

# HUMAN BODY

## SECTION 4: DIGESTION

From *Hands on Science* by Linda Poore, 2003.



Westminster College

### STANDARDS:

*Students know* the sequential steps of digestion and the roles of teeth and the mouth, esophagus, stomach, small intestine, large intestine and colon in the function of the digestive system.

*Students know* plants use carbon dioxide (CO<sub>2</sub>) and energy from sunlight to build molecules of sugar and release oxygen.

*Students will* develop a testable question.

*Students know* how sugar, water and minerals are transported in a vascular plant.

### PRETEST:

1. Use the torso worksheet in Section 1. Draw and label the path a hamburger follows through your digestive system. Label all body parts that aid in digestion. Title your paper: *Digestion of a hamburger.*
2. Write three questions about digestion. We will try to answer some of the questions with science experiments.

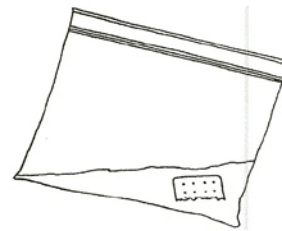
### DISCUSS:

#### 1. ORGANS OF THE DIGESTIVE SYSTEM

List the parts of the digestive system: mouth, esophagus, stomach, small intestine, large intestine. Use the hands on activities below to learn the function of each.

#### 2. TIME TO DIGEST FOOD:

- 1 minute in esophagus to the stomach
- 1 hour in stomach
- 4 or more hours in small intestine
- 15 hours in the large intestine
- 20 hours – total digestion time



### MATERIALS:

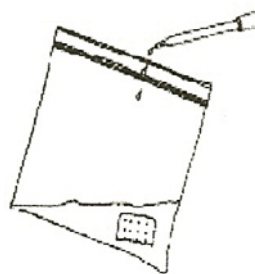
- 10 sandwich bags
- 2 unsalted soda crackers
- iodine solution with dropper
- Benedict's solution (dilute with 4x water)
- hot pot (with very hot water)
- 1 pyrex measuring cup

**NOTE:**

**COLLECTING SALIVA:** 5 students will volunteer to donate saliva. Give each a zip bag containing 1 teaspoon of water and labeled saliva. Give 3 students 1/3 of a soda cracker to break into tiny crumbs and drop into their bag. Two students will collect saliva only. Have the students leave the room for a moment to add plenty of saliva to their bag. The students return with their bag to be the scientist for their experiment.

**DEMONSTRATE:**

**THE MOUTH-SALIVA CONVERTS STARCH TO SUGAR  
HOW DOES SALIVA HELP DIGESTION?**



1. Predict the function of the mouth in digestion: breaking up food, lubricating food to slide down the esophagus, changing starch to a simple sugar (By saliva) so it can be digested.
2. Remind students that iodine tests for starch and Benedict's solution tests for simple sugar.

**3. EXPERIMENTS TO TEST THE REACTION OF SALIVA ON FOOD:**

Add 2 drops of iodine solution to the 4 zip-lock bags described in the chart below. Observe and discuss the results: (save 1 bag of cracker + saliva to test with Benedict's solution)

EXPERIMENTS – Add 2 drops of iodine to	RESULTS SHOULD BE:
1 bag with saliva + 1 tsp. of water	Remains brown, no starch
1 bag with 1 tsp. water only (Control experiment – no saliva)	Remains brown, no starch
1 bag with cracker crumbs + 1 tsp. water	Turns black, has starch
1 bag with cracker crumbs, saliva water	Wait 15 minutes to let the reaction occur. Becomes brown once the starch is changed to sugar by the saliva.

**DEMONSTRATE:**

**DID SALIVA CHANGE STARCH TO SUGAR IN THE CRACKER?**

1. Place Benedict's solution in 4 bags. (see chart below)  
Have students write down what they observe.  
Place all 3 bags in the Pyrex cup with hot water.  
Wait 3 minutes.



EXPERIMENTS	RESULTS SHOULD BE:
1 bag with saliva + 1 tsp water	Blue (control experiment)
1 bag with 1 tsp. water only	Blue (control experiment)
1 bag with cracker crumbs + 1 tsp. water	Blue, no sugar
1 bag with cracker crumbs, saliva, and water	Green, yellow, or red because saliva changed starch to sugar

**2. WHAT DOES SALIVA DO TO STARCH?**

Saliva produces a chemical change in starch, changing it to smaller sugar molecules that can be absorbed through cell walls during digestion. Starch molecules are too large to diffuse through the cell wall.

**3. STARCH MOLECULES BECOME SUGAR MOLECULES**

Make a transparency of the chart on the next page to show the molecules. Starch is a polymer, which is a long chain of hundreds of molecules, connected together. Starch is too big to pass through the cell wall.

**EXPLORE:**

**CAN STARCH MOLECULES PASS THROUGH PLASTIC?**

**CAN IODINE MOLECULES PASS THROUGH PLASTIC?**

- Place a crushed cracker and 2 teaspoons of water in a plastic bag. Put a small piece of white paper in the bag. (paper contains starch) Put 50 ml of water and 20 drops of iodine solution in a cup. Place the closed 'cracker' bag in the cup of iodine/water.

- Predict what will happen.

Can the iodine get through the bag to the cracker and paper?

Can the starch get through the bag and into the cup?

What would you observe in each case? (iodine turns black)

- Observe in 15 to 30 minutes and 1 hour later or the next day.

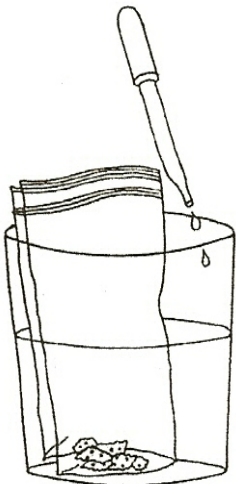
What color is the water in the cup? (brown)

What color is the water in the bag? (black) Why?

