 280:1953, 1999.

    After a detailed discussion concerning one specific woman at high risk for breast cancer, physicians discuss the role of genetic testing and management of her disease. Overall, family history is a major risk factor for breast cancer.

11. Gene therapy setback. *Scientific American,* p. 36, February 2000.

    The death of an 18-year-old man who underwent gene therapy for a rare form of liver disease is discussed, including the possible reasons for his death. Intravenous delivery of the viral particle containing the gene into an artery leading directly to the liver is thought to be one reason.

12. Harper A: Defining the essentiality of nutrients. In Shills ME and others (eds), *Modern nutrition in health and disease,* 9th ed., Baltimore, MD: Williams & Wilkins, 1999.

    A short history of nutrition is provided in the context of the definition of an essential nutrient. Much of the progress in nutrition science has been made in the past 100 years.

13. *Healthy People 2010* targets healthy diet and healthy weight as critical goals. *Journal of the American Dietetic Association* 100:300, 2000.

    Many of the nutrition goals included in Healthy People 2010 *are enumerated. Two key goals are to reduce obesity and inactivity in the American population.*

14. Kant AK and others: A prospective study of diet quality and mortality in women. *Journal of the American Medical Association* 283:2109, 2000.

    Women whose diets included plenty of fruits, vegetables, whole grains, and low-fat meats and dairy products showed a 30% reduction in death, compared with those who ate the most unhealthy diets.

15. JAMA patient page: Maintaining good health. *Journal of the American Medical Association* 282:2092, 1999.

    Habits that are widely regarded as important for health maintenance are not using tobacco in any form, maintaining a healthy weight, exercising regularly, eating a healthy diet, and drinking alcohol only in moderation.

16. Jee SH and others: Smoking and atherosclerotic cardiovascular disease in men with low levels of serum cholesterol: The Korean Medical Insurance Corporation study. *Journal of the American Medical Association* 282:2149, 1999.

    Despite otherwise favorable heart disease risk factors, smoking still raises risk of heart disease over three times that seen in nonsmokers.

17. Liebman B: The changing American diet, *Nutrition Action Healthletter,* p. 8, April 1999.

    Both positive and negative trends in the American diet in the past 30 years are shown in graphic form, demonstrating that improvements have been made, such as a switch from whole milk to fat-reduced and nonfat milk, but much more work needs to be done.

18. Lifestyle and aging. *Mayo Clinic Health Letter,* p. 4, July 1999.

    Mayo Clinic physicians provide their advice for a healthy lifestyle, such as getting regular exercise, opting for many whole-grain choices, and drinking alcohol in moderation, if at all.

19. Moldad AH and others: The spread of the obesity epidemic in the United States, 1991–1998. *Journal of the American Medical Association* 282:1519, 1999.

    Statistics depicting the problem of obesity in the American population are provided. The United States has shown a rapid increase in the number of obese people in the past decade; this will likely contribute to much ill health in future years.

20. Nemeck S: Unequal health. *Scientific American,* p. 40, January 1999.

    Concerns surrounding the health of minority populations are discussed, along with the current government programs that are addressing these issues. Currently overall life expectancy has reached an all-time high of 76.1 years, but for black Americans it stands at just 70.2 years.

21. Patterson RE and others: Genetic revolution: Change and challenge for the dietetics profession. *Journal of the American Dietetic Association* 99:1412, 1999.

Methods used in genetic therapy are reviewed. A detailed glossary of genetics-related terms is provided, along with a discussion of genetic counseling. Health professionals need to understand the basis behind this procedure in order to participate in today's health care.

22. Prepare for the future: Know your ancestors. *Consumer Reports on Health* p. 1, September 1999.

Interpreting your family history as it potentially affects your health is discussed. Use of a family tree for health risks is described.

23. Simopoulos AP: Genetic variation and nutrition. *Nutrition Reviews* 57(5):S10, 1999.

Many nutrition-related diseases that show genetic susceptibility, such as heart disease, hypertension, and osteoporosis, are reviewed, providing much evidence that genetic background must be considered in providing health advice to individuals.

24. Sloann AE: Top 10 trends to watch and work on for the new millennium. *Food Technology* 53(8):40, 1999.

Current trends in the food supply that are described include more packaged, precooked meals; more foods undergoing less processing; more home-delivered foods; a greater variety of snack foods; and a growing number of foods fortified with vitamins, minerals, and other substances that may contribute to better health.

