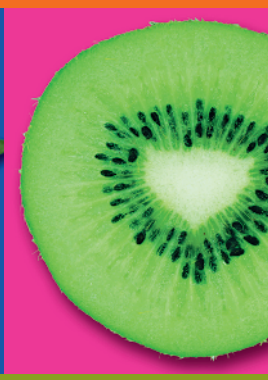
PART ONE

Fundamentals of Nutrition and Foods



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CHAPTER 1

Introduction to Nutrition

AMERICANS ARE FASCINATED WITH FOOD: choosing foods, reading newspaper articles on food, perusing cookbooks, preparing and cooking foods, checking out new restaurants, and, of course, eating foods. Why are we so interested in food? Of course, eating is fun, enjoyable, and satisfying, especially when we are eating with other people whose company we like. Beyond the physical and emotional satisfaction of eating, we often are concerned about how food choices affect our health. Our choice of diet strongly influences whether we will get certain diseases, such as heart disease, cancer, and stroke—the three biggest killers in the United States. Indeed, high costs are associated with poor eating patterns. In 2004, the Centers for Disease Control and Prevention estimated the annual cost of heart disease and stroke in the United States at $368 billion, including health-care expenditures and lost productivity from death and disability. No doubt eating right contributes to health and quality of life, and this is reflected in growing consumer awareness of eating healthy. Restaurants are responding by removing supersized menus and offering fruit and milk instead of cookies and soda, for example.

This introductory chapter explores why we choose the foods we eat and then explains important nutrition concepts that build a foundation for the remaining chapters. It will help you to:

- Identify factors that influence food selection
- Define *nutrition, kilocalorie, nutrient,* and *nutrient density*
- Identify the classes of nutrients and their characteristics
- Describe four characteristics of a nutritious diet
- Define Dietary Reference Intakes and explain their function
- Compare the EAR, RDA, AI, and UL
- Describe the processes of digestion, absorption, and metabolism
- Explain how the digestive system works

FACTORS INFLUENCING FOOD SELECTION

Why do people choose the foods they do? This is a very complex question, and many factors influence what you eat, as you can see from this list:

- Flavor
- Other aspects of food (such as cost, convenience, nutrition)
- Demographics
- Culture and religion
- Health
- Social and emotional influences
- Food industry and the media
- Environmental concerns

Now we will look at these factors in depth.

■ **FLAVOR** An attribute of a food that includes its appearance, smell, taste, feel in the mouth, texture, temperature, and even the sounds made when it is chewed.

■ **TASTE** Sensations perceived by the taste buds on the tongue.

■ **TASTE BUDS** Clusters of cells found on the tongue, cheeks, throat, and roof of the mouth. Each taste bud houses 60 to 100 receptor cells. The body regenerates taste buds about every three days. These cells bind food molecules dissolved in saliva and alert the brain to interpret them.

Flavor

The most important consideration when choosing something to eat is the flavor of the food (Figure 1-1). **Flavor** is an attribute of a food that includes its appearance, smell, taste, feel in the mouth, texture, temperature, and even the sounds made when it is chewed. Flavor is a combination of all five senses: taste, smell, touch, sight, and sound. From birth, we have the ability to smell and taste. Most of what we call taste is really smell, a fact we realize when a cold hits our nasal passages. Even though the taste buds are working fine, the smell cells are not, and this dulls much of food's flavor.

Taste comes from 10,000 **taste buds**—clusters of cells that resemble the sections of an orange. Taste buds, found on the tongue, cheeks, throat, and roof of the mouth, house 60 to 100 receptor cells each. The body regenerates taste buds about every three days. They are most numerous in children under age six, and this may explain why youngsters are such picky eaters.

These taste cells bind food molecules dissolved in saliva and alert the brain to interpret them. Although the tongue often is depicted as having regions that specialize in particular taste sensations—for example, the tip is said to detect sweetness—researchers know that taste buds for each sensation (sweet, salty, sour, bitter, and umami) are actually scattered around the tongue. In fact, a single taste bud can have receptors for all five sensations. We also know that the back of the tongue is more sensitive to bitter and that food temperature influences taste.

FIGURE 1-1
The most important consideration when choosing something to eat is flavor.
Courtesy of PhotoDisc/Getty Images.

Umami, the fifth basic taste, differs from the traditional sweet, sour, salty, and bitter tastes by providing a savory, sometimes meaty sensation. Umami is a Japanese word and the taste is evident in many Japanese ingredients and flavorings, such as seaweed, dashi stock, and mushrooms, as well as other foods. The umami taste receptor is very sensitive to glutamate, which occurs naturally in foods such as meat, fish, and milk, and it is often added to processed foods in the form of the flavor enhancer monosodium glutamate (MSG). Despite the frequent description of umami as meaty, many foods, including mushrooms, tomatoes, and Parmesan cheese, have a higher level of glutamate than an equal amount of beef or pork. This explains why foods that are cooked with mushrooms or tomatoes seem to have a fuller, rounder taste than when cooked alone.

If you could taste only sweet, salty, sour, bitter, and umami, how could you taste the flavor of cinnamon, chicken, or any other food? This is where smell comes in. Your ability to identify the flavors of specific foods requires smell.

The ability to detect the strong scent of a fish market, the antiseptic odor of a hospital, the aroma of a ripe melon, and thousands of other smells is possible thanks to a yellowish patch of tissue the

size of a quarter high up in your nose. This patch is actually a layer of 12 million specialized cells, each sporting 10 to 20 hairlike growths called cilia that bind with the smell and send a message to the brain. Of course, if you have a bad cold and mucus clogs up your nose, you lose some sense of smell and taste. Our sense of smell may not be as refined as that of dogs, which have billions of olfactory cells, but we can distinguish among about 10,000 scents.

You can smell foods in two ways. If you smell coffee brewing while you are getting dressed, you smell it directly through your nose. But if you are drinking coffee, the smell of the coffee goes to the back of your mouth and then up into your nose. To some extent, what you smell (or taste) is determined by your genetics and also your age.

All foods have texture, a natural texture granted by Mother Nature. It may be coarse or fine, rough or smooth, tender or tough. Whichever the texture, it influences whether you like the food. The natural texture of a food may not be the most desirable texture for a finished dish, and so a cook may create different texture. For example, a fresh apple may be too crunchy to serve at dinner, and so it is baked or sautéed for a softer texture. Or a cream soup may be too thin, and so a thickening agent is used to increase the viscosity of the soup or, simply stated, make it harder to pour.

Food appearance or presentation strongly influences which foods you choose to eat. Eye appeal is the purpose of food presentation, whether the food is hot or cold. It is especially important for cold foods because they lack the come-on of an appetizing aroma. Just the sight of something delicious to eat can start your digestive juices flowing.

Other Aspects of Food

Food cost is a major consideration. For example, breakfast cereals were inexpensive for many years. Then their prices jumped, and it seemed that most boxes of cereal cost over $3.00. Some consumers switched from cereal to bacon and eggs because the bacon and eggs became less expensive. Cost is a factor in many purchasing decisions at the supermarket, whether one is buying dry beans at $0.39 per pound or fresh salmon at $9.99 per pound.

Convenience is more of a concern now than at any time in the past because of the lack of time to prepare meals. Just think about the variety of foods you can purchase today that are already cooked and can simply be microwaved. Even if you desire fresh fruits and vegetables, supermarkets offer them already cut up and ready to eat. Of course, convenience foods are more expensive than their raw counterparts, and not every budget can afford them.

Everyone's food choices are affected by availability and familiarity. Whether it is a wide choice of foods at an upscale supermarket or a choice of only two restaurants within walking distance of where you work, you can eat only what is available. The availability of foods is very much influenced by the way food is

produced and distributed. For example, the increasing number of soft drink vending machines, particularly in schools and workplaces, has contributed to increasing soft drink consumption year-round. Fresh fruits and vegetables are perfect examples of foods that are most available (and at their lowest prices) when in season. Of course, you are more likely to eat fruits and vegetables, or any food for that matter, with which you are familiar and which you have eaten before.

The nutritional content of a food can be an important factor in deciding what to eat. You probably have watched people reading nutritional labels on a food package, or perhaps you have read nutritional labels yourself. Current estimates show that about 66 percent of Americans use nutrition information labels. Older people tend to read labels more often than younger people do.

Demographics

Demographic factors that influence food choices include age, gender, educational level, income, and cultural background (discussed next). Women and older adults tend to consider nutrition more often than do men or young adults when choosing what to eat. Older adults are probably more nutrition-minded because they have more health problems, such as heart disease and high blood pressure, and are more likely to have to change their diet for health reasons. Older adults also have more concerns with poor dental health, swallowing problems, and digestive problems. People with higher incomes and educational levels tend to think about nutrition more often when choosing what to eat.

