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 2007, the Centers for Disease Control and Prevention estimated the annual cost of heart disease and stroke in the United States at $431 billion, including health-care expenditures and lost productivity from death and disability.

A 2005 survey by the International Food Information Council found that at least 89 percent of American adults sampled indicated that they believe diet, exercise, and physical activity influence health. These beliefs are reflected in the popularity of books, magazines, and weight-loss programs offering dietary and health advice. Recent consumption statistics, however, show that many of us are still choosing diets that are out of sync with dietary guidance. Many Americans eat too much sodium, saturated fat, and added sugar, and too few fruits, vegetables, and whole grains. And the prevalence of obesity and diet-related illnesses continues to rise. Although we may intend to have a healthy diet, other preferences often beguile us into food choices that may eventually harm our health.

Eating a healthy diet and exercising is not just a concern for adults but for children and teenagers as well. Overweight is a serious health concern for children and adolescents. Data from 1976 to 2003–2004 show that the prevalence of overweight is increasing. For children aged 6–11 years, prevalence increased from 6.5 to 18.8 percent; and for those aged 12–19 years, prevalence increased from 5.0 to 17.4 percent. Overweight children and adolescents are at risk for health problems during their youth and as adults. For example, during their youth, overweight children and adolescents are more likely to have risk factors associated with cardiovascular disease and type 2 diabetes than are other children and adolescents.

Young adults who go to college also face the challenge of not gaining what is called the "Freshman 15." As teenagers leave home and become more responsible for themselves and their eating habits, they often gain weight, although not always 15 pounds. Causes for freshmen gaining weight (particularly females) include eating unhealthy foods in the cafeteria, keeping unhealthy foods and snacks in the dorm room, drinking too much alcohol, and exercising too infrequently. College can be stressful and lead to poor eating choices.

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
- Distinguish between whole, processed, and organic foods
- Compare how a meat-based or a plant-based diet impacts the environment

# FACTORS INFLUENCING FOOD SELECTION

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

- 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

The most important consideration when choosing something to eat is the taste of the food (Figure 1-1). You may think that taste and flavor are the same thing, but taste is actually a component of flavor. ***Flavor*** is an attribute of a food that includes its taste, smell, 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.

**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.

FIGURE 1-1:
The most important consideration when choosing something to eat is taste.
Courtesy of Digital Image.

**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.

***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.

These taste cells bind food molecules dissolved in saliva and alert the brain to interpret them. Although the tongue is often 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.

Taste buds are most numerous in children under age six, and this may explain why youngsters are such picky eaters. Children generally prefer higher levels of sweetness and saltiness in their food than adults do. This will change in adolescence, when their taste preferences become more like those of adults. Children will also develop food preferences that reflect their culture. For instance, in many Asian cultures, combining sweet and umami is common, whereas this would not be common in the United States. Cultural food preferences often adapt when people relocate into another culture.

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. 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.

Of course, if you have a bad cold and mucus clogs up your nose, you lose some sense of smell and taste. With a cold, you can still taste salty and sweet, but you will have a hard time distinguishing the difference between flavors, such as beef from lamb.

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 $0.69 per pound or fresh salmon at $13.99 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. Take-out meals are also more expensive, but common in certain households.

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 75 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*** 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).

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

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. 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.

**FIGURE 1-2:** Food Practices of World Religions

| Religion | Dietary Practices |
|---|---|
| Judaism | Kashrut: Jewish dietary law of keeping kosher.<br>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.<br>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.<br>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.<br>4. All fruits, vegetables, grains, and eggs can be served with dairy or meat meals.<br>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).<br>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. They also abstain from wine and oil, except for certain feast days that may fall during a fasting period. Shellfish are allowed. Wednesdays and Fridays are also fast days throughout the year. |
| Protestantism | 1. Food on religious holidays is largely determined by a family's cultural background and preferences.<br>2. Fasting is uncommon. |