25. Solving the diet-and-disease puzzle. *Nutrition Action Health Letter,* p. 3, May 1999.

Current nutrition research trials in the United States are described, along with the specific doses of vitamins and minerals used and the other health practices included. These trials are trying to determine if risks of diseases such as colon cancer, breast cancer, heart disease, cataracts, and strokes can be reduced through diet and lifestyle manipulation.

26. Stamler J and others: Low risk-factor profile and long-term cardiovascular and noncardiovascular mortality and life expectancy. *Journal of the American Medical Association* 282:2012, 1999.

Individuals with favorable blood cholesterol and blood pressure values who did not smoke and did not have diabetes or evidence of existing heart disease showed much lower mortality and greater longevity (up to 9 years) than the comparison group.

27. Stephenson J: Gene therapy trials show clinical efficacy. *Journal of the American Medical Association* 283:589, 2000.

Successful application of gene therapy in children with a rare immune deficiency disease is described, as well as potential uses of gene therapy for people with hemophilia.

28. Subar AF and others: Dietary sources of nutrients in the U.S. diet, 1989 to 1991. *Journal of the American Dietetic Association* 98:537, 1998.

Leading contributors of the variety of nutrients consumed on a daily basis are described, such as the chief sources of fat, carbohydrate, and protein in the American diet. Currently cheese, beef, and milk are the major sources of saturated fat in our diets.

29. Thompson L: Human gene therapy: Harsh lessons, high hopes. *FDA Consumer,* p. 19, September–October 2000.

FDA is hopeful that one day gene therapy will work in a wider number of diseases. Currently a person has to have the right disease, such that the appropriate gene can be inserted into the specific cell lacking the correct gene. The results also need to be positive.

30. Tippet KS and others: Food consumption surveys in the U.S. Dept. of Agriculture. *Nutrition Today* 34:33, 1999.

The variety of food consumption surveys conducted over the past 80 years by the U.S. Department of Agriculture are described, including studies currently underway. These indicate few adults consume the recommended amounts of fruits and vegetables each day.

31. White MT and others: Genetic testing for disease susceptibility: Social, ethical, and legal issues for family physicians. *American Family Physician* 60:748, 1999.

Guidelines for patient counseling concerning genetic testing are discussed, as well as the benefits and risks of genetic testing. It is best that people undergo genetic counselling before genetic tests are performed.

32. Yet another study—Should you pay attention? *Tufts University Nutrition Letter,* p. 4, September 1990.

Types of studies used to investigate diet and health relationships are described, as well as how to interpret findings from various study designs. Overall a single study hardly ever tells the whole story.

TAKE ACTION

I. EXAMINE YOUR EATING HABITS MORE CLOSELY.

Choose one day of the week that is typical of your eating pattern. Using the first table found in Appendix E, list all foods and drinks you consumed for 24 hours. In addition, write down the approximate amounts of food you ate in units, such as cups, ounces, teaspoons, and tablespoons. Check the food composition table in Appendix A for examples of appropriate serving units for different types of foods, such as meat and vegetables. After completing this activity, you will use this list of foods for future assignments.

After you record the amount of each food and drink consumed, indicate in the table why you chose to consume the item. Use the following symbols to indicate your reasons. Place the corresponding abbreviation in the space provided, indicating why you picked that food or drink.

FLVR	Flavor/texture	HUNG	Hunger
CONV	Convenience	FAM	Family/cultural
EMO	Emotions	PEER	Peers
AVA	Availability	NUTR	Nutritive value
ADV	Advertisement	$	Cost
WTCL	Weight control	HLTH	Health

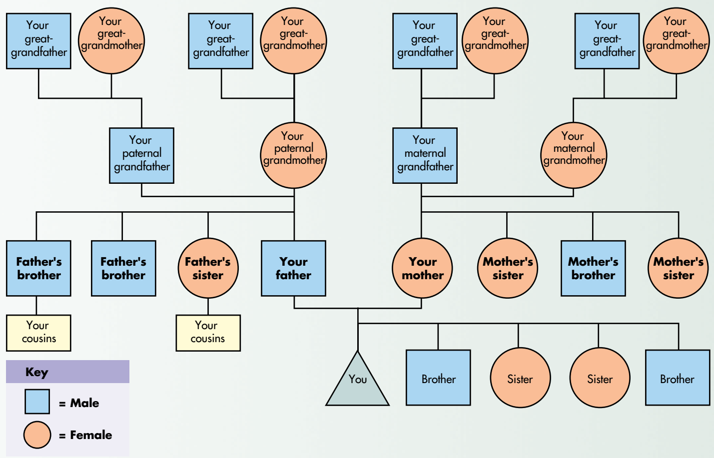
There can be more than one reason for choosing a particular food or drink.