Culture and Religion

CULTURE The behaviors and beliefs of a certain social, ethnic, or age group.

Culture can be defined as the behaviors and beliefs of a certain social, ethnic, or age group. A culture strongly influences the eating habits of its members. Each culture has norms about which foods are edible, which foods have high or low status, how often foods are consumed, what foods are eaten together, when foods are eaten, and what foods are served at special events and celebrations (such as weddings).

In short, your culture influences your attitudes toward and beliefs about food. For example, some French people eat horsemeat, but Americans do not consider horsemeat acceptable to eat. Likewise, many common American practices seem strange or illogical to persons from other cultures. For example, what could be more unusual than boiling water to make tea and adding ice to make it cold again, sugar to sweeten it, and then lemon to make it tart? When immigrants come to live in the United States, their eating habits gradually change, but they are among the last habits to adapt to the new culture.

For many people, religion affects their day-to-day food choices. For example, many Jewish people abide by the Jewish dietary laws, called the Kashrut. They do not eat pork, nor do they eat meat and dairy products together.

FIGURE 1-2 FOOD PRACTICES OF WORLD RELIGIONS

Religion	Dietary Practices
Judaism	Kashrut: Jewish dietary law of keeping kosher.
	1. *Meat and poultry.* Permitted: Meat of animals with a split hoof that chew their cud (includes cattle, sheep, goats, deer); a specific list of birds (includes chicken, turkey, goose, pheasant, duck). Not permitted: Pig and pork products, mammals that don't have split hooves and chew their cud (such as rabbit), birds not specified (such as ostrich). All animals require ritual slaughtering. All meat and poultry foods must be free of blood, which is done by soaking and salting the food or by broiling it. Forequarter cuts of mammals are also not eaten.
	2. *Fish.* Permitted: Fish with fins and scales. Not permitted: Shellfish (scallops, oysters, clams), crustaceans (crab, shrimp, lobster), fishlike mammals (dolphin, whale), frog, shark, eel. Do not cook fish with meat or poultry.
	3. Meat and dairy are not eaten or prepared together. Meals are dairy or meat, not both. It is also necessary to have two sets of cooking equipment, dishes, and silverware for dairy and meat.
	4. All fruits, vegetables, grains, and eggs can be served with dairy or meat meals.
	5. A processed food is considered kosher only if the package has a rabbinical authority's name or insignia.
Roman Catholicism	1. Abstain from eating meat on Fridays during Lent (the 40 days before Easter). 2. Fast (one meal is allowed) and abstain from meat on Ash Wednesday (beginning of Lent) and Good Friday (the Friday before Easter).
Eastern Orthodox Christianity	Numerous feast days and fast days. On fast days, no fish, meat, or other animal products (including dairy products) are allowed. Shellfish are allowed.
Protestantism	1. Food on religious holidays is largely determined by a family's cultural background and preferences. 2. Fasting is uncommon.
Mormonism	1. Prohibit tea, coffee, and alcohol. Some Mormons abstain from anything containing caffeine. 2. Eat only small amounts of meat and base diet on grains. 3. Some Mormons fast once a month.
Seventh-Day Adventist Church	1. Many members are lacto-ovo vegetarians (eat dairy products and eggs but no meat or poultry). 2. Avoid pork and shellfish. 3. Prohibit coffee, tea, and alcohol. 4. Drink water before and after meals, not during. 5. Avoid highly seasoned foods and eating between meals.
Islam	1. All foods are permitted (halal) except for swine (pigs), four-legged animals that catch prey with the mouth, birds of prey that grab prey with their claws, animals (except fish and seafood) that have not been slaughtered according to ritual, and alcoholic beverages. Use of coffee and tea is discouraged. 2. Celebrate many feast and fast days. On fast days, they do not eat or drink from sunup to sundown.

FIGURE 1-2 (Continued)

Hinduism	**1. Encourages eating in moderation.** **2. Meat is allowed, but the cow is sacred and is not eaten. Also avoided are pork and certain fish. Many Hindus are vegetarian.** **3. Many Hindus avoid garlic, onions, mushrooms, and red foods such as tomatoes.** **4. Water is taken with meals.** **5. Some Hindus abstain from alcohol.** **6. Hindus have a number of feast and fast days.**
Buddhism	**1. Dietary laws vary depending on the country and the sect. Many Buddhists do not believe in taking life, and so they are lacto-ovo vegetarians (eat dairy products and eggs but no meat or poultry).** **2. Celebrate feast and fast days.**

Muslims also have their own dietary laws. Like Jews, they will not eat pork. Their religion also prohibits drinking alcoholic beverages. For other people, religion influences what they eat mostly during religious holidays and celebrations. Religious holidays such as Passover are observed with appropriate foods. Figure 1-2 explains the food practices of different religions.

Health

Have you ever dieted to lose weight? Most Americans are trying to lose weight or keep from gaining it. You probably know that obesity and overweight can increase your risk of cancer, heart disease, diabetes, and other health problems. What you eat influences your health. Even if you are healthy, you may base food choices on a desire to prevent health problems and/or improve your appearance.

A knowledge of nutrition and a positive attitude toward nutrition may translate into nutritious eating practices. Just knowing that eating lots of fruits and vegetables may prevent heart disease does not mean that someone will automatically start eating more of those foods. For some people, knowledge is enough to stimulate new eating behaviors, but for most people, knowledge is not enough and change is difficult. Many circumstances and beliefs prevent change, such as a lack of time or money to eat right. But some people manage to change their eating habits, especially if they feel that the advantages (such as losing weight or preventing cancer) outweigh the disadvantages.

Social and Emotional Influences

People have historically eaten meals together, making meals important social occasions. Our food choices are influenced by the social situations we find ourselves in, whether in the comfort of our own home or eating out in a restaurant. For

example, social influences are involved when several members of a group of college friends are vegetarian. Peer pressure no doubt influences many food choices among children and young adults. Even as adults, we tend to eat the same foods that our friends and neighbors eat. This is due to cultural influences as well.

Food is often used to convey social status. For example, in a trendy, upscale New York City restaurant, you will find prime cuts of beef and high-priced wine.

Emotions are closely tied to some of our food selections. As a child, you may have been given something sweet to eat, such as cake or candy, whenever you were unhappy or upset. As an adult, you may gravitate to those kinds of foods, called comfort foods, when under stress.

Food Industry and the Media

The food industry very much influences what you choose to eat. After all, the food companies decide what foods to produce and where to sell them. They also use advertising, product labeling and displays, information provided by their consumer services departments, and websites to sell their products.

On a daily basis, the media (television, newspapers, magazines, radio, etc.) portray food in many ways: paid advertisements, articles on food in magazines and newspapers, and foods eaten on television shows. Much research has been done on the impact of television food commercials on children. Quite often the commercials succeed in getting children to eat foods such as cookies, candies, and fast food. Television commercials probably are contributing to higher calorie and fat intakes.

The media also report frequently on new studies related to food, nutrition, and health topics. It is hard to avoid hearing sound bites such as "more fruits and vegetables lower blood pressure." Media reports may influence which foods people eat.

Environmental Concerns

Some people have environmental concerns, such as the use of chemical pesticides, and so they often, or always, choose organically grown foods (which are grown without such chemicals—see Food Facts on page 30 for more information). Many vegetarians won't eat meat or chicken because livestock and poultry require so much land, energy, water, and plant food, which they consider wasteful.

Now that you have a better understanding of why we eat the foods we do, we can look at some basic nutrition concepts and terms.

MINI-SUMMARY

Figure 1-3 summarizes factors that influence what we eat.

FIGURE 1-3 FACTORS INFLUENCING WHAT YOU EAT

- Flavor
  - Taste
  - Smell
  - Appearance
  - Texture
- Other Aspects of Food
  - Cost
  - Convenience
  - Availability
  - Familiarity
  - Nutrition
- Demographics
  - Age
  - Gender
  - Educational level
  - Income
- Culture and Religion
  - Traditional foods and food habits
  - Attitudes and beliefs
  - Special events and celebrations
  - Religious foods and food practices
- Health
  - Health status and desire to improve health
  - Desire to improve appearance
  - Nutrition knowledge and attitudes
- Social and Emotional Influences
  - Social status
  - Peer pressure
  - Emotional status
  - Food associations
- Food Industry and the Media
  - Food industry
  - Food advertising
  - Food portrayal in media
  - Reporting of nutrition/health studies
- Environmental Concerns
  - Use of synthetic fertilizers and pesticides
  - Wastefulness of fattening up livestock/poultry

BASIC NUTRITION CONCEPTS

Nutrition

■ **NUTRITION** A science that studies nutrients and other substances in foods and in the body and the way those nutrients relate to health and disease. Nutrition also explores why you choose particular foods and the type of diet you eat.