(*continued*)

| | |
|---|---|
| Mormonism | 1. Prohibit tea, coffee, and alcohol. Some Mormons abstain from anything containing caffeine.<br>2. Eat only small amounts of meat and base diet on grains.<br>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).<br>2. Avoid pork and shellfish.<br>3. Prohibit coffee, tea, and alcohol.<br>4. Drink water before and after meals, not during.<br>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.<br>2. Celebrate many feast and fast days. On fast days, they do not eat or drink from sunup to sundown. |
| Hinduism | 1. Encourages eating in moderation.<br>2. Meat is allowed, but the cow is sacred and is not eaten. Also avoided are pork and certain fish. Many Hindus are vegetarian.<br>3. Many Hindus avoid garlic, onions, mushrooms, and red foods such as tomatoes.<br>4. Water is taken with meals.<br>5. Some Hindus abstain from alcohol.<br>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).<br>2. Celebrate feast and fast days. |

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. Carbohydrates, such as in cake or candy, tend have calming effects. Eating in response to emotions can lead to overeating and overweight.

## 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, and the like) 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 can certainly 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 26 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. See Hot Topic on page 28 for more information on some of the environmental concerns of commercial food production.

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.

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

**FIGURE 1-3:** Mini-Summary Factors Influencing What You Eat

- Flavor
  - Taste
  - Smell
  - Appearance
  - Texture
- Other Aspects of Food
  - Cost
  - Convenience
  - Availability

(*continued*)

- 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*** 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 and other substances in food 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

**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.

such as heart disease and certain cancers. 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.

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

In summary, nutrition is a science that studies nutrients and other substances in foods, and how they affect the body, especially in terms of 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 raises the temperature of 1 kilogram of water 1 degree Celsius. Just as 1 kilogram contains 1000 grams, 1 kilocalorie contains 1000 calories.

When you read in a magazine that a cheeseburger has 350 calories, understand that it is actually 350 kilocalories. The American public has been told for years that an apple has 80 calories, a glass of regular milk has 150 calories, and so on, when the correct term is not calories but kilocalories. This has been done in part to make the numbers easier to read and to ease calculations. Imagine adding up your calories for the day, and having most numbers be 6 digits long, such as 350,000 calories for a cheeseburger. 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 energy 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.

**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.

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

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

**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 |

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

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

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

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

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

**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, that are soluble in fat, not water, and that provide a rich source of energy and structure to cells.

Foods rarely contain just one nutrient. Most foods provide a mix of nutrients. For example, bread often is thought of as providing primarily carbohydrates, 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 are biologically active in the body and may protect health), and other substances.

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. Alcohol, although not considered a nutrient because it does not promote growth or maintenance of the body, does yield energy: Seven kcalories per gram.

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).

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.

***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, which are 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.

***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 fat-free 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 so protein can be used to build new cells). 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.

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.

***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.

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 (Figure 1-6).

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.

**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.

**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.

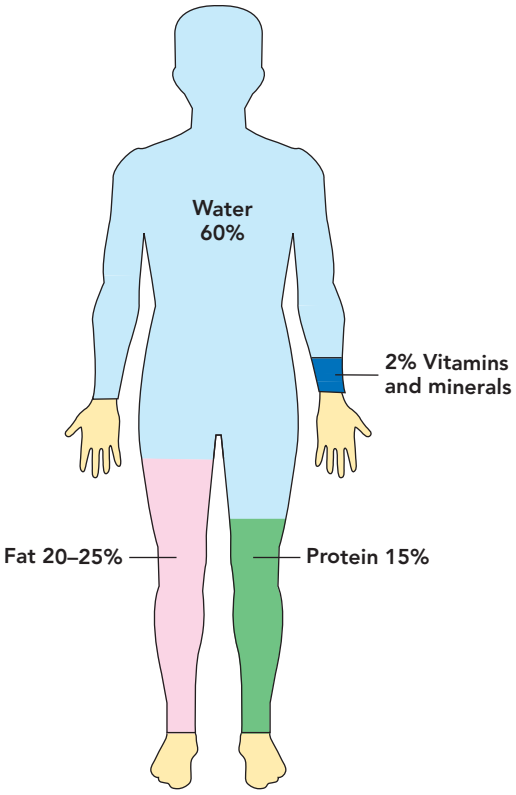
**MINERALS**
Noncaloric, inorganic chemical substances found in a wide variety of foods; needed to regulate body processes, maintain the body, and allow growth and reproduction.

