

MS Food and the Digestive System

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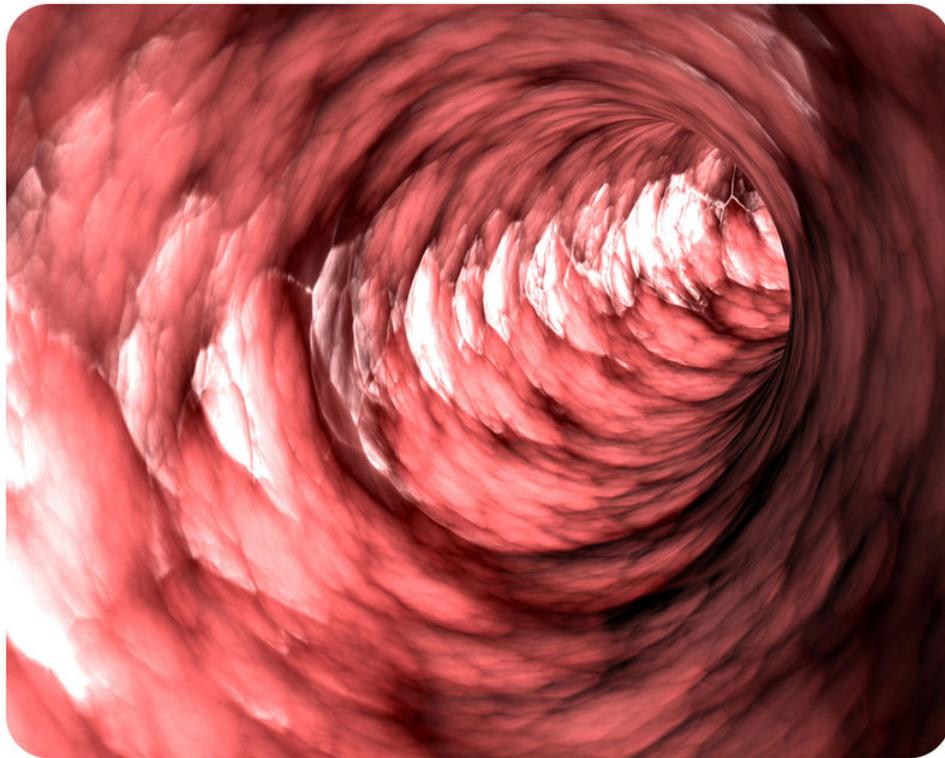
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CHAPTER 1**MS Food and the Digestive System****CHAPTER OUTLINE**

- 1.1 Food and Nutrients
- 1.2 Choosing Healthy Foods
- 1.3 The Digestive System
- 1.4 References



The above image shows a close-up of the inside of a fleshy tunnel. Could it be an intestine? It could. Or it could be something else. But what is an intestine? It is an organ in the digestive system. The digestive system does what you think it does - it digests your food.

But does the inside of your intestine really look like a tunnel? Some would say an intestine looks more like a mountain range, with peaks and valleys. Why? The peaks and valleys would represent the villi that are inside of the intestines. They increase the surface area of the intestine so they can absorb as many nutrients as possible.

So what is another function of the digestive system? Absorption. What happens when you get sick? Does the digestive system work properly? What nutrients and vitamins do you need in order to make sure that your digestive system and your whole body works properly? What do the villi in the intestines have to do with these processes? As you read, think about the organs that help you digest and absorb the nutrients in your foods. Also, consider how healthy eating leads to healthy organ systems.

1.1 Food and Nutrients

Lesson Objectives

- Explain why the body needs food.
- Identify the roles of carbohydrates, proteins, and lipids.
- Give examples of vitamins and minerals, and state their functions.
- Explain why water is a nutrient.

Check Your Understanding

- What are the four types of organic compounds?
- What do all cells need in order to function?
- What are muscles made of?

Vocabulary

calorie Unit used to measure the energy in food.

essential amino acids Amino acids that must come from the proteins in foods; you cannot make these amino acids.

minerals Chemical elements that are needed for body processes.

nutrients Chemicals in food that your body needs.

starch Large, complex carbohydrate; found in foods such as vegetables and grains; broken down by the body into sugars that provide energy.

trans fat Manufactured fat that is added to certain foods to keep them fresher for longer.

vitamins Substances that the body needs in small amounts to function properly.

Why We Need Food

Did you ever hear the old saying “An apple a day keeps the doctor away”? Do apples really prevent you from getting sick? Probably not, but eating apples and other fresh fruits can help keep you healthy. The girl shown in **Figure 1.1**

**FIGURE 1.1**

This girl is eating a salad of vegetables and leafy green vegetables. Fresh vegetables such as these are excellent food choices for good health.

is eating fresh vegetables as part of a healthy meal. Why do you need foods like these for good health? What role does food play in the body?

Your body needs food for three reasons:

- Food gives your body energy. You need energy for everything you do.
- Food provides building materials for your body. Your body needs building materials so it can grow and repair itself.
- Food contains substances that help control body processes. Your body processes must be kept in balance for good health.

For all these reasons, you must have a regular supply of nutrients. **Nutrients** are chemicals in food that your body needs. There are six types of nutrients:

- Carbohydrates.
- Proteins.
- Lipids.
- Vitamins.
- Minerals.
- Water.

Carbohydrates, proteins, and lipids give your body energy. Proteins provide building materials. Proteins, vitamins, and minerals help control body processes.

Nutrients that Provide Energy

Molecules of carbohydrates, proteins, and lipids contain energy. When your body digests food, it breaks down the molecules of these nutrients. This releases the energy so your body can use it. The energy in food is measured in units called **calories**.

Carbohydrates

Carbohydrates are nutrients that include sugars, starches, and fiber. How many grams of carbohydrates you need each day are shown in **Figure 1.2**. It also shows some foods that are good sources of carbohydrates.



Fresh fruits are good sources of simple carbohydrates. An apple has about 20 grams of carbohydrates.



Whole grain breads are a good source complex carbohydrates. A slice of whole grain bread has about 15 grams of carbohydrates.



Vegetables are good sources of complex carbohydrates. A cup of cooked acorn squash has about 30 grams of carbohydrates.

FIGURE 1.2

Up to the age of 13 years, you need about 130 grams of carbohydrates a day. Most of the carbohydrates should be complex. They are broken down by the body more slowly than simple carbohydrates. Therefore, they provide energy longer and more steadily. What other foods do you think are good sources of complex carbohydrates?

There are two types of carbohydrates: simple and complex.

Simple Carbohydrates

Sugars are small, simple carbohydrates that are found in foods such as fruits and milk. The sugar found in fruits is called fructose. The sugar found in milk is called lactose. These sugars are broken down by the body to form glucose, the simplest sugar of all. Glucose is used by cells for energy.

Remember the discussion of cellular respiration in the *Cell Functions* chapter? Cellular respiration turns glucose into the usable form of chemical energy, ATP. One gram of sugar provides your body with four Calories of energy.

Some people cannot digest lactose, the sugar in milk. This condition is called lactose intolerance. If people with this condition drink milk, they may have cramping, bloating, and gas. To avoid these symptoms, they should not drink

milk, or else they should drink special, lactose-free milk.

Complex Carbohydrates

Starch is a large, complex carbohydrate. Starches are found in foods such as vegetables and grains. Starches are broken down by the body into sugars that provide energy. Like sugar, one gram of starch provides your body with four calories of energy.