■ **NUTRIENTS** The nourishing substances in food that provide energy and promote the growth and maintenance of your body.

■ **DIET** The food and beverages you normally eat and drink.

Nutrition is a science. Compared with some other sciences, such as chemistry, that have been studied for thousands of years, nutrition is a young science. Many nutritional facts revolve around nutrients, such as carbohydrates. **Nutrients** are the nourishing substances in food that provide energy and promote the growth and maintenance of the body. In addition, nutrients aid in regulating body processes such as heart rate and digestion and in supporting the body's optimum health.

Nutrition researchers look at how nutrients relate to health and disease. Almost daily we are bombarded with news reports that something in the food we eat, such as fat, is not good for us—that it may indeed cause or complicate conditions such as heart disease and cancer. Researchers look closely at the relationships between nutrients and disease, as well as the processes by which you choose what to eat and the balance of foods and nutrients in your diet.

In summary, nutrition is a science that studies nutrients and other substances in foods and in the body and the way those nutrients relate to health and disease. Nutrition also explores why you choose the foods you do and the type of **diet** you eat. *Diet* is a word that has several meanings. Anyone who has tried to lose weight has no doubt been on a diet. In this sense, *diet* means weight-reducing diet and is often thought of in a negative way. But a more general definition of *diet* is the foods and beverages you normally eat and drink.

Kilocalories

■ **KILOCALORIE** A measure of the energy in food, specifically the energy-yielding nutrients.

■ **BASAL METABOLISM** The minimum energy needed by the body for vital functions when at rest and awake.

■ **THERMIC EFFECT OF FOOD** The energy needed to digest and absorb food.

Food energy, as well as the energy needs of the body, is measured in units of energy called **kilocalories**. The number of kilocalories in a particular food can be determined by burning a weighed portion of that food and measuring the amount of heat (or kilocalories) it produces. A kilocalorie, also called a Calorie (notice the uppercase "C"), raises the temperature of 1 kilogram of water 1 degree Celsius. Just as 1 kilogram contains 1000 grams, 1 kilocalorie contains 1000 calories (notice the lowercase "c"). When you read in a magazine that a cheeseburger has 350 calories, understand that it is really 350 kilocalories. The American public has been told for years that an apple has 80 calories, a glass of regular milk has 120 calories, and so on, when the correct term is *not* calories but kilocalories. The media shortened the term *kilocalories* to *calories*, which is incorrect. This book uses the term *kilocalorie* and its abbreviations, kcalorie and kcal, throughout each chapter.

The number of kcalories you need is based on three factors: your energy needs when your body is at rest and awake (referred to as **basal metabolism**), your level of physical activity, and the energy you need to digest and absorb food (referred to as the **thermic effect of food**). Basal metabolic needs include en-

ergy needed for vital bodily functions when the body is at rest but awake. For example, your heart is pumping blood to all parts of your body, your cells are making proteins, and so on. Your basal metabolic rate (BMR) depends on the following factors:

1. Gender. Men have a higher BMR than women do because men have a higher proportion of muscle tissue (muscle requires more energy for metabolism than fat does).
2. Age. As people age, they generally gain fat tissue and lose muscle tissue. BMR declines about 2 percent per decade after age 30.
3. Growth. Children, pregnant women, and lactating women have higher BMRs.
4. Height. Tall people have more body surface than shorter people do and lose body heat faster. Their BMR is therefore higher.
5. Temperature. BMR increases in both hot and cold environments, to keep the temperature inside the body constant.
6. Fever and stress. Both of these increase BMR. Fever raises BMR by 7 percent for each 1 degree Fahrenheit above normal. The body reacts to stress by secreting hormones that speed up metabolism so that the body can respond quickly and efficiently.
7. Exercise. Exercise increases BMR for several hours afterward.
8. Smoking and caffeine. Both cause increased energy expenditure.
9. Sleep. Your BMR is at its lowest when you are sleeping.

The basal metabolic rate also decreases when you diet or eat fewer kcalories than normal. The BMR accounts for the largest percentage of energy expended—about two-thirds for individuals who are not very active.

Your level of physical activity strongly influences how many kcalories you need. Figure 1-4 shows the kcalories burned per hour for a variety of activities. The number of kcalories burned depends on the type of activity, how long and how hard it is performed, and the individual's size. The larger your body is, the more energy you use in physical activity. Aerobic activities such as walking, jogging, cycling, and swimming are excellent ways to burn calories if they are brisk enough to raise heart and breathing rates. Physical activity accounts for 25 to 40 percent of total energy needs.

The thermic effect of food is the smallest contributor to your energy needs: from 5 to 10 percent of the total. In other words, for every 100 kcalories you eat, 5 to 10 are used for digestion, absorption, and metabolism of nutrients, our next topic.

Nutrients

As stated, nutrients provide energy or kcalories, promote the growth and maintenance of the body, and/or regulate body processes. There are about 50 nutrients that can be arranged into six classes, as follows:

1. Carbohydrates
2. Fats (the proper name is lipids)

FIGURE 1-4 KCALORIES PER HOUR EXPENDED IN COMMON PHYSICAL ACTIVITIES

Moderate Physical Activity	Kcals/Hour for a 154-Pound Person
Hiking	367
Light gardening/yard work	331
Dancing	331
Golf (walking and carrying clubs)	331
Bicycling (less than 10 mph)	294
Walking (3.5 mph)	279
Weight lifting (general light workout)	220
Stretching	184
Vigorous Physical Activity	**Kcals/Hour for a 154-Pound Person**
Running/jogging (5 mph)	588
Bicycling (over 10 mph)	588
Swimming (slow freestyle laps)	514
Aerobics	478
Walking (4.5 mph)	464
Heavy yard work (chopping wood)	441
Weight lifting (vigorous effort)	441
Basketball (vigorous)	441

Source: 2005 Report of the Dietary Guidelines Advisory Committee.

3. Protein
4. Vitamins
5. Minerals
6. Water

Each nutrient class performs different functions in the body, as shown in Figure 1-5.

Foods rarely contain just one nutrient. Most foods provide a mix of nutrients. For example, bread often is thought of as providing primarily carbohydrates,

FIGURE 1-5 FUNCTIONS OF NUTRIENTS

Nutrients	Provide Energy	Promote Growth and Maintenance	Regulate Body Processes
Carbohydrates	X		
Lipids	X	X	X
Protein	X	X	X
Vitamins		X	X
Minerals		X	X
Water		X	X

but it is also an important source of certain vitamins and minerals. Food contains more than just nutrients. Depending on the food, it may contain colorings, flavorings, caffeine, phytochemicals (minute substances in plants that may protect health), and other substances.

■ **ENERGY-YIELDING NUTRIENTS** Nutrients that can be burned as fuel to provide energy for the body, including carbohydrates, fats, and proteins.

Carbohydrates, lipids, and protein are called **energy-yielding nutrients** because they can be burned as fuel to provide energy for the body. They provide kcalories as follows:

Carbohydrates:	4 kcalories per gram
Lipids:	9 kcalories per gram
Protein:	4 kcalories per gram

(A gram is a unit of weight in the metric system; there are about 28 grams in 1 ounce.) Vitamins, minerals, and water do not provide energy or calories.

■ **MICRONUTRIENTS** Nutrients needed by the body in small amounts, including vitamins and minerals.

The body needs vitamins and minerals in small amounts, and so these nutrients are called **micronutrients** (*micro* means small). In contrast, the body needs large amounts of carbohydrates, lipids, and protein, and so they are called **macronutrients** (*macro* means large).

■ **MACRONUTRIENTS** Nutrients needed by the body in large amounts, including carbohydrates, lipids, and proteins.

Another way to group the classes of nutrients is to look at them from a chemical point of view. In chemistry, any compound that contains carbon is called **organic**. If a compound does not contain carbon, it is called **inorganic**. Carbohydrates, lipids, proteins, and vitamins are all organic. Minerals and water are inorganic.

■ **ORGANIC** In chemistry, any compound that contains carbon.

■ **INORGANIC** In chemistry, any compound that does not contain carbon.

Carbohydrates are a large class of nutrients, including sugars, starches, and fibers, that function as the body's primary source of energy. *Sugar* is most familiar in its refined forms, such as table sugar and high-fructose corn syrup, and is used in soft drinks, cookies, cakes, pies, candies, jams, jellies, and other sweetened foods. Sugar is also present naturally in fruits and milk (even though milk does not taste sweet). *Starch* is found in breads, breakfast cereals, pastas, potatoes, and beans. Both sugar and starch are important sources of energy for the body. *Fiber* can't be broken down or digested in the body, and so it is excreted. It therefore does not provide energy for the body. Fiber does a number of good things in the body, such as improve the health of the digestive tract. Good sources of fiber include legumes (dried beans and peas), fruits, vegetables, whole-grain foods such as whole-wheat bread and cereal, nuts, and seeds.

