THE DIGESTIVE SYSTEM

from

The Human Body Systems Series

Teacher's Guide
THE DIGESTIVE SYSTEM
Grade Levels: 6 - 9
(Review for grades 10-12)
Viewing Time: 20 minutes with video quiz

INTRODUCTION
This video is designed for use in grades 6 - 9 as an introduction to the major ideas and concepts associated with the human digestive system, and for use in grades 10-12 as review.

PROGRAM OBJECTIVES
After viewing the video and participating in the lesson activities, the students will be able...

• Describe the function and workings of the digestive system.

• Identify the main parts of the digestive system.

• Identify the six main substances required by the body for proper nutrition.

• Recognize the importance of a balanced diet.

• Define key vocabulary terms associated with the digestive system.

SUMMARY OF THE VIDEO
This video describes the human digestive system and the importance of proper nutrition and balanced diet. Through the use of live-action video and computer graphics, students will discover the workings of the digestive system and the key organs involved in providing the body’s cells with the energy they need for survival. Key vocabulary terms and definitions are provided as well as discussions about the importance of exercise and a balanced diet.
INSTRUCTIONAL NOTES

Before presenting this lesson to your students, we suggest that you preview the video and review this guide and the accompanying blackline master activities in order to familiarize yourself with their content.

Duplicate any blackline masters you wish to distribute. If you plan to use the Video Quiz, which immediately follows the video presentation, you may wish to distribute Blackline Master 1, Video Quiz, before showing the video.

Blackline Master 7, **Taste Test**, is an experiment which requires the following supplies: test foods, such as potato, apple, lemon, lettuce, sugar, salt, and orange; blunt knife, small plates; and blindfold. Prepare the food items in advance by cutting them into small pieces. Give each group or individual a sample of all food items.

Blackline Master 8, **Water Content of Fruits and Vegetables** requires access to an oven and the following supplies: various fruits and vegetables, such as lettuce, cabbage, orange, apple, and banana; scale. This experiment may be assigned as homework, with parental permission.

As you review the materials presented in this guide, you may find it necessary to make some changes, additions, or deletions to meet the specific needs of your class. We encourage you to do so, for only by tailoring this program to your class will they obtain the maximum instructional benefits afforded by the materials.

It is also suggested that the video presentation take place before the entire group under your supervision. The lesson activities grow out of the context of the video; therefore, the presentation should be a common experience for all students.
INTRODUCING THE VIDEO

Write the number 100 trillion (100,000,000,000,000) on the blackboard. Ask for a volunteer to read that number. Tell the class that the topic for the day has something to do with that number. Announce that the topic is human digestion. Can anyone guess what that number has to do with digestion? Well, there are over 100 trillion cells in an adult and everyone of those living cells needs energy. That energy is provided by the digestive system and delivered by the circulatory system.

Present the video. The viewing time is 14:00 for the program and about 5:00 for the Video Quiz.

BLACKLINE MASTER DESCRIPTIONS

Most of the follow-up activities for this program are designed for middle school grades. If you use this program with an older audience you will need to adapt the materials appropriately.

Blackline Master 1, Video Quiz, is to be used at the end of the video program. At the completion of the video, there is a short ten question quiz. The narrator will read the questions which are displayed on the screen. Students can use this sheet to record their answers. Answers to the questions are provided in the Answer Key on page 5 of this teacher’s guide.

Blackline Master 2, Vocabulary, is a collection of important vocabulary words from the video. You may want to distribute the sheet before viewing the video so students can listen for definitions.

Blackline Master 3, Parts of the Digestive System, contains a diagram of the digestive system. Students are to label the various parts of the system with the terms in the box at the bottom of the page.
Blackline Masters 4 and 5, The Food Pyramid, is a take-off on the USDA Food Pyramid, which was established to guide people in proper food choices. Students are to keep a log of what they eat over a two-day period. They should record everything from snacks to main meals. Once they have recorded this information, they can use The Food Pyramid sheet to analyze their food choices. Have students determine a way to use the Food Pyramid chart and the log of their two-day diets. Color-coding the six food groups might be one method. They could then put a colored check next to food choices they made that fit a particular food group. Have students share their results and then carry on a discussion of the importance of a balanced diet.