Fiber is another type of large, complex carbohydrate. Unlike sugars and starches, fiber does not provide energy. However, it has other important roles in the body. There are two types of fiber found in food: soluble fiber and insoluble fiber. Each type has a different role. Soluble fiber dissolves in water. It helps keep sugar and fat at normal levels in the blood. Insoluble fiber does not dissolve in water. As it moves through the large intestine, it absorbs water. This helps keep food waste moist so it can pass easily out of the body.

Eating foods high in fiber helps fill you up without providing too many calories. Most fruits and vegetables are high in fiber. Some examples are shown in **Figure 1.3**.

Proteins

Proteins are nutrients made up of smaller molecules called amino acids. As discussed in the *Introduction to Living Things* chapter, the amino acids are arranged like "beads on a string." These amino acid chains then fold up into a three-dimensional molecule. Proteins have several important roles in the body. For example, proteins:

- Make up muscles.
- Help control body processes.
- Help the body fight off bacteria and other "foreign invaders."
- Carry substances in the blood.

If you eat more proteins than you need for these purposes, the extra proteins are used for energy. One gram of protein provides four calories of energy. This is the same amount as one gram of sugar or starch. How many grams of proteins you need each day are shown in **Figure 1.4**. It also shows some foods that are good sources of proteins.

There are many different amino acids, the building blocks of proteins, but your body needs only 20 of them. Your body can make ten of these amino acids from simpler substances. The other ten amino acids must come from the proteins in foods. These ten are called **essential amino acids**. Only animal foods, such as milk and meat, contain all ten essential amino acids in a single food. Plant foods are missing one or more essential amino acids. However, by eating a combination of plant foods, such as beans and rice, you can get all ten essential amino acids.

Lipids

Lipids are nutrients such as fats that store energy. The heart and skeletal muscles rely mainly on lipids for energy. One gram of lipids provides nine calories of energy. This is more than twice the amount provided by carbohydrates or proteins. Lipids have several other roles in the body. For example, lipids:

- Protect nerves.
- Help control blood pressure.
- Help blood to clot.
- Make up the membranes that surround cells.

Fats are one type of lipid. Stored fat gives your body energy to use for later. It's like having money in a savings account. It's there in case you need it. Stored fat also cushions and protects internal organs. In addition, it insulates the body. It helps keep you warm in cold weather.

High-Fiber Foods

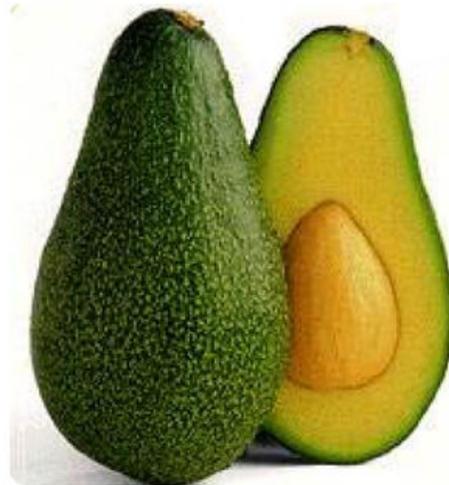
A cup of broccoli has about 11 grams of fiber



A cup of green peas has about 9 grams of fiber



A pear has about 5 grams of fiber.



An avocado has about 12 grams of fiber.

FIGURE 1.3

Between the ages of 9 and 13 years, girls need about 26 grams of fiber a day, and boys need about 31 grams of fiber a day. Do you know other foods that are high in fiber?

Fats and other lipids are necessary for life. However, they can be harmful if you eat too much of them, or the wrong type of fats. Fats can build up in the blood and damage blood vessels. This increases the risk of heart disease.

There are two types of lipids, saturated and unsaturated.

- a. Saturated lipids can be unhealthy, even in very small amounts. They are found mainly in animal foods, such as meats, whole milk, and eggs. Saturated lipids increase cholesterol levels in the blood. Cholesterol is a fatty substance that is found naturally in the body. Too much cholesterol in the blood can lead to heart disease. It is



An 8 oz. glass of milk has about 8 grams of protein.



A 3 oz. serving of chicken has about 20 grams of protein.



A cup of kidney beans has about 16 grams of protein.

FIGURE 1.4

Between the ages of 9 and 13 years, you need about 34 grams of proteins a day. What other foods do you think are good sources of proteins?

best to limit the amount of saturated lipids in your diet.

- Unsaturated lipids are found mainly in plant foods, such as vegetable oil, olive oil, and nuts. Unsaturated lipids are also found in fish, such as salmon. Unsaturated lipids are needed in small amounts for good health because your body cannot make them. Most lipids in your diet should be unsaturated.

Another type of lipid is called **trans fat**. Trans fats are manufactured and added to certain foods to keep them fresher for longer. Foods that contain trans fats include cakes, cookies, fried foods, and margarine. Eating foods that contain trans fats increases the risk of heart disease. You should do your best to eat fewer foods that contain it.

Beginning in 2010, California banned trans fats from restaurant products, and, beginning in 2011, from all retail baked goods.

Vitamins and Minerals

Vitamins and minerals are also nutrients. They do not provide energy, but they are needed for good health.

Vitamins

Vitamins are substances that the body needs in small amounts to function properly. Humans need 13 different vitamins. Some of them are listed in **Table 1.1**. The table also shows how much of each vitamin you need each day. Vitamins have many roles in the body. For example, Vitamin A helps maintain good vision. Vitamin B₉ helps form red blood cells. Vitamin K is needed for blood to clot when you have a cut or other wound.

TABLE 1.1: Vitamins Needed For Good Health

Vitamin	One Reason You Need It	Some Foods that Have It	How Much of It You Need Each Day (at ages 9–13 years)
Vitamin A	Needed for good vision	Carrots, spinach, milk, eggs	600 μg ($1 \mu\text{g} = 1 \times 10^{-6} \text{ g}$)
Vitamin B ₁	Needed for healthy nerves	Whole wheat, peas, meat, beans, fish, peanuts	0.9 mg ($1 \text{ mg} = 1 \times 10^{-3} \text{ g}$)
Vitamin B ₃	Needed for healthy skin and nerves	Beets, liver, pork, turkey, fish, peanuts	12 mg
Vitamin B ₉	Needed to make red blood cells	Liver, peas, dried beans, green leafy vegetables	300 μg
Vitamin B ₁₂	Needed for healthy nerves	Meat, liver, milk, shellfish, eggs	1.8 μg
Vitamin C	Needed for growth and repair of tissues	Oranges, grapefruits, red peppers, broccoli	45 mg
Vitamin D	Needed for healthy bones and teeth	Milk, salmon, tuna, eggs	5 μg
Vitamin K	Needed for blood to clot	Spinach, Brussels sprouts, milk, eggs	60 μg

Some vitamins are produced in the body. For example, vitamin D is made in the skin when it is exposed to sunlight. Vitamins B₁₂ and K are produced by bacteria that normally live inside the body. Most other vitamins must come from foods. Foods that are good sources of vitamins are listed in **Table 1.1**. They include whole grains, vegetables, fruits, and milk.