■ **CARBOHYDRATES** A large class of nutrients, including sugars, starch, and fibers, that function as the body's primary source of energy.

■ **LIPIDS** A group of fatty substances, including triglycerides and cholesterol, and that are soluble in fat, not water, and that provide a rich source of energy and structure to cells.

Lipids are a group of fatty substances, including triglycerides and cholesterol, that are soluble in fat, not water, and that provide a rich source of energy and structure to cells. The most familiar lipids are fats and oils, which are found in butter, margarine, vegetable oils, mayonnaise, and salad dressings. Lipids are also found in the fatty streaks in meat, the fat under the skin of poultry, the fat in milk and cheese (except skim milk and products made with it), baked goods such as cakes, fried foods, nuts, and many processed foods, such as canned soups and frozen dinners. Most breads, cereals, pasta, fruits, and vegetables have little or no fat. Triglycerides are the major form of lipids. They provide energy for the body as well as a way to store energy as fat.

Most of the kcalories we eat come from carbohydrates or fats. Only about 15 percent of total kcalories come from **protein**. This doesn't mean that protein is less important. On the contrary, protein is the main structural component of all the body's cells. It is made of units called amino acids, which are unique in that they contain nitrogen. Besides its role as an important part of cells, protein regulates body processes and can be burned to provide energy (although the body prefers to burn carbohydrates and lipids). Protein is present in significant amounts in foods from animal sources, such as beef, pork, chicken, fish, eggs, milk, and cheese. Protein appears in plant foods, such as grains, beans, and vegetables, in smaller quantities. Fruits contain only very small amounts of protein.

PROTEIN Major structural component of the body's cells that is made of nitrogen-containing amino acids assembled in chains, particularly rich in animal foods.

There are 13 different vitamins in food. **Vitamins** are noncaloric, organic nutrients found in a wide variety of foods. They are essential in small quantities to regulate body processes, maintain the body, and allow growth and reproduction. Instead of being burned to provide energy for the body, vitamins work as helpers. They assist in the processes of the body that keep you healthy. For example, vitamin A is needed by the eyes for vision in dim light. Vitamins are found in fruits, vegetables, grains, meat, dairy products, and other foods. Unlike other nutrients, many vitamins are susceptible to being destroyed by heat, light, and other agents.

VITAMINS Noncaloric, organic nutrients found in a wide variety of foods that are essential in small quantities to regulate body processes, maintain the body, and allow growth and reproduction.

Minerals are also required by the body in small amounts and do not provide energy. Like vitamins, they work as helpers in the body and are found in a variety of foods. Some minerals, such as calcium and phosphorus, become part of the body's structure by building bones and teeth. Unlike vitamins, minerals are indestructible and inorganic.

MINERALS Noncaloric, inorganic chemical substances found in a wide variety of foods; needed to regulate body processes, maintain the body, and allow growth and reproduction.

Although deficiencies of energy or nutrients can be sustained for months or even years, a person can survive only a few days without water. Experts rank water second only to oxygen as essential to life. Water plays a vital role in all bodily processes and makes up just over half the body's weight. It supplies the medium in which various chemical changes of the body occur and aids digestion and absorption, circulation, and lubrication of body joints. For example, as a major component of blood, water helps deliver nutrients to body cells and removes waste to the kidneys for excretion.

It's been said many times, "You are what you eat." This is certainly true; the nutrients you eat can be found in your body. As mentioned, water is the most plentiful nutrient in the body, accounting for about 60 percent of your weight. Protein accounts for about 15 percent of your weight, fat for 20 to 25 percent, and carbohydrates for only 0.5 percent. The remainder of your weight includes minerals, such as calcium in bones, and traces of vitamins.

Most, but not all, nutrients are considered **essential nutrients**. Essential nutrients either cannot be made in the body or cannot be made in the quantities needed by the body; therefore, we must obtain them from food. Carbohydrates (in the form of glucose), vitamins, minerals, water, some lipids, and some parts of protein are considered essential.

ESSENTIAL NUTRIENTS Nutrients that either cannot be made in the body or cannot be made in the quantities needed by the body; therefore, we must obtain them from food.

Nutrient Density

All foods were not created equal in terms of the kcalories and nutrients they provide. Some foods, such as milk, contribute much calcium to your diet, especially when you compare them with other beverages, such as soft drinks. The typical can of cola (12 fluid ounces) contributes large amounts of sugar (40 grams, or about 10 teaspoons), no vitamins, and virtually no minerals. When you compare calories, you will find that skim milk (at 86 kcalories per cup) packs fewer calories than does cola (at 97 kcalories per cup). Therefore, we can say that milk is more "nutrient-dense" than cola, meaning that milk contains more nutrients per kcalorie than colas do.

NUTRIENT DENSITY A measure of the nutrients provided in a food per kcalorie of that food.

The **nutrient density** of a food depends on the amount of nutrients it contains and the comparison of that to its caloric content. In other words, nutrient density is a measure of the nutrients provided per kcalorie of a food. As Figure 1-6 shows, broccoli offers many nutrients for its few calories. Broccoli is considered to have a high nutrient density because it is high in nutrients relative to its caloric value. Vegetables and fruits are examples of nutrient-dense foods. In comparison, a cupcake contains many more kcalories and few nutrients. By now, you no doubt recognize

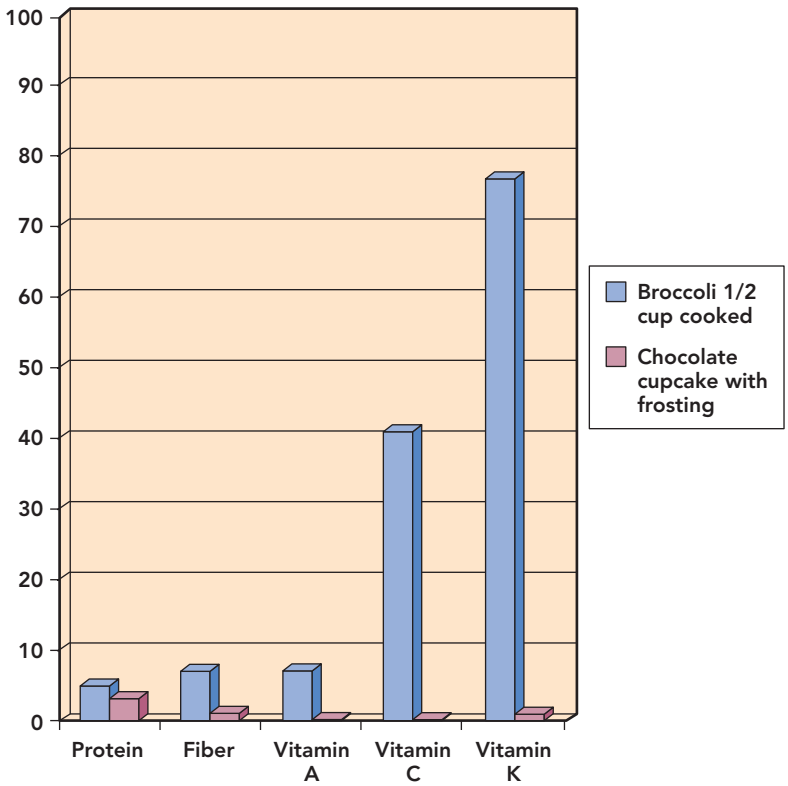
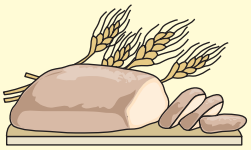


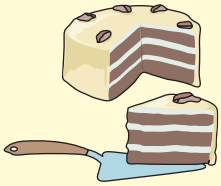
FIGURE 1-6 Nutrition density comparison.*

*Percent of Dietary Reference Intakes for Selected Nutrients

FIGURE 1-7
Six classes of nutrients.

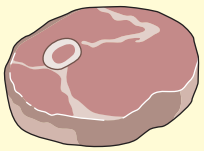
Carbohydrates – A large class of nutrients including sugar, starches, and fibers that are the body's primary source of energy.





Lipids (fats) – A group of fatty substances including triglycerides and cholesterol that are not soluble in water and that provide a rich source of energy and structure to the body's cells.

Proteins – Major structural part of body's cells composed of nitrogen-containing amino acids, particularly rich in animal foods.