Application

Now ask yourself what your most frequent reason is for eating or drinking. To what degree is health a reason for your food choices? Should you make it a higher priority?

II. CREATE YOUR FAMILY TREE FOR HEALTH-RELATED CONCERNS.

Figure 1-6 in the Nutrition Perspective provides one such example.



Under each heading, list year born, year died (if applicable), major diseases that developed during the person's lifetime, and cause of death (if applicable).

Note that you are likely to be at risk for any diseases listed. Creating a plan for preventing such diseases when possible, especially those that developed in your family members before age 50–60 years, is advised. Speak with your physician about any concerns arising from this exercise.

Nutrition Perspective

Genetics and Nutrition

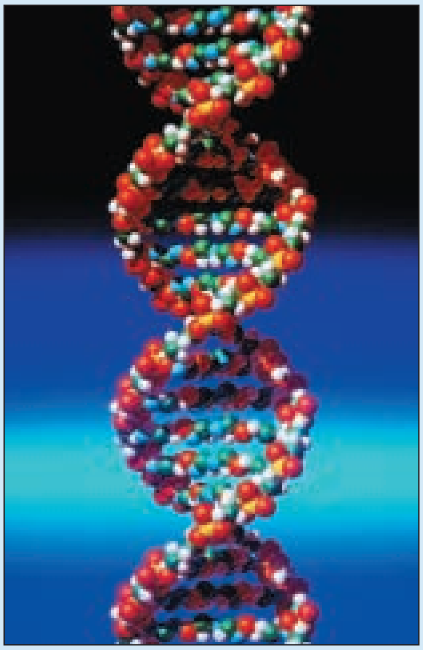
The growth, development, and maintenance of cells, and ultimately of the entire organism, are directed by genes present in the cells. The genes contain the codes that control the expression of individual traits, such as height, eye color, and susceptibility to many diseases. An individual's genetic risk for a given disease is an important factor, although often not the only factor, in determining whether he or she develops that disease.[23]

Interest in the human genetic code and its relationship to specific diseases has exploded in recent years. Currently, the federal government is sponsoring a program to sequence the more than 100,000 genes present on human chromosomes.[7] This Human Genome Project is not actually sequencing the genes of just one person but is compiling a composite genome based on the DNA contributed by about 50 individuals. Each gene essentially represents a recipe, noting the ingredients (specifically, amino acids) and how those ingredients should be put together. The human genome then would be the cookbook.

It is likely that soon it will be relatively easy to screen a person's DNA for genes that increase the risk for disease. Currently, a woman can pay about $2600 to be tested for the BRCA1 and BRAC2 genes; these greatly increase the risk for breast cancer (see a later section in this feature). To date, scientists have developed about 600 genetic tests. Many are for very rare diseases and fortunately often are much less expensive than for the BRCA genes. These are especially valuable for families plagued by certain illnesses, but more routine testing of now-healthy people to predict future risks of cancer or other diseases is poised to grow rapidly. This is a brand new field and is about to mushroom into the significant part of medical practice, as almost every medical condition has a genetic component. Most, however, are not single gene disorders but, instead, arise from alterations in a number of genes.[21]

Each year new links between specific genes and diseases are reported. It is thought that the decoding of the human genome will ultimately transform the practice of medicine, allowing for the prediction years in advance of what illnesses will likely eventually develop in a person. The hope is then to replace genes that encourage diseases, such as cancer and Alzheimer's, with those that do not.[29]

An exciting application of the Human Genome Project are gene chips. About 100,000 pieces of DNA can be loaded onto a chip the size of a fingernail. Blood can be placed on the chip and rapidly tested for altered genes. Genetic material binding to certain areas on the chip can signal a healthy form of a specific gene or alternately a form that is associated with disease. Currently, about 75 laboratories in the United States are using gene chips to investigate disease risk. Information from gene chips provides opportunities for physicians in the future to diagnose disease more carefully and to prescribe individual medical therapies, instead of treating all patients with the same disease with essentially the same therapy. It is likely that many medications may be more appropriate, given certain genetic traits.[30]



Genes are present on DNA—a double helix. The cell nucleus contains most of the DNA in the body.