Not getting enough vitamins can cause health problems. For example, too little vitamin C causes a disease called scurvy. People with scurvy have bleeding gums, nosebleeds, and other symptoms. Getting too much of some vitamins can also cause health problems. The vitamins to watch out for are vitamins A, D, E, and K. These vitamins are stored by the body, so they can build up to high levels. Very high levels of these vitamins can even cause death, although this is very rare.

Minerals

Minerals are chemical elements that are needed for body processes. Minerals are different from vitamins because they do not contain the element carbon. Minerals that you need in relatively large amounts are listed in **Table 1.2**. Minerals that you need in smaller amounts include iodine, iron, and zinc.

Minerals have many important roles in the body. For example, calcium and phosphorus are needed for strong bones and teeth. Potassium and sodium are needed for muscles and nerves to work normally.

TABLE 1.2: Minerals Needed For Good Health

Mineral	One Reason You Need It	Some Foods that Have It	How Much of It You Need Each Day (at ages 9–13 years)
Calcium	Needed for strong bones and teeth	Milk, soy milk, green leafy vegetables	1,300 mg
Chloride	Needed for proper balance of water and salts in body	Table salt, most packaged foods	2.3 g
Magnesium	Needed for strong bones	Whole grains, green leafy vegetables, nuts	240 mg

TABLE 1.2: (continued)

Mineral	One Reason You Need It	Some Foods that Have It	How Much of It You Need Each Day (at ages 9–13 years)
Phosphorus	Needed for strong bones and teeth	Meat, poultry, whole grains	1,250 mg
Potassium	Needed for muscles and nerves to work normally	Meats, grains, bananas, orange juice	4.5 g
Sodium	Needed for muscles and nerves to work normally	Table salt, most packaged foods	1.5 g

Your body cannot produce any of the minerals that it needs. Instead, you must get minerals from the foods you eat. Good sources of minerals are listed in **Table 1.2**. They include milk, green leafy vegetables, and whole grains.

Not getting enough minerals can cause health problems. For example, too little calcium may cause osteoporosis. This is a disease in which bones become soft and break easily. Getting too much of some minerals can also cause health problems. Many people get too much sodium. Sodium is added to most packaged foods. People often add more sodium to their food by using table salt. Too much sodium causes high blood pressure in some people.

Water

Did you know that water is also a nutrient? By weight, your cells are about two-thirds water, so you cannot live without it. In fact, you can survive for only a few days without water.

You lose water in each breath you exhale. You also lose water in sweat and urine. If you do not take in enough water to replace the water that you lose, you may develop dehydration. Symptoms of dehydration include dry mouth, headaches, and feeling dizzy. Dehydration can be very serious. Severe dehydration can even cause death.

When you exercise, especially on a hot day, you lose more water in sweat than you usually do. You need to drink extra water before, during, and after exercise. The children in **Figure 1.5** are drinking water while playing outside on a warm day. They need to drink water to avoid dehydration.

Getting too much water can also be dangerous. Excessive water may cause a condition called hyponatremia. In this condition, water collects in the brain and causes it to swell. Hyponatremia can cause death. It requires emergency medical care.

Lesson Summary

- The body needs food for energy, building materials, and substances that help control body processes.
- Carbohydrates, proteins, and lipids provide energy and have other important roles in the body.
- Vitamins and minerals do not provide energy but are needed in small amounts for the body to function properly.
- The body must have water to survive.

**FIGURE 1.5**

When you are active outside on a warm day, it's important to drink plenty of water. You need to replace the water you lose in sweat.

Review Questions

Recall

1. What are three reasons that your body needs food?
2. Which nutrients can be used for energy?
3. What are some foods that are good sources of vitamin C?
4. What are two minerals that are needed for strong bones and teeth?

Apply Concepts

5. Name two types of fiber and state the role of each type of fiber in the body.
6. Your body needs 20 different amino acids. Why do you need to get only ten of these amino acids from food? Name foods you can eat to get these ten amino acids.
7. Compare and contrast saturated and unsaturated lipids.
8. Identify three vitamins that are produced in the body. How are they produced?
9. Why do you need to drink extra water when you exercise on a hot day? What might happen if you did not drink extra water?

Critical Thinking

10. List some of the functions of proteins in the body. Based on your list, predict health problems people might have if they do not get enough proteins in foods.

Further Reading / Supplemental Links

- Alexandra Powe Allred. *Nutrition*. Perfection Learning, 2005.
- Ann Douglas and Julie Douglas. *Body Talk: The Straight Facts on Fitness, Nutrition, and Feeling Great about Yourself!* Maple Tree Press, 2006.
- DK Publishing. *Food*. DK Children, 2005.
- Donna Shryer. *Body Fuel: A Guide to Good Nutrition*. Marshall Cavendish Children's Books, 2007.
- Linda Bickerstaff. *Nutrition Sense*. Rosen Central, 2008.

CK–12. High School *Biology*. Chapter 38, Lesson 1.

- <http://www.iom.edu/Object.File/Master/21/372/0.pdf>
- <http://www.nlm.nih.gov/medlineplus/ency/article/002404.htm>
- <http://www.textbookofbacteriology.net/normalflora.html>
- <http://en.wikipedia.org/wiki/Vitamins>
- <http://www.alexandrapoweallred.com/>

Points to Consider

Think about how you can be sure you are getting enough nutrients.

- Do you think knowing the nutrients in the foods you eat are important?
- Do you have to keep track of all the nutrients you eat, or is there an easier way to choose foods that provide the nutrients you need?

1.2 Choosing Healthy Foods

Lesson Objectives

- State how to use MyPyramid to get the proper balance of nutrients.
- Describe how to read food labels to choose foods wisely.
- Explain how to balance food with exercise.

Check Your Understanding

- What is a nutrient?
- Why do you need extra energy when you exercise?

Vocabulary

ingredient A specific item that a food contains.

main ingredient The ingredient that is present in the food in the greatest amount.

MyPlate Visual representation of the relative daily portions of various food groups; replaced MyPyramid in 2011.

MyPyramid Diagram that shows how much you should eat each day of foods from six different food groups.

nutrition facts label The label on packaged food that shows the nutrients in the food.

obesity Having a very high percentage of body fat; obese people are at least 20 percent heavier than their healthy weight range.

serving size Tells you how much of the food you should eat to get the nutrients listed on the label.

Introduction

Foods such as whole grain breads, fresh fruits, and fish provide nutrients you need for good health. But different foods give you different types of nutrients. You also need different amounts of each nutrient. How can you choose the right mix of foods to get the proper balance of nutrients? Two tools can help you choose foods wisely: MyPyramid and food labels.

MyPyramid

MyPyramid is a diagram that shows how much you should eat each day of foods from six different food groups. It recommends the amount of nutrients you need based on your age, your sex, and your level of activity. MyPyramid is shown in **Figure 1.6**. The six food groups in MyPyramid are:

- Grains, such as bread, rice, pasta, and cereal.
- Vegetables, such as spinach, broccoli, carrots, and sweet potatoes.
- Fruits, such as oranges, apples, bananas, and strawberries.
- Oils, such as vegetable oil, canola oil, olive oil, and peanut oil.
- Dairy, such as milk, yogurt, cottage cheese, and other cheeses.
- Meat and beans, such as chicken, fish, soybeans, and kidney beans.