Vitamins – 13 noncaloric nutrients found in a wide variety of foods (especially fruits and vegetables)

Minerals – Noncaloric, inorganic chemical substances found in a wide variety of foods

Both vitamins and minerals are essential in small amounts to maintain the body, regulate body processes, and for growth and reproduction.

Water – Inorganic nutrient that plays a vital role in all bodily processes and makes up just over half of the body's weight.

that some foods, such as candy bars, have a low nutrient density, meaning that they are low in nutrients and high in kcalories. These foods are called **empty-kcalorie foods** because the kcalories they provide are "empty" (that is, they deliver few nutrients). The next section will tell you more about what a nutritious diet is.

■ **EMPTY-KCALORIE FOODS**
Foods that provide few nutrients for the number of kcalories they contain.

MINI-SUMMARY

1. Nutrition is a science that studies nutrients and other substances in foods and in the body and the way those nutrients relate to

health and disease. Nutrition also explores why you choose the foods you do and the type of diet you eat.

2. The number of kcalories (a measure of the energy in food) you need is based on three factors: your energy needs when your body is at rest and awake (basal metabolism), your level of physical activity, and the energy you need to digest and absorb food (thermic effect of food).
3. Nutrients are the nourishing substances in food, providing energy and promoting the growth and maintenance of the body. In addition, nutrients regulate the many body processes and support the body's optimum health and growth.
4. The six classes of nutrients are carbohydrates, fats (properly called lipids), protein, vitamins, minerals, and water. Carbohydrates, fats, and proteins, are macronutrients, while vitamins and minerals are micronutrients. Their characteristics are summarized in Figure 1-7.
5. Nutrient density is a measure of the nutrients provided per kcalorie of a food.

CHARACTERISTICS OF A NUTRITIOUS DIET

A nutritious diet has four characteristics. It is:

1. Adequate
2. Balanced
3. Moderate
4. Varied

■ **ADEQUATE DIET** A diet that provides enough kcalories, essential nutrients, and fiber to keep a person healthy.

■ **MODERATE DIET** A diet that avoids excessive amounts of kcalories or any particular food or nutrient.

■ **BALANCED DIET** A diet in which foods are chosen to provide kcalories, essential nutrients, and fiber in the right proportions.

Your diet must provide enough nutrients, but not too many. This is where adequate and moderate diets fit in. An **adequate diet** provides enough kcalories, essential nutrients, and fiber to keep you healthy, whereas a **moderate diet** avoids taking in excessive amounts of kcalories or eating more of one food or food group than is recommended. In the case of kcalories, for example, consuming too many leads to obesity. The concept of moderation allows you to choose appropriate portion sizes of any food as well as to indulge occasionally in high-kcalorie, high-fat foods such as french fries and premium ice cream.

Although it may sound simple to eat enough, but not too much, of the necessary nutrients, surveys show that most adult Americans find this hard to do. One of the best ways to overcome this problem is to select nutrient-dense foods. As stated earlier, nutrient-dense foods contain many nutrients for the kcalories they provide.

Next, you need a **balanced diet**. Eating a balanced diet means eating more servings of nutrient-dense foods such as whole grains, fruits, and vegetables and fewer servings of foods such as cakes, cookies, and chips, which supply few nutrients. For example, if you drink a lot of soft drinks, you will be getting too much

sugar and possibly not enough calcium, a mineral found in milk. This is a particular concern for children, whose bones are growing and who are more likely than ever before to be obese. The typical American diet is unbalanced. We eat more fried foods and fatty meats than we need, and we drink too much soda. At the same time we eat too few fruits, vegetables, and whole grains. A balanced diet is also likely to be adequate and moderate.

■ **VARIED DIET** A diet in which you eat a wide selection of foods to get necessary nutrients.

Last, you need a **varied diet**—in other words, you need to eat a wide selection of foods to get the necessary nutrients. If you imagine everything you eat for one week piled in a grocery cart, how much variety is in that cart from week to week? Do you eat the same bread, the same brand of cereal, the same types of fresh fruit, and so on, every week? Do you constantly eat favorite foods? Do you try new foods? A varied diet is important because it makes it more likely that you will get the essential nutrients in the right amounts. Our next topic, the Dietary Reference Intakes, gets specific about the amounts we need of most nutrients.

MINI-SUMMARY

A nutritious diet is adequate, moderate, balanced, varied, and packed with nutrient-dense foods.

NUTRIENT RECOMMENDATIONS: DIETARY REFERENCE INTAKES

■ **DIETARY REFERENCE INTAKE (DRI)** Nutrient standards that include four lists of values for dietary nutrient intakes of healthy Americans and Canadians.

■ **RECOMMENDED DIETARY ALLOWANCE (RDA)** The dietary intake value that is sufficient to meet the nutrient requirements of 97 to 98 percent of all healthy individuals in a group.

■ **ADEQUATE INTAKE (AI)** The dietary intake that is used when there is not enough scientific research to support an RDA.

The **Dietary Reference Intakes (DRIs)** expand and replace what you may have known as the Recommended Dietary Allowances in the United States and the Recommended Nutrient Intakes in Canada. (The **Recommended Dietary Allowance (RDA)** is the amount of a nutrient that meets the known nutrient needs of practically all healthy persons.) The DRIs are developed by the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes of the Food and Nutrition Board (a unit of the Institute of Medicine, part of the National Academy of Sciences), with involvement by Canadian scientists.

DRIs are estimates of nutrient intakes to be used for planning and evaluating diets. The DRIs are greatly expanded from the original RDAs and include the original RDAs as well as three new values.

1. **Recommended Dietary Allowance (RDA).** The dietary intake value that is sufficient to meet the nutrient requirements of 97 to 98 percent of all healthy individuals in a group. The RDA is based on the Estimated Average Requirement (EAR). If there is not enough scientific evidence to justify setting an EAR, an Adequate Intake is given.
2. **Adequate Intake (AI).** The dietary intake value that is used when an RDA cannot be based on an EAR. AI is based on an approximation of nutrient intake for a group (or groups) of healthy people. For example, there is no EAR or RDA for

calcium, only an AI. An AI is given when there is insufficient scientific research to support an RDA. Both the RDA and the AI may be used as goals for individual intake or to assess individual intake.

■ **TOLERABLE UPPER INTAKE LEVEL (UL)** The maximum intake level above which the risk of toxicity would increase.

3. **Tolerable Upper Intake Level (UL).** The maximum intake level above which the risk of toxicity increases. Intakes below the UL are unlikely to pose a risk of adverse health effects in healthy people. For most nutrients, this figure refers to total intakes from food, fortified food, and nutrient supplements. UL cannot be established for some nutrients, due to inadequate research.

■ **ESTIMATED AVERAGE REQUIREMENT (EAR)** The dietary intake value that is estimated to meet the requirement of half the healthy individuals in a group.

4. **Estimated Average Requirement (EAR).** The dietary intake value that is estimated to meet the requirement of half the healthy individuals in a group. At this level of intake, the remaining 50 percent would not have its needs met. An EAR is set only when there is conclusive scientific research. The EAR is used to assess the nutritional adequacy of intakes of groups or populations and in nutrition research.

The DRIs vary depending on age and gender, and there are DRIs for pregnant and lactating women. The DRIs are meant to help healthy people maintain health and prevent disease. They are not designed for seriously ill people, whose nutrient needs may be much different.

■ **ESTIMATED ENERGY REQUIREMENT (EER)** The dietary energy intake (measured in kcalories) needed to maintain energy balance in a healthy adult.

The 2002 Dietary Reference Intake report established an **Estimated Energy Requirement (EER)** for healthy individuals. EER is the dietary energy intake measured in kcalories that is needed to maintain energy balance in a healthy adult so that he or she does not gain or lose weight. Your actual EER depends on your age, gender, weight, height, and level of physical activity. There is no RDA or UL for kcalories because these concepts do not apply to energy and would lead to weight gain.

■ **ACCEPTABLE MACRONUTRIENT DISTRIBUTION RANGE (AMDR)** The percent of total kilocalories coming from carbohydrate, fat, or protein that is associated with a reduced risk of chronic disease while providing adequate intake.

The 2002 Dietary Reference Intake report also established **Acceptable Macronutrient Distribution Ranges (AMDR)** for carbohydrate, fat, and protein. AMDR is defined as the percent of total kilocalories coming from carbohydrate, fat, or protein that is associated with a reduced risk of chronic disease while providing an adequate intake. For example, adults (and children over 1 year old) should obtain 45 to 65 percent of their total kcalories from carbohydrates. The AMDR for adults is 20 to 35 percent of total kcalories from fat and 10 to 35 percent of total kcalories from protein. The wide range allows for more flexibility in dietary planning for healthy people.