**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 along with many vitamins and minerals) 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.

FIGURE 1-6:
Body Composition.

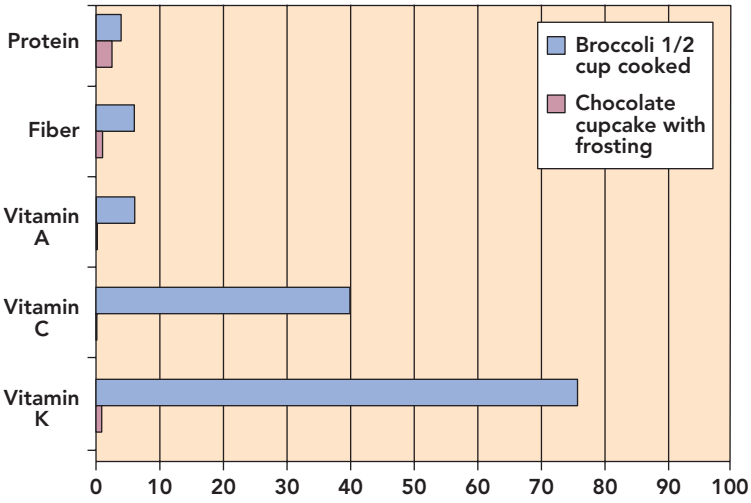



**NUTRIENT DENSITY**
A measure of the nutrients provided in a food per kcalorie of that food.

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

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 1-7 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 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.

FIGURE 1-7:
Nutrition density comparison.*




*Percent of Dietary Reference Intakes for Selected Nutrients.

## MINI-SUMMARY

1. Nutrition is a science that studies nutrients and other substances in foods, and how they affect the body, especially in terms of 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 1-8.
5. Nutrient density is a measure of the nutrients provided per kcalorie of a food.