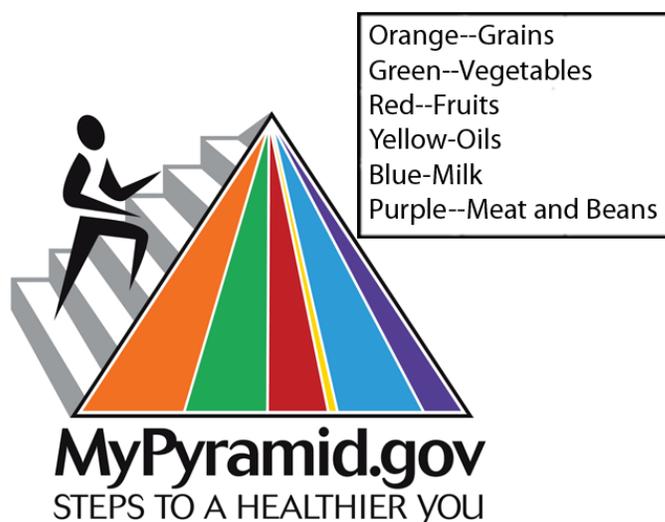


FIGURE 1.6

MyPyramid can help you choose foods wisely for good health. Each colored band represents a different food group. The key shows which food group each color represents. Which colored band of MyPyramid is widest? Which food group does it represent?

Using MyPyramid

In MyPyramid, each food group is represented by a band of a different color. For example, grains are represented by an orange band, and vegetables are represented by a green band. The wider the band, the more foods you should choose from that food group each day.

The orange band in MyPyramid is the widest band. This means that you should choose more foods from the grain group than from any other single food group. The green, blue, and red bands are also relatively wide. Therefore, you should choose plenty of foods from the vegetable, dairy, and fruit groups as well. You should choose the fewest foods from the food group with the narrowest band. Which band is narrowest? Which food group does it represent?

Healthy Eating Guidelines

Did you ever hear the saying, “variety is the spice of life”? Variety is also the basis of a healthy eating plan. When you choose foods based on MyPyramid, you should choose a variety of different foods. Follow these guidelines

to make the wisest food choices for good health. Keep in mind that nutritional rules may change as you get older. As food provides energy and nutrients for growth and development, nutritional requirements may vary with body weight, age, sex, activity, and body functioning.

- Make at least half your daily grain choices whole grains. Examples of whole grains are whole wheat bread, whole wheat pasta, and brown rice.
- Choose a variety of different vegetables each day. Be sure to include both dark green vegetables, such as spinach and broccoli, and orange vegetables, such as carrots and sweet potatoes.
- Choose a variety of different fruits each day. Select mainly fresh fruits rather than canned fruits and whole fruits instead of fruit juices.
- When choosing oils, go for unsaturated oils, such as olive oil, canola oil, or vegetable oil.
- Choose low-fat or fat-free milk and other dairy products. For example, select fat-free yogurt and low-fat cheese.
- For meats, choose fish, chicken, and lean cuts of beef. Also, be sure to include beans, nuts, and seeds.

What about Ice Cream, Cookies, and Potato Chips?

Are you wondering where foods like ice cream, cookies, and potato chips fit into MyPyramid? The white tip of MyPyramid represents foods such as these. These are foods that should be eaten only in very small amounts and not very often. Such foods contain very few nutrients, and are called nutrient-poor. Instead, they are high in fats, sugars, and sodium, which are nutrients that you should limit in a healthy eating plan. Ice cream, cookies, and potato chips are also high in calories. Eating too much of them may lead to unhealthy weight gain.

MyPlate

In June 2011, the United States Department of Agriculture replaced My Pyramid with **MyPlate**. MyPlate depicts the relative daily portions of various food groups. See <http://www.choosemyplate.gov/> for further information.

The following guidelines accompany MyPlate:

1. Balancing Calories

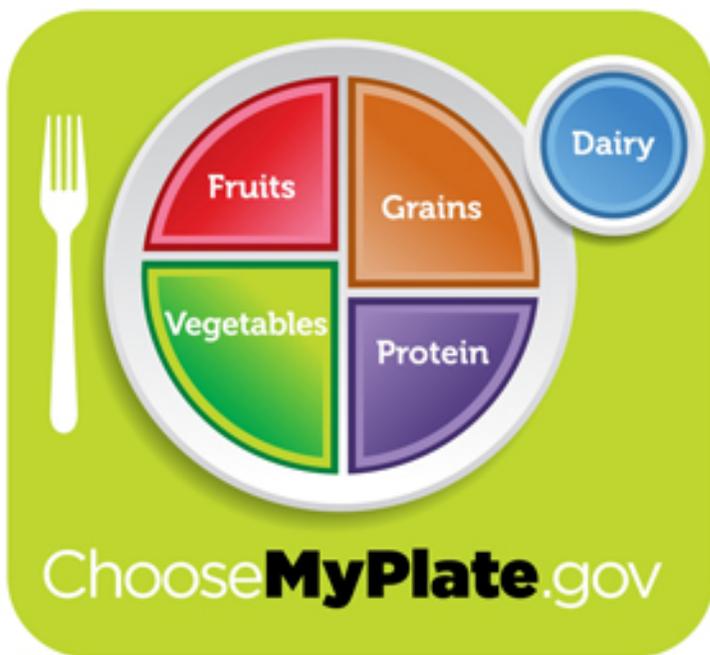
- Enjoy your food, but eat less.
- Avoid oversized portions.

2. Foods to Increase

- Make half your plate fruits and vegetables.
- Make at least half your grains whole grains.
- Switch to fat-free or low-fat (1%) milk.

3. Foods to Reduce

- Compare sodium in foods like soup, bread, and frozen meals [U+2015] and choose the foods with lower numbers.
- Drink water instead of sugary drinks.

**FIGURE 1.7**

MyPlate is a visual guideline for balanced eating, replacing MyPyramid in 2011.

Food Labels

In the United States, packaged foods are required by law to have nutrition facts labels. A **nutrition facts label** shows the nutrients in a food. Packaged foods are also required to list their ingredients. An **ingredient** is a specific item that a food contains.

Using Nutrition Facts Labels

An example of a nutrition facts label is shown in **Figure 1.8**. The information listed at the right of the label tells you what to look for. At the top of the label, look for the serving size. The serving size tells you how much of the food you should eat to get the nutrients listed on the label. A cup of food from the label in **Figure 1.8** is a serving. The calories in one serving are listed next. In this food, there are 250 calories per serving.

Next on the nutrition facts label, look for the percent daily values (% DV) of nutrients. Remember the following tips when reading a food label:

- A food is low in a nutrient if the percent daily value of the nutrient is 5% or less.
- The healthiest foods are low in nutrients such as fats and sodium.
- A food is high in a nutrient if the percent daily value of the nutrient is 20% or more.
- The healthiest foods are high in nutrients such as fiber and proteins.

Look at the percent daily values on the food label in **Figure 1.8**. Which nutrients have values of 5% or less? These are the nutrients that are low in this food. They include fiber, vitamin A, vitamin C, and iron. Which nutrients have values of 20% or more? These are the nutrients that are high in this food. They include sodium, potassium, and calcium.