The RDA and AI are useful in planning diets for individuals. The EAR can be used to plan diets for groups to ensure that most people get enough nutrients and also to assess the number of people with inadequate intakes within a group.

MINI-SUMMARY

1. The DRI includes four dietary intake values: RDA (value estimated to meet the requirements of 97 to 98 percent of healthy individu-

als in a group), AI (the dietary intake used when there is not enough scientific basis for an EAR or RDA), UL (maximum intake), and EAR (value estimated to meet the requirements of half the healthy individuals in a group).

2. The DRIs also include Estimated Energy Requirements and Acceptable Macronutrient Distribution Ranges for carbohydrate, fat, and protein.
3. The DRIs are used to assess dietary intakes as well as to plan diets. The RDA and AI are useful in planning diets for individuals. The EAR can be used to plan diets for groups.

WHAT HAPPENS WHEN YOU EAT

Digestion, Absorption, and Metabolism

DIGESTION The process by which food is broken down into its components in the mouth, stomach, and small intestine with the help of digestive enzymes.

ENZYMES Compounds that speed up the breaking down of food so that nutrients can be absorbed. Also perform other functions in the body.

ABSORPTION The passage of digested nutrients through the walls of the intestines or stomach into the body's cells. Nutrients are then transported through the body via the blood or lymph system.

METABOLISM All the chemical processes by which nutrients are used to support life.

To become part of the body, food must be digested and absorbed. **Digestion** is the process by which food is broken down into its components in the mouth, stomach, and small intestine with the help of digestive **enzymes**. Protein is digested, or broken down, into its building blocks, called amino acids; complex carbohydrates are reduced to simple sugars such as glucose; and fat molecules are broken down into fatty acids.

Before the body can use any nutrients that are present in food, the nutrients must pass through the walls of the stomach or intestines into the body's tissues, a process called **absorption**. Nutrients are absorbed into either the blood or the lymph, two fluids that circulate throughout the body, delivering needed products to the cells and picking up wastes. Blood is composed mostly of:

- Water
- Red blood cells (which carry and deliver oxygen to the cells)
- White blood cells (which are important in resistance to disease, called immunity)
- Nutrients
- Other components

Lymph is similar to blood but has no red blood cells. It goes into areas where there are no blood vessels to feed the cells.

Within each cell, **metabolism** takes place. Metabolism refers to all the chemical processes by which nutrients are used to support life. Metabolism has two parts: the building up of substances (called **anabolism**) and the breaking down of substances (called **catabolism**). Within each cell, nutrients such as glucose

■ **ANABOLISM** The metabolic process by which body tissues and substances are built.

■ **CATABOLISM** The metabolic processes by which large, complex molecules are converted to simpler ones.

■ **GASTROINTESTINAL TRACT** A hollow tube running down the middle of the body in which digestion of food and absorption of nutrients take place.

■ **ORAL CAVITY** The mouth.

■ **SALIVA** A fluid secreted into the mouth from the salivary glands that contains important digestive enzymes and lubricates the food so that it may readily pass down the esophagus.

are split into smaller units in a catabolic reaction that releases energy. The energy is either converted to heat to maintain body temperature or used to perform work within the cell. During anabolism, substances such as proteins are built from their amino-acid building blocks.

Gastrointestinal Tract

Once we have smelled and tasted food, our meal goes on a journey through the **gastrointestinal tract** (also called the digestive tract), a hollow tube that runs down the middle of your body (Figure 1-8). The top of the tube is your mouth, which is connected in turn to your pharynx, esophagus, stomach, small intestine, large intestine, rectum, and anus, where solid wastes leave the body. The gastrointestinal tract is such a busy place that the cells lining it are replaced every few days.

The digestive system starts with the mouth, also called the **oral cavity**. Your tongue and teeth help with chewing. The tongue, which extends across the floor of the mouth, moves food around the mouth during chewing. Your 32 permanent teeth grind and break down food. Chewing is important because it breaks up the food into smaller pieces so that it can be swallowed. **Saliva**,

Mouth:	Tastes food. Chews food. Makes saliva.
Pharynx:	Directs food from mouth to esophagus.
Esophagus:	Passes food to stomach.
Stomach:	Makes enzyme that breaks down protein. Makes hydrochloric acid. Churns and mixes food. Acts like holding tank.
Small intestine:	Makes enzymes. Digests most of food. Absorbs nutrients across villi into blood and lymph.
Large intestine:	Passes waste to be excreted. Reabsorbs water and some minerals. Absorbs vitamins made by bacteria.
Rectum:	Stores feces.
Anus:	Keeps rectum closed. Opens for elimination.

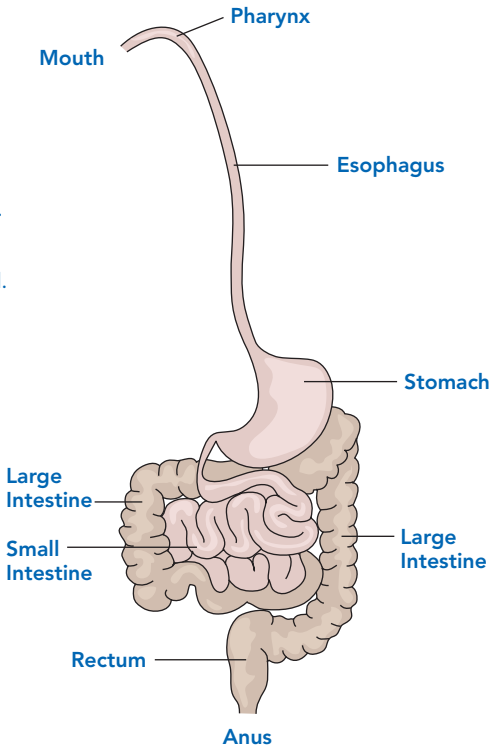


FIGURE 1-8
Human digestive tract.

■ **BOLUS** A ball of chewed food that travels from the mouth through the esophagus to the stomach.

■ **PHARYNX** A passageway that connects the oral and nasal cavities to the esophagus and air tubes to the lungs.

■ **EPIGLOTTIS** The flap that covers the air tubes to the lungs so that food does not enter the lungs during swallowing.

■ **ESOPHAGUS** The muscular tube that connects the pharynx to the stomach.

■ **PERISTALSIS** Involuntary muscular contraction that forces food through the entire digestive system.

■ **LOWER ESOPHAGEAL (CARDIAC) SPHINCTER** A muscle that relaxes and contracts to move food from the esophagus into the stomach.

■ **STOMACH** J-shaped muscular sac that holds about 4 cups of food when full and prepares food chemically and mechanically so that it can be further digested and absorbed.

■ **HYDROCHLORIC ACID** A strong acid made by the stomach that aids in protein digestion, destroys harmful bacteria, and increases the ability of calcium and iron to be absorbed.

■ **CHYME** A semiliquid mixture in the stomach that contains partially digested food and stomach secretions.

a fluid secreted into the mouth from the salivary glands, contains important digestive enzymes and lubricates the food so that it may pass readily down the esophagus. Digestive enzymes help break down food into forms of nutrients that can be used by the body. Enzymes in the saliva start the digestion of carbohydrate. The tongue rolls the chewed food into a **bolus** (ball) to be swallowed.

The **pharynx** is a passageway about 5 inches long that connects the oral and nasal cavities to the esophagus and the air tubes to the lungs. When swallowing occurs, a flap of tissue, the **epiglottis**, covers the air tubes so that food does not get into the lungs. Food now enters the **esophagus**, a muscular tube that leads to the stomach. Food is propelled down the esophagus by **peristalsis**, rhythmic contractions of muscles in the wall of the esophagus. You might think of this involuntary contraction that forces food through the entire digestive system as squeezing a marble (the bolus) through a rubber tube. Peristalsis also helps break up food into smaller and smaller particles.

Food passes from the esophagus through the **lower esophageal (cardiac) sphincter**, a muscle that relaxes and contracts (in other words, opens and closes) to move food from the esophagus into the stomach. The **stomach**, a J-shaped muscular sac that holds about 4 cups (or 1 liter) of food when full, is lined with a mucous membrane. Within the folds of the mucous membrane are digestive glands that make **hydrochloric acid** and an enzyme to break down proteins. Hydrochloric acid aids in protein digestion, destroys harmful bacteria, and increases the ability of calcium and iron to be absorbed. Because hydrochloric acid can damage the stomach, the stomach protects itself with a thick lining of mucus. Also, acid is produced only when we eat or think about eating.