Nutritional Diseases with a Genetic Link

Most chronic diseases in which nutrition plays a role are also influenced by genetics.[23] The risks of developing heart disease, hypertension, obesity, diabetes, cancer, and osteoporosis are influenced by interactions between genetic and nutritional factors. Studies of families, including those with twins and adoptees, provide strong support for the effect of genetics in these disorders. In fact, family history is considered to be one of the important risk factors in the development of many nutrition-related diseases.

Heart Disease

About one of every 500 people in the American population has a defective gene that greatly delays cholesterol removal from the bloodstream. As you will learn in Chapter 6, this and other genetic effects lead to an increased risk of developing heart disease at a young age. Diet changes can help these people, but medications and possibly surgery may be needed to address these problems.

Hypertension

An estimated 10 to 15% of the American population is very sensitive to salt intake. When these salt-sensitive individuals consume too much salt, their blood pressure climbs above the desirable range. The fact that more of these people are African-American than White suggests a genetic component. At present, the only way to determine whether individuals with hypertension are salt sensitive is to place them on a salt-restricted diet and see if their blood pressure falls. Note also that many cases of hypertension are unrelated to salt sensitivity and are caused by other factors (see Chapter 11).

Obesity

Most obese Americans have at least one parent who is also obese. Findings from many human studies suggest that a variety of genes (likely 50 or more) are involved in the regulation of body weight (see Chapter 13 for more details). Little is known, however, about the specific nature of these genes in humans or how the actual changes in body metabolism (such as lower energy use in general or fat use in particular) are produced.

Still, although some individuals may be genetically predisposed to store body fat, whether they actually do so depends on how much excess energy—above energy needs—they ultimately consume. A common concept in nutrition is that *nurture*—how people live and the environmental factors that influence them—allows *nature*—each person's genetic potential—to be expressed. Although not everyone with a genetic tendency toward obesity develops this condition, he or she does have a higher lifetime risk than individuals without a genetic predisposition to obesity.

Diabetes

Both of the two common types of diabetes have genetic links, as revealed by family and twin studies. Only sensitive and expensive testing can determine who is at risk. The form of diabetes involved in about 90% of all cases, called type 2 diabetes, also has a strong link to obesity. A genetic tendency for type 2 diabetes is expressed once a person becomes obese but often not before, again illustrating that nurture affects nature (see Chapter 5 for more details).

Cancer

A few types of cancer (e.g., some forms of colon and breast cancer) have a strong genetic link, and genetics may play a role in others. Because obesity increases the risk of many forms of cancer, a diet excessive in energy and fat is also a risk factor. And one-third of all cancers result from smoking. Again, genetics is often not enough—environment also contributes to the risk profile (see Chapter 10 for more details).

Osteoporosis

Bone mineral content, and in turn bone strength, is similar in twins as well as in mothers and their daughters. The exact relative importance of genetic versus dietary factors is unknown, but a number of genes have been shown to contribute to a person's overall risk of low bone mineral content. In any case, children and adolescents need to consume sufficient calcium to build strong, dense bones, thus reducing the risk of problems, particularly osteoporosis in women, later in life. Adults should then continue that practice. The porous bones that are a result of osteoporosis greatly increase the risk of fractures, especially in the wrist, spine, and hip. As discussed in Chapter 11, the risk of osteoporosis in women can be greatly reduced by a combination of medical and nutritional means if therapy is started at least by midlife.

YOUR GENETIC PROFILE

From this discussion, you can see that a family history of certain diseases raises your risk of developing those diseases. By recognizing your potential for developing a particular disease, you