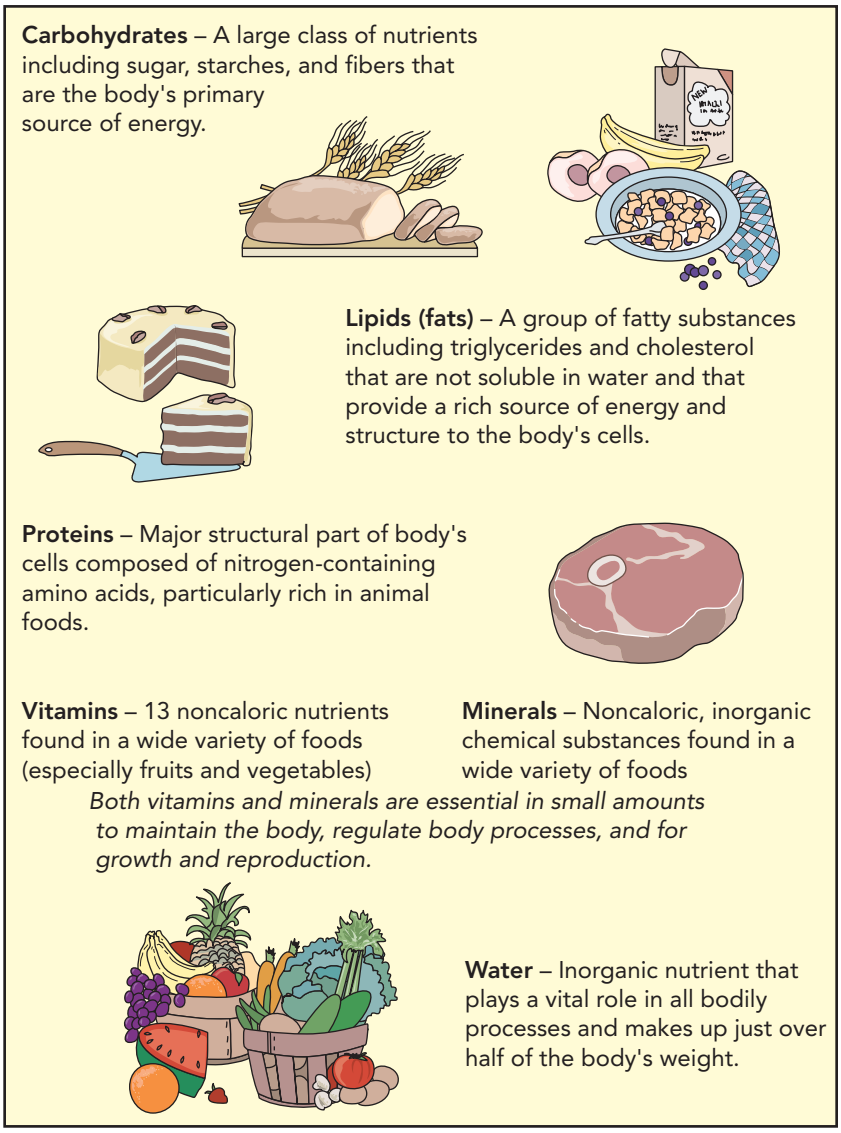



FIGURE 1-8:
Six classes of nutrients.

## CHARACTERISTICS OF A NUTRITIOUS DIET

**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.

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

A nutritious diet has four characteristics. It is:

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

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.

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.

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

## NUTRIENT RECOMMENDATIONS: DIETARY REFERENCE INTAKES

The ***Dietary Reference Intakes (DRIs)*** expand and replace what you may have known as the Recommended Dietary Allowances (RDAs) in the United States and the Recommended Nutrient Intakes in Canada. The DRIs are developed by a committee of scientists within the National Academy of Scientists.

DRIs are a set of values that serve as standards for nutrient intakes for healthy persons in the United States and Canada. The DRIs are greatly expanded from the original RDAs and include the original RDAs as well as three new values. These values are:

1. **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.
2. **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), but is set higher so that the needs of most healthy people will be met. The RDAs may be used as nutrient goals for individuals. If there is not enough scientific evidence to justify setting an EAR, an RDA can't be established, so an Adequate Intake (discussed next) is given.
3. **Adequate Intake (AI).** The dietary intake value that is used when an RDA cannot be based on an EAR. An AI is given when there is insufficient scientific research to support an RDA. It is based on observed intakes of a nutrient by a group of healthy persons. For example, there is no EAR or RDA for calcium, only an AI. Like the RDA, the AI may be used as a goal for individual intake or to assess individual intake. Unlike the RDA, the AI is more tentative in part because it is based more on scientific judgment, rather than scientific evidence.
4. **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.

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.

The 2002 Dietary Reference Intake report established an ***Estimated Energy Requirement (EER)*** for healthy individuals. EER is the average 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.

The 2002 Dietary Reference Intake report also established ***Acceptable Macronutrient Distribution Ranges (AMDR)*** for carbohydrate, fat, and protein (Figure 1-9). 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 adequate intake and

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

**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.

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

**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.

**FIGURE 1-9:** Acceptable Macronutrient Distribution Ranges

| Age | AMDR for Carbohydrate | AMDR for Fat | AMDR for Protein |
|---|---|---|---|
| 1 to 3 years old | 45–65% | 30–40% | 5–20% |
| 4 to 18 years old | 45–65% | 25–35% | 10–30% |
| Over 18 years old | 45–65% | 20–35% | 10–35% |

nutrients. 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.

### MINI-SUMMARY

1. The DRI includes four dietary intake values: EAR (value estimated to meet the requirements of half the healthy individuals in a group), RDA (value estimated to meet the requirements of 97 to 98 percent of healthy individuals in a group), AI (the dietary intake used when there is not enough scientific basis for an EAR or RDA), and UL (maximum intake).
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.

**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.

**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.

## WHAT HAPPENS WHEN YOU EAT

## DIGESTION, ABSORPTION, AND METABOLISM

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 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