From the top part of the stomach, food is slowly moved to the lower part, where the stomach churns it with the hydrochloric acid and digestive enzymes. The stomach has the strongest muscles and thickest walls of all the organs in the gastrointestinal tract. The food is now called **chyme** and has a semiliquid consistency. Chyme is next passed into the first part of the small intestine in small amounts (the small intestine can't process too much food at one time) through the **pyloric sphincter**, which operates like the lower esophageal sphincter. Liquids leave the stomach faster than solids do, and carbohydrate or protein foods leave faster than fatty foods do. The stomach absorbs few nutrients, but it does absorb alcohol. It takes 1.5 to 4 hours after you have eaten for the stomach to empty.

The **small intestine**, about 15 to 20 feet long, has three parts: the **duodenum**, the **jejunum**, and the **ileum**. The small intestine was so named because its diameter is smaller (about 1 inch) than that of the large intestine (about $2^1/_2$ inches), not because it is shorter. Actually, the small intestine is longer.

The duodenum, about 1 foot long, receives the digested food from the stomach as well as enzymes from other organs in the body, such as the pancreas and

liver. The liver provides **bile**, a substance that is necessary for fat digestion. Bile is stored in the gallbladder and released into the duodenum when fat is present. The pancreas provides bicarbonate, a substance that neutralizes stomach acid. The small intestine itself produces digestive enzymes.

On the folds of the duodenal wall (and throughout the entire small intestine) are tiny, fingerlike projections called **villi**. Under a microscope you will see hairlike structures on the villi. These are called **microvilli** or the **brush border**. The villi and microvilli increase the surface area of the small intestine and therefore allow for more absorption of nutrients into the body. The muscular walls of the small intestine mix the chyme with the digestive juices and bring the nutrients into contact with the villi. Most nutrients pass through the villi of the duodenum and jejunum into either the blood or the lymph vessels, where they are transported to the liver and to the body cells.

The duodenum connects with the second section of the small intestine, the jejunum, which connects to the ileum. Most digestion is completed in the first half of the small intestine; whatever is left goes into the large intestine. Food is in the small intestine for about 7 to 8 hours and spends about 18 to 24 hours in the large intestine.

The **large intestine** (also called the **colon**) is about 5 feet long and extends from the end of the ileum to a cavity called the rectum. One of the functions of the large intestine is to receive the waste products of digestion and pass them on to the rectum. Waste products are the materials that were not absorbed into the body. The large intestine does absorb water, some minerals (such as sodium and potassium), and a few vitamins made by bacteria residing there. Bacteria are normally found in the large intestine and are necessary for a healthy intestine. Intestinal bacteria make some important substances, such as vitamin K. They also can digest some components of food that we don't digest, such as fiber.

The **rectum** stores the waste products until they are released as solid feces through the **anus**, which opens to allow elimination.

- **PYLORIC SPHINCTER** A muscle that permits passage of chyme from the stomach to the small intestine.
- **SMALL INTESTINE** The digestive tract organ that extends from the stomach to the opening of the large intestine.
- **DUODENUM** The first segment of the small intestine, about 1 foot long.
- **JEJUNUM** The second portion of the small intestine between the duodenum and the ileum.
- **ILEUM** The final segment of the small intestine.
- **BILE** A substance made by the liver that is stored in the gallbladder and released when fat enters the small intestine because it helps digest fat.
- **VILLI** Tiny fingerlike projections in the wall of the small intestines that are involved in absorption.
- **MICROVILLI (BRUSH BORDER)** Hairlike projections on the villi that increase the surface area for absorbing nutrients.
- **LARGE INTESTINE (COLON)** The part of the gastrointestinal tract between the small intestine and the rectum.
- **RECTUM** The last section of the large intestine, in which feces, the waste products of digestion, is stored until elimination.
- **ANUS** The opening of the digestive tract through which feces travels out of the body.

MINI-SUMMARY

1. Before the body can use the nutrients in food, the food must be digested and the nutrients absorbed through the walls of the stomach and/or intestine into either the blood or the lymph system.
2. Within each cell, metabolism (all the chemical processes by which nutrients are used to support life) takes place. Metabolism has two parts: anabolism (building up) and catabolism (breaking down).
3. Figure 1-8 summarizes food digestion and absorption.

CHECK-OUT QUIZ

1. Match the nutrients with their functions/qualities. The functions/qualities may be used more than once.

NUTRIENTS	FUNCTIONS
Carbohydrate	Provides energy
Lipid	Promotes growth and maintenance
Protein	Supplies the medium in which chemical changes of the body occur
Vitamins	Works as main structure of cells
Minerals	Regulates body processes
Water	

2. Match the Dietary Reference Intake values with their definition.

DRI VALUE	DEFINITION
RDA	Value for kcalories
AI	Maximum safe intake level
UL	Value that meets requirements of 50 percent of individuals in a group
EAR	Value that meets requirements of 97 to 98 percent of individuals
EER	Value used when there is not enough scientific data to support an RDA

3. Match the terms on the left with their definitions on the right.

TERM	DEFINITION
Absorption	Process of building substances
Enzyme	Involuntary muscular contraction
Anabolism	Substance that speeds up chemical reactions
Peristalsis	Process of breaking down substances
Catabolism	Process of nutrients entering the tissues from the gastrointestinal tract

4. Which digestive organ passes waste to be excreted and reabsorbs water and minerals?
   a. stomach b. small intestine
   c. large intestine d. liver

5. Which nutrient supplies the highest number of calories per gram?
   a. carbohydrate b. fat c. protein d. vitamin pills

6. Flavor is a combination of all five senses.
   a. True b. False

7. Women have a higher basal metabolic rate than men do.
   a. True b. False

8. Hydrochloric acid aids in protein digestion, destroys harmful bacteria, and increases the ability of calcium and iron to be absorbed.
   a. True b. False

9. The nutrient density of a food depends on the amount of nutrients it contains and the comparison of that value to its caloric content.
   a. True b. False

10. The DRIs are designed for both healthy and sick people.
    a. True b. False

ACTIVITIES AND APPLICATIONS

1. How Many Kcalories Do You Need Each Day?

   Use the following two steps to calculate the number of kcalories you need.

   A. To determine your basal metabolic needs, multiply your weight in pounds by 10.9 if you are male and by 9.8 if you are female. (These numbers are based on a BMR factor of 1.0 kcalorie per kilogram of body weight per hour for men and 0.9 for women.) Example: 150-pound woman × 9.8 = 1470 kcalories

   B. To determine how much you use each day for physical activity, first determine your level of activity.

      Very light activity—You spend most of your day seated or standing.
      Light activity—You spend part of your day up and about, such as in teaching or cleaning house.
      Moderate activity—You engage in exercise for an hour or so at least every other day, or your job requires some physical work.
      Heavy activity—You engage in manual labor, such as construction.

      Once you have picked your activity level, you need to multiply your answer in A by one of the following numbers.

      Very light (men and women): Multiply by 1.3
      Light (men): Multiply by 1.6
      Light (women): Multiply by 1.5
      Moderate (men): Multiply by 1.7
      Moderate (women): Multiply by 1.6
      Heavy (men): Multiply by 2.1
      Heavy (women): Multiply by 1.9

Example: A woman with light activity.

1470 kcalories × 1.5 = 2205 kcalories needed daily

Compare the number of kcalories you need with your Estimated Energy Requirement, using Appendix B. The results should be similar.

2. Factors Influencing What You Eat

Answer the following questions to try to understand the factors influencing what you eat. Compare your answers with a friend or classmate.

A. How many meals and snacks do you eat each day, and when are they eaten?
B. What are your favorite foods?
C. What foods do you avoid eating and why?
D. Rate the importance of each of these factors when selecting foods (1 = very important, 3 = somewhat important, 5 = not important)

Cost
Convenience
Availability
Familiarity
Nutrition

E. Are you usually willing to try a new food?
F. What holidays do you and your family celebrate? What foods are served?
G. Do your food habits differ from those of your family? Your friends? Your co-workers? If yes, describe how your food habits are different and why you think this is so.
H. What foods, if any, do you eat to stay healthy or improve your appearance?
I. How much do you know about nutrition? How important is good nutrition to you?
J. Do you eat differently when you are with others than you do when alone?
K. Which foods do you eat when you are under stress?
L. Which foods do you eat when you are sick?
M. Do you think that food advertising affects what you eat? Describe.
N. Do you prefer organic fruits and vegetables? Why or why not?
O. Are you a vegetarian, and if so, why did you choose this eating style?

3. Taste and Smell

Pick one of your favorite foods, eat it normally, and then take a bite of it while holding your nose. How does it taste when you can't smell very well? What influence does smell have on taste?

4. Nutrient-Dense Foods

Pick one food that you ate yesterday that could be considered nutrient-dense. Also pick one food that would not be considered nutrient-dense. Compare the nutrition labels. Explain why you chose these foods.