Blackline Master 6, Six Basic Substances For Nutrition, contains a chart describing the sources and uses of the six basic substances needed for proper nutrition. You will want students to refer back to The Food Pyramid chart during a discussion about good food choices.

Blackline Master 7, Taste Test, is a simple experiment that demonstrates the connection between taste and smell. There are supplies required for this experiment, detailed in the Instructional Notes, page 2.

Blackline Master 8, Water Content of Fruits and Vegetables, is an experiment designed to demonstrate that water is a major component of many fruits and vegetables. Humans need about twelve 8-ounce glasses of water every day. We get much of that water from foods we eat. Supplies required for this experiment are detailed in the Instructional Notes, page 2.

Blackline Master 9, Quiz, is the formal test for this unit of study.
INTERNET ACTIVITIES

1. Visit The Food Zone, an interactive, educational website designed for the 8th through 12th grades science classroom at http://kauai.cudenver.edu:3010
   Also included are experiments and quizzes.

2. Smoking and Your Digestive System is the National Digestive Disease Information Clearinghouse at http://www.niddk.nih.gov/Smoking/smoking.html

DISCUSSION QUESTIONS

1. Discuss the relationship between the digestive and circulatory systems.

2. Discuss the importance of a well-balanced diet to maintaining a healthy body.

3. Discuss how students might make use of the Food Pyramid developed by the USDA.

ANSWER KEY

Blackline Master 1, Video Quiz

1. Digestion is the process of breaking down food into a form that the body can use.
2. Carbohydrates, proteins, fats, vitamins, minerals, and fiber.
3. c
4. A calorie is used to measure the energy potential of food.
5. a
6. An example of mechanical digestion in the mouth is the teeth tearing and grinding the food into smaller pieces.
7. d
8. b
9. The villi of the small intestine are responsible for transferring the food that has been processed through the
digestive system into the circulatory system for delivery to the cells of the body.

10. A balanced diet is necessary for a healthy body because it is the best method for assuring that the six necessary substances (proteins, carbohydrates, fats, vitamins, minerals, and fiber) are taken into the body.

**Blackline Master 2, Vocabulary**

1. **digestion** - the process of breaking food down to be used by the body
2. **calorie** - a measurement to show how much energy a food contains
3. **nutrients** - the useable portions of food used for growth, repair, and replacement
4. **esophagus** - the tube leading from the throat to the stomach
5. **saliva** - liquid released in the mouth to moisten food and to begin the dissolving of food
6. **liver** - organ located near the stomach; makes bile which helps break fat into smaller pieces called fat droplets
7. **pancreas** - makes pancreatic juice which contains many enzymes that act on the food in the small intestine; the pancreas also produces sodium bicarbonate to neutralize the acidity of the food coming from the stomach
8. **enzymes** - substances which chemically act on food to break it down into simpler substances
9. **peristalsis** - muscular contractions that move food through the digestive system
10. **bolus** - the name given to a food ball formed in the mouth and then swallowed
11. **chyme** - the name given to food as it leaves the stomach and moves into the small intestine
12. **villi** - structures which line the walls of the small intestine and are responsible for transferring food into the circulatory system
1. To plan a balanced diet, a person will take the time to study the Food Pyramid and compare diet choices with the food group servings recommended on the chart.

2. A balanced diet is important to a healthy body because it will help to insure that necessary carbohydrates, proteins, fats, vitamins, minerals, and fiber are being taken into the body.
Blackline Master 7, Taste Test
Conclusions:
1. Most people will have trouble guessing all the test samples without the sense of smell to help.
2. Answers will vary but might include some idea similar to the Taste Test experiment. A blindfolded person might be asked to smell the food samples and try to identify what they are.

Blackline Master 8, Water Content of Fruits and Vegetables
Conclusions:
1. This will depend on what food items are selected to be tested.
2. Divide the weight of the water by the overall weight before placing in the oven and multiply by 100 to get a percentage.