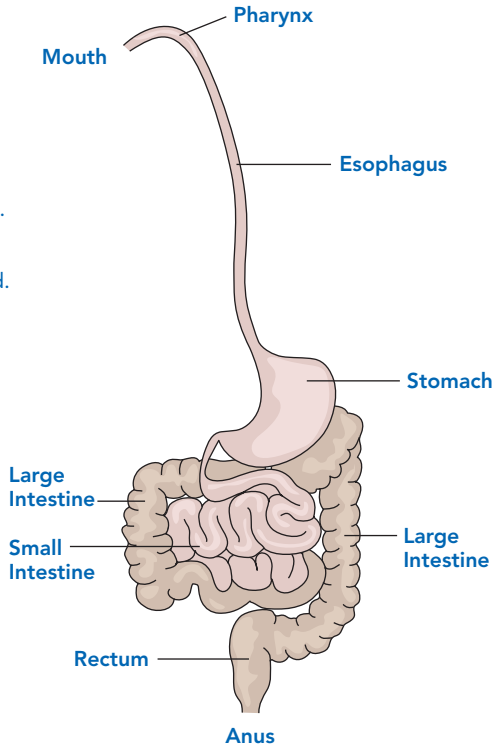
Once we have smelled and tasted food, our meal goes on a journey through the ***gastrointestinal tract*** (also called the digestive tract), a hollow tube that runs down the middle of your body (Figure 1-10). The top of the tube is your mouth, which is connected in turn to your pharynx, esophagus, stomach, 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***, 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

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




**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.

**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.

FIGURE 1-10:
Human digestive tract.

**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.

**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.

(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.

It is the hydrochloric acid in the stomach that contributes to heartburn. Heartburn is a painful burning sensation in the esophagus, just below or behind the breastbone. Heartburn occurs when the lower esophageal sphincter fails to close tightly enough, allowing the stomach contents to back up (also called reflux) into the esophagus. This partially digested material is usually acidic and can irritate the esophagus. Frequent, ongoing heartburn may be a sign of gastroesophageal reflux disease (GERD). Ways to treat heartburn and GERD include eating small meals, avoiding foods and beverages that aggravate heartburn, losing weight (if overweight), and possibly medications.

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.

Ulcers are a common digestive problem that can affect the duodenum or the stomach. A peptic ulcer is a sore on the lining of the stomach or duodenum. Peptic ulcers are common: One in ten Americans develops an ulcer at some time in his or her life. One cause of peptic ulcer is bacterial infection, but some ulcers are caused by long-term use of nonsteroidal anti-inflammatory agents (NSAIDs), like aspirin and ibuprofen. Taking antibiotics, quitting smoking, limiting consumption of caffeine and alcohol, and reducing stress can speed healing and prevent ulcers from recurring.

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.

## 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 1-10 summarizes food digestion and absorption.

**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 to help digest fat.

**VILLI**
Tiny fingerlike projections in the wall of the small intestines that are involved in absorption.

**MICROVILLI (BRUSH BORDER)**
Hair-like 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.

## 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 coworkers? 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, or compare

their kcalorie and nutrient content by going to this website: www.nal.usda.gov/fnic/foodcomp/search/

Type in a food next to "Keyword," and select the specific food and then the portion size. The next screen will give a nutrient analysis that you can print and compare.

## 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 "H" under "Health A to Z." Next, click on heart disease. Using the links, find 5 ways to reduce your risk of heart disease.

### Nutrition.gov

www.nutrition.gov

From this government site, you can access many nutrition topics right from the home page. Click on "In the News." Then click on a nutrition article and summarize this article in one paragraph.

### National Organic Program

www.ams.usda.gov/nop

Visit the website for the National Organic Program to find out if a "natural" food can also be labeled as "organic." Click on "Labeling."

### Center for Science in the Public Interest: Eating Green

www.cspinet.org/EatingGreen

Click on "Eating Green Calculator" and fill in how much in the way of animal products you eat each week. Then click on "Calculate Impact" and find out the environmental impact of your eating habits. Also use the "Score Your Diet" tool to show how your diet scores on nutrition, the environment, and animal welfare.

### Center for Young Womens' Health

www.youngwomenshealth.org/college101.html

Read "College Eating and Fitness 101." List 5 suggestions they make to help you not gain the Freshman 15.

### Alcohol Calorie Calculator

www.collegedrinkingprevention.gov/CollegeStudents/calculator/alcoholcalc.aspx

Fill in the "Average Drinks per Week" column and then press "Compute." You will see how many calories you take in each month and in one year from alcoholic beverages.