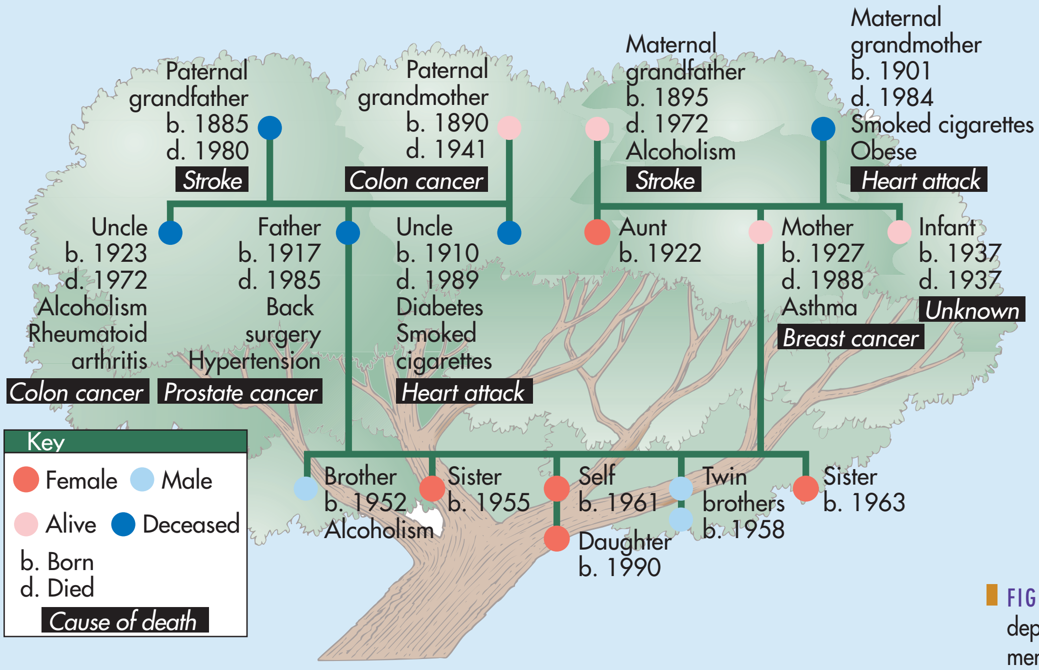


FIGURE 1-6 Example of a family tree depicting disease presentation in family members.

can avoid behavior that contributes to it.[22] For example, women with a family history of breast cancer should avoid becoming obese, should minimize alcohol use, and should obtain mammograms regularly. In general, the more of your relatives who had a genetically transmitted disease and the closer they are related to you, the greater your risk. One way to assess your risk is to put together a family tree of illnesses and deaths by compiling a few key facts on your primary relatives: siblings, parents, aunts and uncles, and grandparents, as suggested in the Take Action section.

Figure 1-6 shows an example of a family tree (also called a genogram). High-risk conditions include two or more first-degree relatives in a family with a specific disease (first-degree relatives include one's parents, siblings, and offspring). Another sign of risk of inherited disease is development of the disease in a first-degree relative before age 50 to 60 years. In the family in Figure 1-6, prostate cancer killed the man's father. This means that the son should be tested regularly for prostate cancer. His sisters should consider frequent mammograms and other preventive practices because the mother died of breast cancer. Because heart disease and stroke are also common in the family, all the children should adopt a lifestyle that minimizes the risk of developing these diseases, such as a moderate fat and sodium intake. Colon cancer is also evident in the family, so careful screening throughout life is important.

Gene Therapy

Scientists are currently developing therapies to correct some genetic disorders.[29] Typically, the gene of interest is inserted into a virus, and then this virus is injected into the target tissue. For example, a gene that stimulates blood vessel growth has been inserted into a **virus**, and this combination has been injected into the hearts of people with poor heart circulation. This gene therapy has led to improvement in health. In addition, in 1990 two girls were treated for a severe immune deficiency disease with genetic therapy. Both girls are alive and well today. Scientists hope that one day gene therapy applications such as these can be used to treat many diseases, especially inherited diseases.[27] Still, much more research is needed for that to happen. The death of a young man in Pennsylvania involved in a gene therapy protocol that injected gene-laden viral particles into the main artery leading to the liver. This attempt to correct a defective enzyme in his liver shows that we need much more experience with this technology before it becomes widespread.[11]

virus The smallest known type of infectious agent, many of which cause disease in humans. They do not metabolize, grow, or move by themselves. They reproduce by the aid of a living cellular host. Viruses are essentially a piece of genetic material surrounded by a coat of protein.

CRITICAL THINKING

Wesley notices that at family gatherings his parents, uncles, aunts, and older siblings typically drink excessive amounts of alcohol. His father has been arrested for driving while intoxicated, as has one of his aunts. Two of his uncles died before the age of 60 from alcohol abuse. As Wesley approaches the age of legal drinking, he wonders if he is destined to fall into the pattern of alcohol abuse. What advice would you give to Wesley concerning his future use of alcohol?

phenylketonuria (PKU) A disease caused by a defect in the ability of the liver to metabolize the amino acid phenylalanine into the amino acid tyrosine. Toxic by-products of phenylalanine can then build up in the body and lead to mental retardation.

Genetic testing for disease susceptibility will be more common in the future as the genes that increase risk for various diseases are isolated and deciphered.