Nutrition Facts	
Serving Size 1 cup (228g) Servings Per Container 2	
Amount Per Serving	
Calories 250	Calories from Fat 110
% Daily Value*	
Total Fat 12g	18%
Saturated Fat 3g	15%
Trans Fat 3g	
Cholesterol 30mg	10%
Sodium 470mg	20%
Potassium 700mg	20%
Total Carbohydrate 31g	10%
Dietary Fiber 0g	0%
Sugars 5g	
Protein 5g	
Vitamin A	4%
Vitamin C	2%
Calcium	20%
Iron	4%
* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.	
	Calories: 2,000 2,500
Total Fat	Less than 65g 80g
Sat. Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g

FIGURE 1.8

Reading nutrition facts labels can help you choose healthy foods. Look at the nutrition facts label shown here. Do you think this food is a good choice for a healthy eating plan? Why or why not?

Using Ingredients Lists

The food label in **Figure 1.9** includes the list of ingredients in a different food. The ingredients on food labels are always listed from the highest amount to the lowest amount. This means that the main ingredient is listed first. The **main ingredient** is the ingredient that is present in the food in the greatest amount. As you go down the list, the ingredients are present in smaller and smaller amounts.

Reading the ingredients lists on food labels can help you choose the healthiest foods. At the top of the list, look for ingredients such as whole grains, vegetables, milk, and fruits. These are the ingredients you need in the greatest amounts for balanced eating. Avoid foods that list fats, oils, sugar, or salt at the top of the list. For good health, you should avoid getting too much of these ingredients. Be aware that ingredients such as corn syrup are sugars.

You should also use moderation when eating foods that contain ingredients such as white flour or white rice. These ingredients have been processed, and processing removes nutrients. The word "enriched" is a clue that an ingredient has been processed. Ingredients are enriched with added nutrients to replace those lost during processing. However, enriched ingredients are still likely to have fewer nutrients than unprocessed ingredients.

Nutrition Facts		
Serving Size	½ cup (52 g)	
Servings Per Container	8	
Amount Per Serving		
Calories 200	Calories from Fat 45	
	% Daily Value*	
Total Fat 5 g	8 %	
Saturated Fat 2.5 g	13 %	
Trans fat 0 g		
Cholesterol 0 mg	0 %	
Sodium 160 mg	7 %	
Total Carbohydrate 37 g	12 %	
Dietary Fiber 1 g	4 %	
Sugars 17 g		
Protein 2 g		
Vitamin A 0 %	Vitamin C 0 %	Calcium 0 %
Iron 10 %	Thiamin 10 %	Riboflavin 0 %
Niacin 20 %	Vitamin B ₆ 0 %	Folic Acid 10 %
*Percent Daily Values are based on a 2000 Calorie diet. Your daily values may be higher or lower depending on your calorie needs.		
Ingredients: Enriched wheat flour (wheat flour, iron, Vitamin B ₁ , folic acid), high-fructose corn syrup, vegetable oil (canola and soybean oil, partially hydrogenated palm kernel oil), sugar, salt, raisins, cornstarch, whole grain oats, baking soda, artificial flavor, caramel color		

Ingredients List

FIGURE 1.9

This food label includes the list of ingredients in the food. The main ingredient is enriched wheat flour, followed by high-fructose corn syrup. Why should you avoid foods with ingredients such as these at the top of the ingredients list?

Balancing Food with Exercise

Look at MyPyramid in **Figure 1.6**. Note the person walking up the side of the pyramid. This shows that exercise is important for balanced eating. Exercise helps you use any extra energy in the foods you eat. The more active you are, the more energy you use. You should try to get at least an hour of physical activity just about every day. **Figure 1.10** shows some activities that can help you use extra energy.

How Does Fat Form?

Any unused energy in food is stored in the body as fat. This is true whether the extra energy comes from carbohydrates, proteins, or lipids. What happens if you take in more energy than you use, day after day? You will store more and more fat and become overweight.

Eventually, you may become obese. **Obesity** is having a very high percentage of body fat. Obese people are at least 20 percent heavier than their healthy weight range. The excess body fat of obesity is linked to many diseases. Obese people often have serious health problems, such as diabetes, high blood pressure, and high cholesterol. They are also more likely to develop arthritis and some types of cancer. People that remain obese during their entire adulthood usually do not live as long as people that stay within a healthy weight range.

The current generation of children and teens is the first generation in our history that may have a shorter life than their parents. The reason is their high rate of obesity and the health problems associated with obesity. You can avoid gaining weight and becoming obese. The choice is yours. Choose healthy foods by using MyPyramid and reading food labels. Then get plenty of exercise to balance the energy in the foods you eat.

Balancing Food with Exercise

**FIGURE 1.10**

All of these activities are good ways to exercise and use extra energy. The calories given for each activity are the number of calories used in an hour by a person that weighs 100 pounds. Which of these activities uses the most calories? Which of the activities do you enjoy?

Lesson Summary

- MyPyramid shows how much you should eat each day of foods from six different food groups.
- Reading food labels can help you choose the healthiest foods.
- Regular exercise helps you use extra energy and avoid unhealthy weight gain.

Review Questions

Recall

1. List the six food groups represented by MyPyramid.
2. Which food group contains soybeans, kidney beans, and fish?
3. What guideline should you follow in choosing foods from the grains food group?
4. Which ingredient is always listed first on a food label?
5. What happens if you take in more energy than you use, day after day?

Apply Concepts

6. Explain how you can use MyPyramid to choose foods that provide the proper balance of nutrients.
7. Why should you limit foods like ice cream and potato chips in a healthy eating plan?
8. Explain how you can use food labels to choose foods that are high in fiber.
9. Why should you try to avoid foods with processed ingredients? What are some examples of processed ingredients?

Critical Thinking

10. You are trying to convince your friends that it is worth it to eat healthy and do physical activity. What will you tell them? Give examples from the chapter.

Further Reading / Supplemental Links

- Eric Schlosser and Charles Wilson. *Chew on This: Everything You Don't Want to Know about Fast Food*. Houghton Mifflin, 2006.
- John Burstein. *The Shape of Good Nutrition: The Food Pyramid*. Crabtree Publishing Company, 2008.
- Rose McCarthy. *Food Labels: Using Nutrition Information to Create a Healthy Diet*. Rosen Publishing Group, 2008.
- Sandra Giddens. *Making Smart Choices about Food, Nutrition, and Lifestyle*. Rosen Central, 2008.

CK–12. High School *Biology*. Chapter 38, Lesson 1.

- <http://www.cfsan.fda.gov/acrobat/nutfacts.pdf>
- <http://www.cfsan.fda.gov/dms/foodlab.html>
- <http://www.fns.usda.gov/tn/parents/nutritionlabel.html>
- <http://www.health.gov/dietaryguidelines/dga2005/document/pdf/DGA2005.pdf>
- <http://www.mypyramid.gov>
- <http://www.newswise.com/articles/view/537296>
- <http://www.nlm.nih.gov/medlineplus/ency/article/002459.htm>
- <http://www.nlm.nih.gov/medlineplus/exerciseforchildren.html>
- <http://www.prb.org/Articles/2005/WillRisingChildhoodObesityDecreaseUSLifeExpectancy.aspx>
- <http://www.sciencemag.org/cgi/content/summary/307/5716/1716>
- <http://en.wikipedia.org/wiki>

Points to Consider

Next we discuss the digestive system.

- Discuss how you think foods may be broken down into nutrients that your body can use? For example, how do you think an apple becomes simple sugars that your body can use for energy? Or how might a piece of cheese become proteins that your body can use for building materials?