# FOOD FACTS: HOW TO RECOGNIZE WHOLE FOODS, PROCESSED FOODS, AND ORGANIC FOODS

When people talk about food, you may hear some terms with which you are not familiar or are unsure of. *Whole foods* (besides being the name of a chain of stores), are foods pretty much as we get them from nature. Examples include eggs, fresh fruits and vegetables, beans and peas, whole grains, and fish. Whole foods are often not processed, but some are minimally processed. Milk, for example, is minimally processed to make it safe to drink. Fresh meat is also minimally processed so that consumers can buy just what they want.

*Processed foods* have been prepared using a certain procedure: milling (white flour), cooking and freezing (such as frozen pancakes or dinners), canning (canned vegetables), dehydrating (dried fruits), or culturing with bacteria (yogurt). In some cases, processing removes nutrients, such as when whole wheat is milled to make white flour. In other cases, processing helps retain nutrients, such as when freshly picked vegetables are frozen.

Whereas the food supply once contained mostly whole farm-grown foods, today's supermarket shelves are stocked primarily with processed foods. 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 flour. Then sugar and fat are added. Highly processed foods, such as many breakfast cereals, cookies, crackers, sauces, soups, baking mixes, frozen entrees, pasta, snack foods, and condiments, are staples nowadays.

When processing adds nutrients, the resulting food is either an enriched or a fortified food. For example, white flour must be enriched with several vitamins and iron to make up for some of the nutrients lost during milling. 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.

Organic foods are becoming more and more popular in supermarkets and restaurants. Common organic foods include fruits, vegetables, and cereals. Meat, poultry, and eggs can also be organic.

*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; fertilizers made with synthetic ingredients or sewage sludge; genetic engineering or 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 USDA organic standards. Companies that handle or process organic food before it gets to your local supermarket or restaurant must be certified too.

So what makes organic fruits and vegetables different from nonorganic fruits and vegetables? The organic crop production standards state:

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.

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.


FIGURE 1-11:
The sample cereal boxes show the four labeling categories described below. Courtesy of the U.S. Department of Agriculture.

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 among any fresh produce, depending on their freshness, the seeds used, where they were grown, and so on.

As for nutrition, some studies show that organic foods may be higher in vitamins (especially vitamin C), 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.

Figure 1-11 shows how organic foods are labeled. There are four categories of organic labeling.

1. Foods labeled "100 percent organic" must contain only organically produced ingredients (excluding water and salt).
2. 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 products that are not commercially available in organic form.
3. 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."
4. 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 1-12. Use of the seal is voluntary.


FIGURE 1-12:
USDA organic seal. Courtesy of the U.S. Department of Agriculture.

# HOT TOPIC: HOW THE AMERICAN DIET IMPACTS THE ENVIRONMENT AND HOW RESTAURANTS ARE GOING GREEN

As you drive by many farms across America, you might be inclined to think that we eat a lot of corn, soybeans, and grains. However, it is not Americans who are eating most of these foods: it is livestock, such as beef cattle, dairy cattle, hogs, chickens, and turkeys. Eventually these livestock (except dairy cattle, which give us milk) will be slaughtered to produce meat and poultry. The typical American eats about 8 ounces of meat a day (including beef, poultry, and fish). This amount is about double the global average.

Producing large quantities of meat in America uses many resources and has serious environmental consequences, such as the following.