GENETIC TESTING

In recent years, scientists have developed ways of testing a person's genes for the likelihood of developing certain diseases. For cases such as Huntington's disease, a degenerative brain disorder, a positive gene test guarantees the eventual development of the disease. However, with diseases such as cancer and Alzheimer's disease, a positive gene test simply indicates a greater risk for developing the disease. In addition to the diseases mentioned, risk factors for birth defects, cystic fibrosis, certain forms of muscular dystrophy, and a host of other diseases can be detected through genetic testing.

Today in the United States, newborns are routinely tested for **phenylketonuria,** an inherited metabolic disease that leads to mental retardation and other problems if appropriate treatment is not given. Infants found to have this disorder are put on a special diet, which reduces development of the disease (see Chapter 7 for details). In contrast to infants with phenylketonuria, individuals with genetic predispositions to many other diseases do not always develop disease.

Because genetic background does influence disease risk, certain dietary guidelines are more beneficial for some people than for others. For example, people prone to osteoporosis, as mentioned earlier, need to be more aware of calcium intake. Overall, the benefits of genetic testing include the potential for more individualized nutrition and health advice, more informed decisions by couples attempting to have children (i.e., alternatives such as adoption or therapeutic abortion), increased surveillance for the disease, and the ability to plan appropriately for the future. However, it is not possible, given the resources presently allocated to medical care in America, to identify all people at genetic risk for the major chronic diseases and other health problems. In addition, in many cases genetic susceptibility does not equate to a guarantee of development of the disease. And, in almost all cases, there is no way to cure a specific gene alteration—only the health problems that result can be treated. Thus, the wisdom of genetic testing is an open question.[30] Perhaps preventive measures and careful scrutiny for the specific genetically linked diseases in one's family would suffice.

Researchers also are concerned that people who are found to have genetic alterations that increase disease risk may face job and insurance discrimination. Testing positive could also lead to unnecessary radical treatment. As well, a seemingly hopeless diagnosis could result in depression or withdrawal from life when a cure is out of reach.

Consider the following situations with regard to genetic testing.

- Using the family tree such as in the Take Action section, you realize that colon cancer runs in your family. Knowing that the mortality rate for colon cancer is quite high, would you be tested for specific colon cancer genes (note: these genes do not guarantee colon cancer but do indicate greater risk)? What implications would affect your decision?
- You as a female (or a female you care about, if you are a male) carry the breast cancer gene BRCA1 or BRCA2, or you have a family history of breast cancer. Would you consider mastectomies to try to make sure the disease does not develop? This has been shown to be effective therapy, reducing risk of breast cancer and death by 90%.[8] However, even some high-risk women never actually develop the disease.
- You and your (future) spouse would like to have children. You know that phenylketonuria has occurred in your family and would like to be tested as a carrier. It turns out that both you and your spouse carry the gene for phenylketonuria. Any offspring have a 1 in 4 chance of having the fatal disease. How would this affect your decision to have a child? How would your decision change if you (or your spouse) were already pregnant?

Some experts recommend that anyone considering genetic testing should first undergo genetic counseling.[30] Genetic counselors are trained to analyze family history and evaluate risk of developing or passing along an inherited disease. They can also help determine whether testing is worth the time and trouble, since genetic tests are primarily for people whose family history puts them at especially high risk of having a genetic defect. Genetic counselors can be found by contacting a local hospital or nearby university-affiliated hospital or medical school.

In the final analysis, would you rather know if you were at risk for a specific disease that a genetic test could point out? If so, ask your physician about the possibility and wisdom of testing you for the genetically linked diseases in your family tree. Also, be aware that, throughout this book, discussions will point out how you can personalize nutrition advice based on your genetic background. In this way, you can identify and avoid the "controllable" risk factors that would contribute to the development of genetically linked diseases present in your family.[22]

The following web links will help you gather more information about genetic conditions and testing:

http://www.geneticalliance.org Alliance of Genetic Support Groups.

http://www.kumc.edu/gec/support Information on genetic conditions and rare conditions.

http://cancernet.nci.nih.gov/p_genetics.html Genetics information from the National Cancer Institute.

http://www.nhgri.nih.gov National Human Genome Research Institute (at the NIH) home page. Describes latest research findings, ethics issues, and talking glossary.

http://www.faseb.org/genetics Compilation of major genetics societies throughout the world. Information on genetics meetings, society policy statements, etc.

http://vector.cshl.org Cold Spring Harbor Labs DNA Learning Center home page; includes animation of genetic techniques.

http://www.ncgr.org National Center for Genomic Resources home page.