1.3 The Digestive System

Lesson Objectives

- List the functions of the digestive system.
- Explain the role of enzymes in digestion.
- Describe the digestive organs and their functions.
- Explain the roles of helpful bacteria in the digestive system.
- List ways to help keep your digestive system healthy.

Check Your Understanding

- What is a chemical reaction?
- What is an enzyme?
- What are bacteria?

Vocabulary

absorption Process in which substances are taken up by the blood; after food is broken down into small nutrient molecules, the molecules are absorbed by the blood.

chemical digestion Digestion in which large food molecules are broken down into small nutrient molecules.

digestion Process of breaking down food into nutrients.

digestive system Body system that breaks down food, absorbs nutrients, and gets rid of solid food waste.

duodenum The first part of the small intestine; where most chemical digestion takes place.

esophagus The narrow tube that carries food from the throat to the stomach.

food allergies A condition in which the immune system reacts to harmless substances in food as though they were harmful.

ileum The third part of the small intestine; covered with villi; the few remaining nutrients are absorbed in the ileum.

jejunum The second part of the small intestine; where most nutrients are absorbed into the blood; lined with tiny “fingers” called villi.

large intestine The relatively wide tube between the small intestine and anus where excess water is absorbed from food waste.

mechanical digestion Digestion in which large chunks of food are broken down into small pieces.

small intestine The narrow tube between the stomach and large intestine where most chemical digestion and absorption of nutrients take place.

stomach The sac-like organ at the end of the esophagus where proteins are digested.

villi Contain microscopic blood vessels; nutrients are absorbed into the blood through these tiny vessels; located on the jejunum and the ileum.

What Does the Digestive System Do?

Nutrients in the foods you eat are needed by the cells of your body. How do the nutrients in foods get to your body cells? What organs and processes break down the foods and make the nutrients available to cells? The organs are those of the digestive system. The processes are digestion and absorption.

The **digestive system** is the body system that breaks down food and absorbs nutrients. It also gets rid of solid food waste. The main organs of the digestive system are shown in **Figure 1.11**.

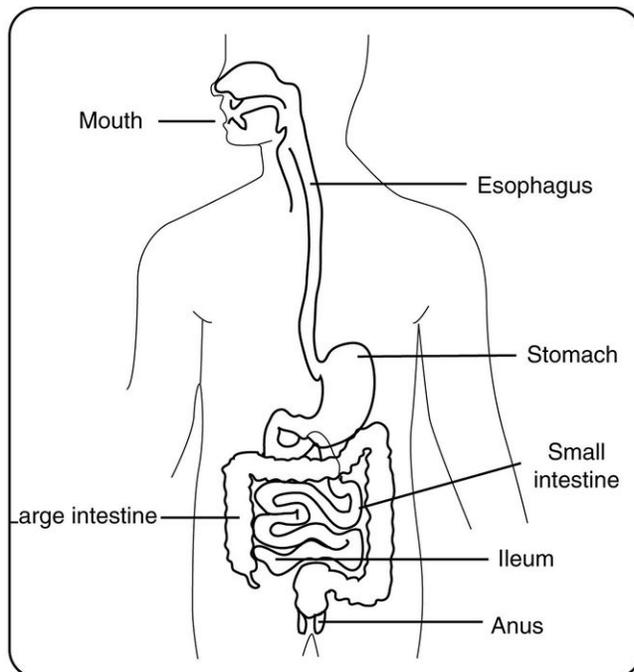


FIGURE 1.11

This drawing shows the major organs of the digestive system. Trace the path of food through the organs of the digestive system as you read about them in this lesson.

Digestion is the process of breaking down food into nutrients. There are two types of digestion, mechanical and chemical. In **mechanical digestion**, large chunks of food are broken down into small pieces. This is a physical

process. In **chemical digestion**, large food molecules are broken down into small nutrient molecules. This is a chemical process.

Absorption is the process that allows substances you eat to be taken up by the blood. After food is broken down into small nutrient molecules, the molecules are absorbed by the blood. After absorption, the nutrient molecules travel in the bloodstream to cells throughout the body.

Some substances in food cannot be broken down into nutrients. They remain behind in the digestive system after the nutrients are absorbed. Any substances in food that cannot be digested and absorbed pass out of the body as solid waste. The process of passing solid food waste out of the body is called elimination.

The Role of Enzymes in Digestion

Chemical digestion could not take place without the help of digestive enzymes. An **enzyme** is a protein that speeds up chemical reactions in the body. Digestive enzymes speed up chemical reactions that break down large food molecules into small molecules.

Did you ever use a wrench to tighten a bolt? You could tighten a bolt with your fingers, but it would be difficult and slow. If you use a wrench, you can tighten a bolt much more easily and quickly. Enzymes are like wrenches. They make it much easier and quicker for chemical reactions to take place. Like a wrench, enzymes can also be used over and over again. But you need the appropriate size and shape of the wrench to efficiently tighten the bolt, just like each enzyme is specific for the reaction it helps.

Digestive enzymes are released, or secreted, by the organs of the digestive system. Examples of digestive enzymes are:

- Amylase, produced in the mouth. It helps break down large starches molecules into smaller sugar molecules.
- Pepsin, produced in the stomach. Pepsin helps break down proteins into amino acids.
- Trypsin, produced in the pancreas. Trypsin also breaks down proteins.
- Pancreatic lipase, produced in the pancreas. It is used to break apart fats.
- Deoxyribonuclease and ribonuclease, produced in the pancreas. They are enzymes that break bonds in nucleic acids like DNA and RNA.

Bile salts are bile acids that help to break down fat. Bile acids are made in the liver. When you eat a meal, bile is secreted into the intestine, where it breaks down the fats. Bile acids also help to remove cholesterol from the body.

Hormones and Digestion

If you are a typical teenager, you like to eat. For your body to break down, absorb and spread the nutrients throughout your body, your digestive system and endocrine system need to work together. The endocrine system sends hormones around your body to communicate between cells like chemical messengers.

Digestive hormones are made by cells lining the stomach and small intestine. These hormones cross into the blood where they can affect other parts of the digestive system. Some of these hormones are listed below.

- Gastrin, which signals the secretion of gastric acid.
- Cholecystokinin, which signals the secretion of pancreatic enzymes.
- Secretin, which signals secretion of water and bicarbonate from the pancreas.
- Ghrelin, which signals when you are hungry.
- Gastric inhibitory polypeptide, which stops or decreases gastric secretion. It also causes the release of insulin in response to high blood glucose levels.

Digestive Organs and Their Roles

The mouth and stomach are just two of the organs of the digestive system. Other digestive system organs are the esophagus, small intestine, and large intestine. From **Figure 17.10** you can see that the digestive organs form a long tube. In adults, this tube is about 30 feet long! At one end of the tube is the mouth. At the other end is the anus. Food enters the mouth and then passes through the rest of the digestive system. Food waste leaves the body through the anus.

The organs of the digestive system are lined with muscles. The muscles contract, or tighten, to push food through the system. This is shown in **Figure 1.12**. The muscles contract in waves. The waves pass through the digestive system like waves through a slinky. This movement of muscle contractions is called peristalsis. Without peristalsis, food would not be able to move through the digestive system. Peristalsis is an involuntary process, which means that it occurs without your conscious control.