Nutrition Web Explorer

U.S. Government Healthfinder www.healthfinder.gov
This government site can help you find information on virtually any health topic. On the home page, click on "Health Library," and then click on "Diseases and Conditions." Next, click on "C" and then click on "Cancer." Read the first article, "Cancer: Questions and Answers." How can you reduce your risk of cancer?

The Food and Nutrition Board www.iom.edu/subpage.asp?id=6634
As noted in this chapter, the Food and Nutrition Board, which develops the DRI, is part of the National Academy of Sciences. Read about it and write a paragraph describing what the Food and Nutrition Board does.

National Organic Program www.ams.usda.gov/nop/Consumers/brochure.html
Visit the website for the National Organic Program to find out if a "natural" food can also be labeled as "organic."

FOOD FACTS FOOD BASICS

Whole foods are foods as we get them from nature. Examples include milk, eggs, meats, poultry, fish, fruits, vegetables, dried beans and peas, and grains. Many whole foods are also considered **fresh foods**. Fresh foods are raw foods that have not been processed (such as canned or frozen) or heated. Fresh foods also do not contain any preservatives. Examples of fresh foods include fresh fruits and vegetables, fresh meats, poultry, and fish.

Organic foods are foods that have been grown without most conventional pesticides, fertilizers, herbicides, antibiotics, or hormones and without genetic engineering or irradiation. Organic farmers use, for example, animal and plant manures to increase soil fertility and crop rotation to decrease pest problems. The goal of organic farming is to preserve the natural fertility and productivity of the land. This chapter's Hot Topic goes into more depth about organic foods.

Processed foods have been prepared using a certain procedure: cooking (such as frozen pancakes), freezing (frozen dinners), canning (canned vegetables), dehydrating (dried fruits), milling (white flour), culturing with bacteria (yogurt), or adding vitamins and minerals (enriched foods). In some cases, processing removes and/or adds nutrients.

When processing adds nutrients, the resulting food is either an **enriched** or a **fortified food**. For example, when whole wheat is milled to produce white flour, nutrients are lost. By law, white flour must be enriched with several vitamins and iron to make up for some of these lost nutrients. A food is considered enriched when nutrients are added to it to replace the same nutrients that are lost in processing.

Milk is often fortified with vitamin D because there are few good food sources of this vitamin. A food is considered fortified when nutrients are added that were not present originally or nutrients are added that increase the amount already present. For example, orange juice does not contain calcium, and so when calcium is added to orange juice, the product is called calcium-fortified orange juice. Probably the most notable fortified food is iodized salt. Iodized salt was introduced in 1924 to combat iodine deficiencies.

Whereas the food supply once contained mostly whole farm-grown foods, today's supermarket shelves are stocked primarily with processed foods. Some of these are minimally processed, such as canned peaches. Many processed foods contain parts of whole foods and often have added ingredients such as sugars, or sugar or fat substitutes. For instance, cookies are made with eggs, and white flour is made from grains. Then sugar, shortening, and nutrients are added. Highly processed foods, such as many breakfast cereals, cookies, crackers, sauces, soups, baking mixes, frozen entrées, pasta, snack foods, and condiments, are staples nowadays.

As you can probably guess, your best bet nutritionally is to consume more whole foods and fewer highly processed foods.

HOT TOPIC ORGANIC FOODS

Organic farming is one of the fastest growing segments of U.S. agriculture. The number of organic farmers is increasing by about 12 percent per year. The Organic Foods Production Act (2000) offers a national definition for the term *organic,* as well as the methods, practices, and substances that can be used in producing and handling organic crops and livestock. Common organic foods include fruits, vegetables, and cereals. Meat, poultry, and eggs can also be organic. This Hot Topic uses a question-and-answer format to help you learn about what organic foods are and what they aren't.

1. What is organic food?

Organic food is produced by farmers who emphasize the use of renewable resources and the conservation of soil and water to enhance environmental quality for future generations. Organic meat, poultry, eggs, and dairy products come from animals that are given no antibiotics or growth hormones. Organic food is produced without using most conventional pesticides, petroleum-based fertilizers or sewage sludge-based fertilizers, bioengineering (also called biotechnology), or ionizing radiation (also called irradiation). Before a product can be labeled "organic," a government-approved certifier inspects the farm where the food is grown to make sure the farmer is following all the rules necessary to meet U.S. Department of Agriculture (USDA) organic standards. Organic farmland has been expanding, and over 12,000 farms were certified organic as of 2005, which is a little under 1 percent of all farms.

2. How often are farms that produce organic foods inspected?

Annual inspections are conducted of each farm producing organic foods. Government-approved certifiers must be notified by a producer immediately of any changes affecting an operation's compliance with the regulations, such as application of a prohibited pesticide to a field. Also, the USDA or the certifying agent is allowed to conduct unannounced inspections at any time to enforce the regulations. The Organic Foods Production Act also requires that residue tests be performed to help in enforcement of the regulations. Certifying agents and the USDA will conduct residue tests of organically produced products when there is reason to believe that they have been contaminated with prohibited substances.

3. What makes organic fruits and vegetables different from nonorganic fruits and vegetables?

The organic crop production standards state that:

A. The land will have no prohibited substances applied to it for at least three years before the harvesting of an organic crop.
B. The use of genetic engineering, ionizing radiation, and sewage sludge is prohibited.
C. Soil fertility and crop nutrients will be managed through tillage and cultivation practices, crop rotations, and cover crops, supplemented with animal and crop waste materials and allowed synthetic materials.
D. Preference will be given to the use of organic seeds and other planting stock, but a farmer may use nonorganic seeding and planting stock under specified conditions.
E. Crop pests, weeds, and diseases will be controlled primarily through management practices, including physical, mechanical, and biological controls.

4. What makes meat, milk, and eggs organic?

Animals for slaughter must be raised under organic management from the last third of gestation, or no later than the second day of life for poultry. Livestock must be fed 100 percent organic feed. Organically

raised animals may not be given hormones to promote growth or antibiotics for any reason (unless an animal is sick or injured, in which case the animal can't be sold as organic). Preventive management practices, including the use of vaccines, are used to keep animals healthy. Also, livestock may be given allowed vitamin and mineral supplements. All organically raised animals must have access to the outdoors, including access to pasture. They may be temporarily confined only for reasons such as health and safety.

5. *How are organic foods labeled?*

There are four categories of labeling. (See Figure 1-9).

A. Foods labeled "100 percent organic" must contain only organically produced ingredients (excluding water and salt).

B. Foods labeled "organic" must consist of at least 95 percent organically produced ingredients (excluding water and salt). Any remaining ingredients must consist of nonagricultural products approved on the national list or agricultural

FIGURE 1-9

The sample cereal boxes show the four labeling categories. From left: cereal with 100 percent organic ingredients; cereal with 95–100 percent organic ingredients; cereal made with at least 70 percent organic ingredients; and cereal with less than 70 percent organic ingredients. Products with less than 70 percent organic ingredients may list specific organically produced ingredients on the side panel of the package, but may not make any organic claims on the front of the package. Look for the name and address of the government-approved certifier on all packaged products that contain at least 70 percent organic ingredients.

Courtesy of the U.S. Department of Agriculture.

products that are not commercially available in organic form.

C. Processed foods labeled "made with organic ingredients" must contain at least 70 percent organic ingredients, and they can list up to three of the organic ingredients or food groups on the principal display panel. For example, soup made with at least 70 percent organic ingredients and only organic vegetables may be labeled either "soup made with organic peas, potatoes, and carrots" or "soup made with organic vegetables."

D. Processed foods that contain less than 70 percent organic ingredients cannot use the term "organic" anywhere on the principal display panel. However, they may identify the specific ingredients that are organically produced on the ingredients statement.

Foods that are 100 or 95 percent organic may display the USDA organic seal, shown in Figure 1-10. Use of the seal is voluntary.

6. *Do organic foods taste better and have more nutrients?*

Many consumers, as well as chefs, feel that organic foods taste better than their conventional counterparts. Whether organic foods taste better is to some extent a matter of personal taste. Also, taste will vary between any fresh fruits, depending on their freshness, the seeds used, where they were grown, and so on.

FIGURE 1-10
USDA organic seal.
Courtesy of the U.S. Department of Agriculture.

As for nutrition, some studies show that organic foods may be higher in vitamins, minerals, and polyphenols (substances in plants that have antioxidant activity) compared with conventionally grown foods. However, there is no solid body of research yet. The nutrient composition of any food grown in soil will vary due to many factors, such as variations in the soil quality, the amount of sunshine, and the amount of rain. Vitamins in plants are created by the plants themselves as long as they get adequate sunshine, water, carbon dioxide, and fertilizer. Minerals must come from the soil.