Blackline Master 9, Quiz
1. Carbohydrates, proteins, fats, vitamins, minerals, and fiber.
2. Just about every chemical reaction in the body must occur in the presence of water. Also, water carries certain substances throughout the bloodstream. It also helps to keep our bodies at the proper temperature.
3. Digestion is the breakdown of food into substances that can be used by the body.
4. Calories are used to measure energy in foods. Our bodies use so many calories of energy daily. The number will vary depending on how active we are or whether we are exercising or relaxing. Any calories not used are converted to fat and stored for future use. So, to maintain a healthy body, a person should not eat large numbers of excess calories that would be stored as fat.
5. An example of mechanical digestion in the mouth is the tearing and grinding of food by the teeth. An example of chemical digestion in the mouth is the release of saliva,
which begins dissolving food.

6. Contractions of muscles push the food along the digestive tract. This is called peristalsis.

7. The stomach churns food with a grinding motion created by three layers of muscles. That is an example of mechanical digestion. The chemical digestion occurs when gastric juices containing pepsin and hydrochloric acid mix with the food.

8. The liver produces a salt solution called bile, which helps to break down fats into small droplets.

9. The pancreas releases enzymes that work on the chyme (food) which comes from the stomach. The pancreas also produces sodium bicarbonate which neutralizes the acidity of the chyme.

10. The villi contain small blood vessels that absorb the nutrients that will be carried by the circulatory system to all the cells of the body.

SCRIPT OF VIDEO PRESENTATION

THE DIGESTIVE SYSTEM

Our bodies are in constant need of nutrients and energy. With trillions of living cells all requiring nourishment and energy, the digestive system becomes all important in the survival of living things. For many animals on earth, eating is a major part of daily life. That’s because food contains the nutrients the body needs for growth, repair and replacement. Also, food provides the energy that the body needs to carry out life-sustaining activities, as well as all the other kinds of activities we enjoy, such as sports. Food has to be prepared, or broken down, into the substances that the body can use. This process of breaking down food is called digestion and is the topic of this video.

SIX SUBSTANCES

Our bodies need six main types of substances: proteins, carbohydrates, fats, vitamins, minerals, and fiber. We also need
water which provides no nutrients or energy, but is critical to life. In fact we could survive many days without food but only a few days without water. Why is water so important? Well, just about every chemical reaction in the body must occur in the presence of water. Also, water carries substances throughout the body in the bloodstream. Water helps to keep our bodies at the proper temperature. Our bodies require about 2.5 to 4 liters of water a day. That is the equivalent of about twelve 8-ounce glasses of water. All food and drinks contain water, so it is replenished throughout the day.

Proteins are the main “body building” foods. They contain the materials for growth, repair, and replacement. Protein rich foods include meat, fish, eggs, cheese, beans, peas, and vegetables. Breads and grains also contain protein but to a lesser extent than the others listed before.

The body’s main source of energy comes from carbohydrates. Potatoes, pastas, cereals, bread, rice, and some fruits and nuts are all good sources of carbohydrates. There are two types of carbohydrates: simple and complex. Simple carbohydrates are sugars. Complex carbohydrates are starches. Carbohydrates are the result of photosynthesis, when plants combine carbon, oxygen, and water.

Fats provide twice as much energy as carbohydrates but are used primarily as storage components for future use. Fats can be divided into two groups. Fats that are solid at room temperature are called saturated fats and include animal fats, dairy products, and solid vegetable shortenings. Unsaturated fats are liquid at room temperature and are oils made from corn, sunflower seeds, and soybeans.

Cholesterol is used by the body, but in some people, it collects on the walls of blood vessels and can block the flow of blood. Cholesterol is found in saturated fats. It is advised
to limit the amount of fats in diets because of the cholesterol question.

Vitamins, minerals, and fiber are substances that are also important to a balanced diet. They contain no energy but do play important roles in maintaining a healthy body. Vitamins are chemicals used for growth, repair, and other body functions. Fresh fruits and vegetables are rich in vitamins. Cooking often destroys vitamins, so eating fresh uncooked fruits and vegetables is a good practice.

Minerals are substances that are also needed for many important body functions. Like vitamins, they are not needed in large amounts. As an example, calcium is used to build strong bones and teeth.