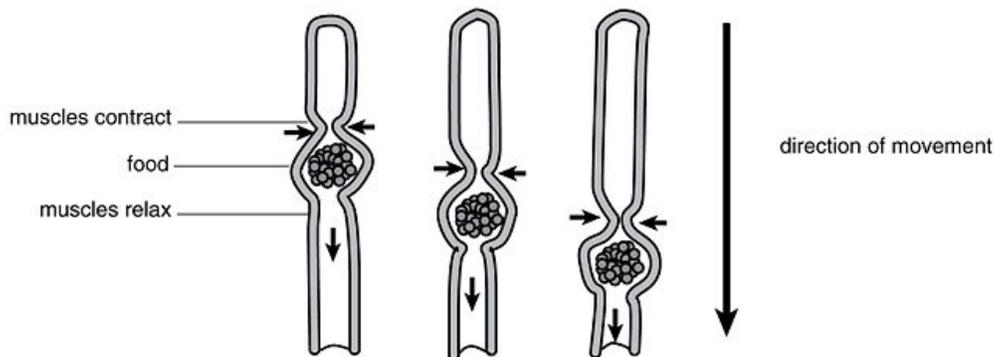


FIGURE 1.12

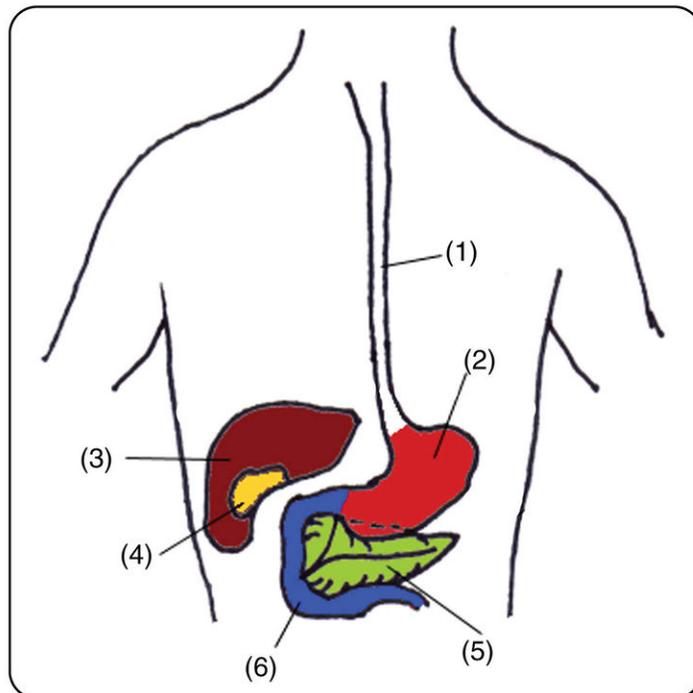
This diagram shows how muscles push food through the digestive system. Muscle contractions travel through the system in waves, pushing the food ahead of them. This is called peristalsis.

The liver, gall bladder, and pancreas are also organs of the digestive system. They are shown in **Figure 1.13**. Food does not pass through these three organs. However, these organs are important for digestion. They secrete or store enzymes or other chemicals that are needed to help digest food chemically.

Mouth, Esophagus, and Stomach

The mouth is the first organ that food enters. But digestion may start even before you put the first bite of food into your mouth. Just seeing or smelling food can cause the release of saliva and digestive enzymes in your mouth.

Once you start eating, saliva wets the food, which makes it easier to break up and swallow. Digestive enzymes, including amylase, start breaking down starches into sugars. Your tongue helps mix the food with the saliva and



KEY:

1. esophagus
2. stomach
3. liver
4. gall bladder
5. pancreas
6. small intes

FIGURE 1.13

This drawing shows the liver, gall bladder, and pancreas. These organs are part of the digestive system. Food does not pass through them, but they secrete substances needed for chemical digestion.

enzymes.

Your teeth also help digest food. Your front teeth are sharp. They cut and tear food when you bite into it. Your back teeth are broad and flat. They grind food into smaller pieces when you chew. Chewing is part of mechanical digestion. Your tongue pushes the food to the back of your mouth so you can swallow it. When you swallow, the lump of chewed food passes down your throat to your esophagus.

The **esophagus** is a narrow tube that carries food from the throat to the stomach. Food moves through the esophagus because of peristalsis. At the lower end of the esophagus, a circular muscle controls the opening to the stomach. The muscle relaxes to let food pass into the stomach. Then the muscle contracts again to prevent food from passing back into the esophagus.

Some people think that gravity moves food through the esophagus. If that were true, food would move through the esophagus only when you are sitting or standing upright. In fact, because of peristalsis, food can move through the esophagus no matter what position you are in — even upside down! Just don't try to swallow food when you are upside down! You could choke if you try to swallow when you are not upright.

The **stomach** is a sac-like organ at the end of the esophagus. It has thick muscular walls. The muscles contract and relax. This moves the food around and helps break it into smaller pieces. Mixing the food around with the enzyme pepsin and other chemicals helps digest proteins.

Water, salt, and simple sugars can be absorbed into the blood from the stomach. Most other substances are broken

down further in the small intestine before they are absorbed. The stomach stores food until the small intestine is ready to receive it. A circular muscle controls the opening between the stomach and small intestine. When the small intestine is empty, the muscle relaxes. This lets food pass from the stomach into the small intestine.

Small Intestine

The **small intestine** is narrow tube that starts at the stomach and ends at the large intestine (see **Figure 1.11**). In adults, the small intestine is about 23 feet long. It is made up of three parts, the duodenum, the jejunum and the ileum.

- The **duodenum** is the first part of the small intestine. This is where most chemical digestion takes place. Many enzymes and other chemicals are secreted here.
- The **jejunum** is the second part of the small intestine. This is where most nutrients are absorbed into the blood. The jejunum is lined with tiny “fingers” called **villi**. A magnified picture of villi is shown in **Figure 1.14**. Villi contain very tiny blood vessels. Nutrients are absorbed into the blood through these tiny vessels. There are millions of villi, so altogether there is a very large area for absorption to take place. In fact, villi make the inner surface area of the small intestine 1,000 times larger than it would be without them. The entire inner surface area of the small intestine is about as big as a basketball court!
- The **ileum** is the third part of the small intestine. Like the jejunum, the ileum is covered with villi. A few remaining nutrients are absorbed in the ileum. From the ileum, any remaining food waste passes into the large intestine.

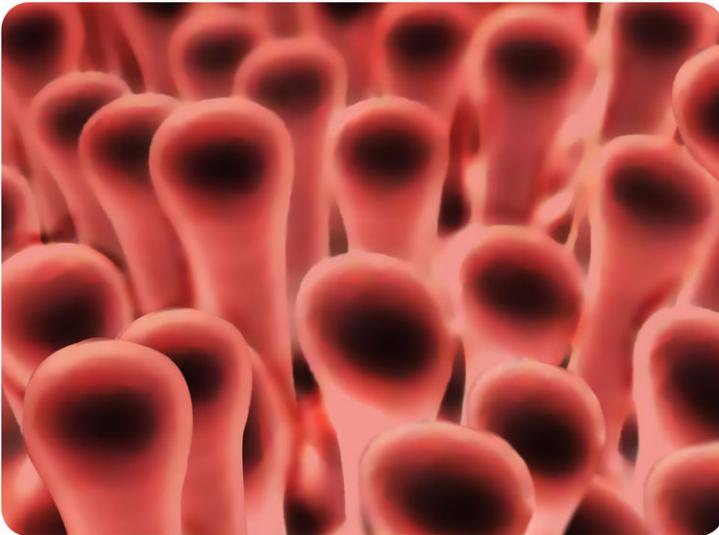


FIGURE 1.14

This is what the villi lining the small intestine look like when magnified. Each one is actually only about 1 millimeter long. Villi are just barely visible with the unaided eye.