1. According to the Food and Agriculture Organization (FAO) of the United Nations, livestock now use 30 percent of the earth's entire land surface, which includes pastures as well as land used to produce feed for livestock. In Latin America, some 70 percent of former forests in the Amazon have been turned over to grazing. Forests have a huge impact on the environment. The trees help balance the oxygen-carbon dioxide balance of the earth by absorbing carbon dioxide from the environment and releasing oxygen. Increased deforestation has led to the accumulation of greenhouse gases in the atmosphere, such as carbon dioxide and methane. The accumulation of these greenhouse gases has enhanced the earth's natural greenhouse effect, by which the temperature of the earth is maintained, leading to global warming. Trees also absorb rainfall by soaking up moisture through their roots, thus preventing runoff and the accompanying soil erosion and flooding. Leaves that fall on the forest ground act as a nutrient source and increase soil fertility. Forests provide essential ecological services by absorbing carbon dioxide, preventing runoff and flooding, and providing homes to diverse forms of wildlife.
2. Livestock farms are major air and water polluters. Cattle naturally produce methane, a potent greenhouse gas that can contribute to global climate change. Livestock production systems also produce other greenhouse gases such as nitrous oxide and carbon dioxide. People who live near or work at these farms breathe in hundreds of gases, which are formed as manure decomposes. The stench can be unbearable. And, of course, there is the problem of waste output: U.S. livestock produce about 900 million tons of manure each year, or about 3 tons for each American. On most factory farms, animals are crowded into relatively small areas; their wastes are funneled into massive cesspools called lagoons. These cesspools often break, leak, or overflow, sending dangerous microbes, nitrate pollution, and drug-resistant bacteria into water supplies.
3. Enormous quantities of water, fuel, fertilizers, and pesticides are required to grow the feed for livestock, utilizing many acres of farmland. In drier climates, huge amounts of irrigation water are used to produce feed grains such as corn. To produce 100 kcalories of plant foods only requires about 50 kcalories from fossil fuels, but to get the equivalent amount of kcalories from beef requires almost 1,600 kcalories. Fertilizers also require a lot of energy to produce, and along with pesticides, they often wind up polluting waterways and drinking water.

Our current method of producing meat is costly and unsustainable, and its harmful environmental consequences will become more troublesome as the world's population grows and demand for meat increases. New government programs and policies will be necessary to reduce damage to the environment while ensuring adequate nutrition for the world's population. One answer to this dilemma can be found in sustainable agriculture.

*Sustainable agriculture* produces abundant food without depleting the earth's resources or polluting its environment. It is agriculture that follows the principles of nature to develop systems for raising crops and livestock that are, like nature, self-sustaining (see Figure 1-13). In recent decades, sustainable farmers and researchers around the world have used a variety of techniques to farm with nature. Sustainable practices lend themselves to smaller, family-scale farms. These farms, in turn, tend to find their best niches in local markets, within local food systems, often selling directly to consumers in farmers' markets or to local restaurants.

FIGURE 1-13:
Sustainable agriculture produces abundant food without depleting the earth's resources or polluting its environment. Courtesy of Digital Vision.

New government programs and policies will also need to encourage Americans to eat less animal protein and eat more fruits, vegetables, beans, grains, nuts, and seeds. Even a meat-free diet that includes dairy and eggs is still much less harmful to the environment than a meat-based diet. Choosing to eat lower down on the food chain creates a lower environmental impact with fewer negative ecological consequences.

Many restaurants are also trying to do their part to purchase sustainable foods including locally grown and organic foods. The mission of Green Foodservice Alliance in Georgia is to "incorporate environmental conservation and sustainability practices into the daily operations of Georgia foodservice establishments." More and more restaurants across the United States are implementing environmentally responsible practices that also include:

1. Saving energy through more energy-efficient equipment and lighting—for example, ENERGY STAR refrigeration models have better insulation and use almost half as much energy as older models
2. Buying tableware and cups made of recycled and renewable materials
3. Buying nontoxic cleaning and sanitation supplies
4. Installing flow restrictors on faucets and using low-flush toilets
5. Recycling
6. Using an energy management program

ENERGY STAR, a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy, identifies and promotes energy-efficient products to reduce greenhouse gas emissions. The ENERGY STAR label can be found on restaurant equipment and lighting.

According to the Environmental Protection Agency, approximately 64 billion paper cups and plates, 73 billion Styrofoam and plastic plates and 190 billion plastic containers and bottles are thrown away every year in the United States. Since paper made from virgin wood contributes to forest depletion, many environment-conscious groups recommend using products made from recycled materials. Currently there is an environment-friendly substitute for just about every disposable item in foodservice, including napkins, paper towels, and facial tissues; trays and tray liners; cold and hot cups; lids; straws; forks, knives, spoons; to-go packaging; salad containers; cleaning products; plates and bowls.

Many factors are driving the green movement in restaurants, from meeting consumer demand for eco-friendly products to conserving resources and dollars to joining a global effort to protect and preserve our natural environment. The changes won't be accomplished overnight, but will take time. Sustainable food programs, waste reduction, recycling and energy-conservation are major endeavors that take time, planning and money.