Fiber helps to keep your digestive tract functioning properly. It is found in such foods as whole grain bread, cereals, vegetables, and fruits.

All foods can be analyzed for how much energy they contain. This measurement is called a calorie. Scientifically speaking, a calorie is the amount of energy required to raise the temperature of 1 gram of water by 1 degree Celsius. An instrument called a calorimeter can be used to test the energy potential of foods. The calorie that nutritionists refer to when describing the energy supplied by food is actually 1,000 calories of heat energy. Some foods are high in calories and some are low. For the average teenager to function, about 2,000 to 3,000 calories of food energy is required on a daily basis. Any calories that are not used as energy will be stored as fat tissue.

So people eat various foods to bring into the body the nutrients needed to sustain life. When food is eaten, it is not in a form that can be used by the body, so it is broken down into nutrients through the process of digestion. This is how it works.
TWO FORMS OF DIGESTION
There are two forms of digestion: mechanical and chemical. Mechanical digestion is the physical grinding and tearing of food to increase its surface area. Greater surface area means a better chance that chemical digestion can do its job. In chemical digestion, enzymes, which help to chemically break down food into simpler substances, react with the food.

Digestion begins in the mouth with the teeth, tongue, and saliva. The sharp-edged teeth tear and rip the food while the premolars and molars, which have flat surfaces, grind the food into smaller pieces. That is the mechanical digestion of the mouth. Saliva is released into the mouth to begin dissolving the food and to make it slippery so that it can pass easily through the throat and esophagus. This is the chemical digestion of the mouth. The tongue helps to push the food between the grinding teeth and to mix it with the saliva. A ball of food, called the bolus, is formed and then swallowed. Muscles in your throat force the food downward. A flap of tissue, called the epiglottis, automatically closes off the trachea or windpipe. This is a tube that leads to the lungs. It is required to get air into the lungs during respiration but water or food is not wanted down this tube. After swallowing, the epiglottis goes back to its normal position and the trachea is once again opened for air.

The food moves into the esophagus, which is a tube leading to the stomach. It takes about seven seconds for food to move down the esophagus. The lining of this tube is coated with slippery mucus. The food is pushed along because of muscular contractions called peristalsis. Contractions behind the food push it forward. Food doesn’t move down through the digestive tract because of gravity alone. Astronauts in space can digest food even in weightless conditions where there isn’t any gravity because of the muscular contractions of peristalsis.
STOMACH
Food moves from the esophagus into the stomach, which has a capacity of two to four liters. The stomach is made up of three layers of muscles that create a grinding motion. The churning of the stomach is the mechanical digestion and, at the same time, gastric juices are released into the stomach to carry on chemical digestion.

The mechanical digestion helps to mix the enzyme pepsin and hydrochloric acid with the food. The pepsin and hydrochloric acid help to break down proteins in the food into simpler proteins. You have probably used hydrochloric acid in science classe to conduct various experiments. You know that this is a strong acid that can easily burn through clothing. How does the stomach protect itself from this acid? Well, a mucus is used to coat the walls of the stomach.

SMALL INTESTINE
After about three to six hours, the food continues to move along through the digestive tract and from the stomach enters the small intestine. The food, which is now called chyme, is in a soft watery form. The small intestine is anything but small. It is only about three centimeters in diameter but it is seven meters or about 23 feet long. Imagine this garden hose which is seven meters long all curled up and folded around itself inside a human being.

The food is pushed along by peristalsis and will now undergo major chemical digestion. Two organs that are located near the small intestine, the liver and pancreas, will provide intestinal juices that will aid in this digestion.

The liver is located to the right of the stomach. One of its important jobs is to produce bile, a substance that will help in digestion. However, bile is not an enzyme but rather a salt solution that breaks down fat into small fat droplets.
Then enzymes in the small intestine can work on the fat. When the bile is made, it is sent and stored in the gall bladder until it is needed in the small intestine.

The pancreas is located between the stomach and small intestine. It manufactures a substance called pancreatic juice. This juice contains many enzymes which will act on the chyme. The pancreas also produces sodium bicarbonate which will neutralize the acidity of the chyme as it comes from the stomach into the small intestine. It takes anywhere from three to five hours for food in the small intestine to be digested. The proteins are broken down into amino acids. Carbohydrates are broken down into simpler sugars, and fats are broken down into fatty acids and glycerol. These nutrients are ready to be sent to the living cells of the body.