The small intestine is much longer than the large intestine. So why is it called “small”? If you compare the small and large intestines in **Figure 1.11**, you will see why. The small intestine is smaller in width than the large intestine.

Large Intestine

The **large intestine** is a wide tube that connects the small intestine with the anus. In adults, it is about 5 feet long. Waste enters the large intestine from the small intestine in a liquid state. As the waste moves through the large

intestine, excess water is absorbed from it. After the excess water is absorbed, the remaining solid waste is called feces.

Circular muscles control the anus. They relax to let the feces pass out of the body through the anus. After feces pass out of the body, they are called stool. Releasing the stool from the body is referred to as a bowel movement.

Liver

The liver has a wide range of functions, a few of which are:

- Removing toxins from the blood.
- Keeping glucose levels stable.
- Creating proteins.
- Producing biochemicals for digestion.

The liver is necessary for survival. You cannot live without a liver. The liver is one of the most important organs in the body when it comes to getting rid of toxins, especially from the gut. The liver filters blood from the intestine. This filtering process can remove microorganisms such as bacteria, fungi, viruses and parasites from the blood. Almost 2 quarts of blood pass through the liver every minute. Since the liver also ensures that glucose levels remain stable, people with liver problems are at risk for diabetes.

Bacteria in the Digestive System

Your large intestine is not just made up of cells. It is also an ecosystem, home to trillions of bacteria. But don't worry. Most of these bacteria are helpful. They have several roles in the body. For example, intestinal bacteria:

- Produce vitamins B₁₂ and K.
- Control the growth of harmful bacteria.
- Break down poisons in the large intestine.
- Break down some substances in food that cannot be digested, such as fiber and some starches and sugars.

Keeping Your Digestive System Healthy

Most of the time, you probably aren't aware of your digestive system. It works well without causing any problems. But most people have problems with their digestive system at least once in awhile. Did you ever eat something that didn't "agree" with you? Maybe you had a stomachache or felt sick to your stomach? Maybe you had diarrhea? These could be symptoms of foodborne illness.

Foodborne Illness

Harmful bacteria can enter your digestive system in food and make you sick. This is called foodborne illness. The bacteria, or the toxins they produce, may cause vomiting or cramping, in addition to the symptoms mentioned above. You can help prevent foodborne illness by following a few simple rules.

- Keep hot foods hot and cold foods cold. This helps prevent any bacteria in the foods from multiplying.
- Wash your hands before you prepare or eat food. This helps prevent bacteria on your hands from getting on the food.

- Wash your hands after you touch raw foods such as meats, poultry, fish, or eggs. These foods often contain bacteria that your hands could transfer to your mouth.
- Cook meats, poultry, fish, and eggs thoroughly before eating them. The heat of cooking kills any bacteria the foods may contain, so they cannot make you sick.

Food Allergies

Food allergies are like other allergies. They occur when the immune system reacts to harmless substances as though they were harmful. Almost 10 percent of children have food allergies. Some of the foods most likely to cause allergies are shown in **Figure 1.15**.

Eating foods you are allergic to may cause vomiting, diarrhea, or skin rashes. Some people are very allergic to certain foods. Eating even tiny amounts of the foods causes them to have serious symptoms, such as difficulty breathing. If they eat the foods by accident, they may need emergency medical treatment.

Foods that Commonly Cause Allergies

Nuts



Eggs



Fish



Milk



Shellfish

FIGURE 1.15

Some of the foods that commonly cause allergies are shown here. They include nuts, eggs, fish, milk, and shellfish. Are you allergic to any of these foods?

If you think you may have food allergies, a doctor can test you to find out for sure. The tests will identify which foods you are allergic to. Then you can avoid eating these foods. This is the best way to prevent the symptoms of food allergies. To avoid the foods you are allergic to, you may have to read food labels carefully. This is especially likely if you are allergic to common food ingredients, such as soybeans, wheat, or peanuts.

A food intolerance, or food sensitivity, is different from a food allergy. A food intolerance happens when the

digestive system is unable to break down a certain type of food. This can result in stomach cramping, diarrhea, tiredness, and weight loss. Food intolerances are often mistakenly called allergies. Lactose intolerance is a food intolerance. A person who is lactose intolerant does not make enough lactase, the enzyme that breaks down the milk sugar lactose. About 75 percent of the world's population is lactose intolerant.

Lesson Summary

- The digestive system breaks down food, absorbs nutrients, and gets rid of food wastes.
- Digestive enzymes speed up the reactions of chemical digestion.
- The main organs of the digestive system are the mouth, esophagus, stomach, small intestine, and large intestine.
- Bacteria in the large intestine produce vitamins and have other roles in the body.

Review Questions

Recall

1. What are three functions of the digestive system?
2. Identify two roles of helpful bacteria in the large intestine.
3. List two rules that can help prevent foodborne illness.

Apply Concepts

4. Describe the roles of the mouth in digestion.
5. In which organs of the digestive system does absorption of nutrients take place? |
6. Explain the role of enzymes in digestion. Give examples to illustrate your answer.
7. Describe peristalsis, and explain why it is necessary for digestion.
8. How can the inner surface area of the small intestine be as big as a basketball court? How does this help the small intestine absorb nutrients?

Critical Thinking

9. Assume a person has an illness that prevents the large intestine from doing its normal job. Why might the person have diarrhea?
10. Explain why eating high-fiber foods can help prevent constipation.

Further Reading / Supplemental Links

CK–12, High School *Biology*, Chapter 38, Lesson 2.

- Carol Ballard. *The Digestive System*. Heinemann Library, 2003.

- Robert J. Sullivan. *Digestion and Nutrition*. Chelsea House Publications, 2004.
- Sherri Mabry Gordon. *Peanut Butter, Milk, and Other Deadly Threats: What You Should Know about Food Allergies*. Enslow Publishers, 2006.
- Steve Parker. *Break It Down: The Digestive System*. Raintree, 2006.
- <http://digestive.niddk.nih.gov/ddiseases/pubs/bacteria>
- http://digestive.niddk.nih.gov/ddiseases/pubs/constipation_ez
- <http://hypertextbook.com/facts/2001/AnneMarieThomasino.shtml>
- http://kalishresearch.com/a_gluten.html
- <http://physiwiki.wetpaint.com/page/Chapter+4:+Enzymes+and+Energy?t=anon>
- <http://www.biologyinmotion.com/minilec/wrench.html>
- <http://www.cfsan.fda.gov/dms/a2z-b.html>
- http://www.fsis.usda.gov/Factsheets/Cleanliness_Helps_Prevent_Foodborne_Illness/index.asp
- <http://www.mayoclinic.com/health/food-allergies/AA00057>
- <http://www.textbookofbacteriology.net/normalflora.html>
- <http://en.wikipedia.org/wiki/Stomach>

Points to Consider

- After nutrients are absorbed into the blood, think about how the blood could carry them to all the cells of the body. How does the blood travel? What keeps the blood moving?

1.4 References

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