To do that, the nutrients must be absorbed into the blood vessels of the circulatory system. The circulatory system, with its network of blood vessels reaching every cell of the body, will be the transport system. The walls of the small intestine are not smooth but are actually covered with millions of small finger-like structures called villi. The villi contain small blood vessels that absorb the nutrients. These millions of villi increase the surface area of the small intestine 600 times. That translates to an area the size of a tennis court ready to absorb nutrients into the circulatory system.

LARGE INTESTINE

As the food continues on from the small intestine, it is now made up of undigested food and water. Before entering the large intestine, the undigested food passes by a finger-like organ called the appendix. The function of this organ is not clear, but scientists believe it has something to do with helping the body fight bacteria and viruses. The undigested food moves into the large intestine which is shaped like a horseshoe and fits around the small intestine. The large intestine is wider than the small intestine with a di-
ameter of about 6.5 centimeters. However it is only 1.5 meters long. Over the next 18 to 24 hours, most of the water contained inside the undigested food is absorbed. Also, helpful bacteria living in the large intestine make vitamins K and B for use by the body.

Finally, materials that are not absorbed are formed into solid waste. This includes such things as dead bacteria, food roughage, fat, and protein. This waste will move into a small tube called the rectum for storage. Then it is eliminated from the body through the anus, an opening at the end of the rectum.

So, as we have seen, the digestive system, working in cooperation with the circulatory system, provides the trillions of living cells in our bodies with the needed energy for continued survival.

MAINTAINING A HEALTHY BODY
To maintain a healthy body, consider a balanced diet and exercise. Weight control is a major consideration. Remember that the energy potential of food is measured in calories. You want to find a balance between the number of daily calories required by your body and the number of calories of food taken into the body. Calories that aren’t used by the body are stored as fat, usually in a layer of tissue under the skin. So a person can maintain a desired weight if they only take in the number of calories their body uses up. If a person is overweight, they can lose weight through a regulated diet and exercise. If a person uses more energy than they take in, the body will break down stored fat to gain the energy that is needed.

Food does more than just supply the necessary energy needed by the body. It also supplies the materials needed for growth, repair, and maintenance. It is important to take in foods that contain the necessary nutrients. A balanced
A diet that supplies carbohydrates, proteins, fats, vitamins, minerals, fiber, and water is necessary for a healthy body.

The United States Department of Agriculture has issued a chart, called the Food Pyramid, to help people make good choices when it comes to diet. Notice at the foundation, or base of the pyramid, is the group that includes bread, cereal, rice and pasta. People should try and have between 6 and 11 servings from this group daily. Notice that at the top of the pyramid is a group that should be used sparingly: the fats, oils, and sweets. When people eat a balanced diet based on the suggestions provided by the Food Pyramid, they will be getting all the vitamins and nutrients they need for a healthy body.

VIDEO QUIZ
Students may write the answers to the following questions on a separate piece of paper or on the duplicating master entitled Video Quiz.

Question 1: What is digestion?

Question 2: What are the six main types of substances needed by the body for growth, repair, maintenance, and energy?

Question 3: Our bodies need the equivalent of how many eight-ounce glasses of water per day?
   a. 5               b. 10               c. 12               d. 20

Question 4: What is a calorie?

Question 5: How many calories per day does the average teenager require?
   a. 2,500 - 3,000   b. 3,000 - 4,000   c. 4,000 - 5,000
d. 500 - 1,000
Question 6: What is an example of mechanical digestion inside the mouth?

Question 7: Food moves through the digestive tract because of muscular contractions called ___________.
   a. enzymes   b. saliva   c. bolus   d. peristalsis

Question 8: The name of the tube leading into the stomach is ____________.
   a. trachea   b. esophagus   c. bolus   d. epiglottis

Question 9: How are the villi of the small intestine important to the digestive system?

Question 10: Why is a balanced diet important to maintaining a healthy body?