Starch molecules are too large to pass through the plastic bag. (Thus the iodine solution does not turn black.)

Iodine molecules are smaller, passing into the bag, as indicated by a color change (black) in the bag. (cracker and paper have starch)

This is proof that starch molecules are larger than iodine molecules, and that the larger starch molecules can't move through this 'membrane.'

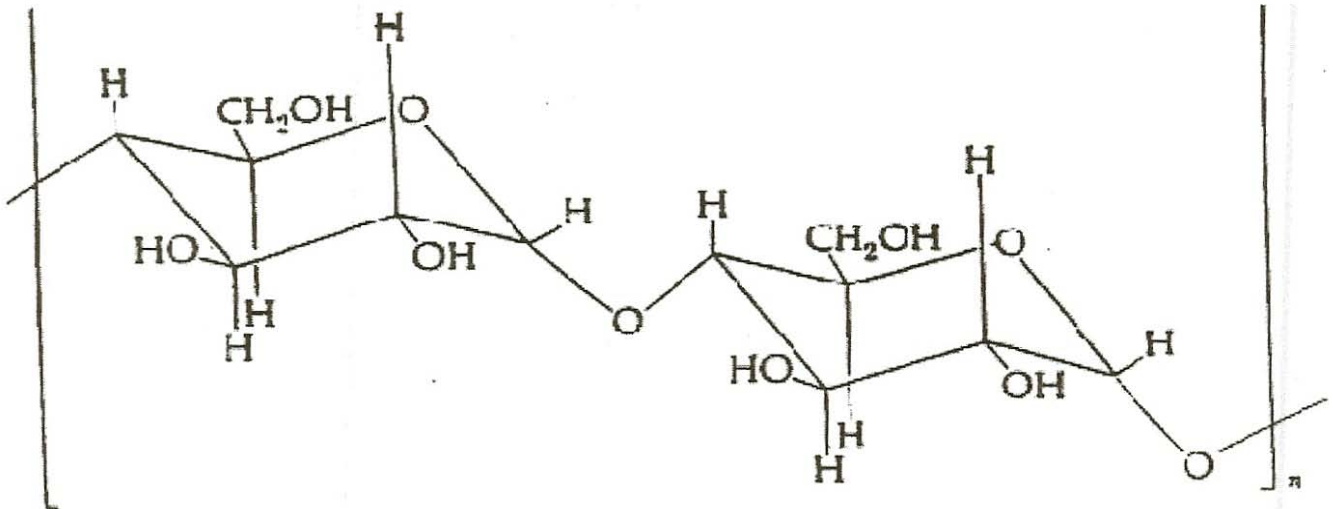


## How is starch converted to sugar?

### STARCH



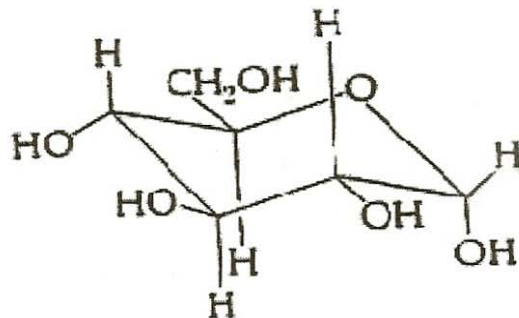
Starch is a polymer made up of hundreds of sugar molecules, bonded together in a chain. One water molecule is lost between each molecule when sugar converts to starch. (Only 2 molecules from the long chain are shown below.) The lower  $n$ ,  $[C_6H_{10}O_5]_n$ , indicates that hundreds of this molecule are connected in a very long chain.



### SIMPLE SUGAR MOLECULE (Glucose)



An enzyme in saliva breaks the polymer bonds in starch, resulting in smaller molecules of simple sugar that can go through the cell walls.



## MATERIALS

*For the Class*

1 stethoscope  
water

## DEMONSTRATE:

### THE ESOPHAGUS CONTRACTS, PUSHING FOOD TO THE STOMACH.

1. **DOES THE ESOPHAGUS PUSH FOOD? CAN YOU SWALLOW UPSIDE-DOWN?** Have several students take a sip of water, touch their toes, and swallow the water.  
How does water get down your throat if you are upside-down?  
Have all students test their esophagus ‘upside-down’ at recess.  
Feel the peristaltic force pushing water down the throat.
2. **CAN YOU HEAR THE PERISTALTIC MOVEMENT IN THE THROAT?** Hold a stethoscope to your throat as you swallow and hear the liquid pushed down the throat.

## MATERIALS

*For the Class*

2 chicken livers  
2 zip-lock sandwich bags  
meat tenderizer powder  
tripe (cows stomach) from grocery store  
use of a refrigerator

## DEMONSTRATE:

### HOW DOES THE STOMACH HELP DIGEST FOOD?

- Pass tripe (cow’s stomach) to each group.
- Feel the hard ridges for grinding food into smaller pieces.
- Cut it in sections for each child to observe and feel. (Tripe can be left wrapped in the package, passed to several rooms, and kept in a freezer for next year. Pick tripe that shows the ridges on the stomach for grinding.)
- The stomach grinds food into small pieces.
- Gastric juices mix with food in the stomach to help change it to a liquid.
- Menudo, served in Hispanic restaurants, is prepared with tripe.

## DEMONSTRATE:

### HOW DO ENZYMES IN THE STOMACH AID DIGESTION?

1. Place 1 liver in each zip bag.  
Label 1 ‘no enzyme’ and use as a control for the experiment.

Place meat tenderizer (enzyme) in the other bag and label it 'enzyme'.  
Close both zip locks.

2. Predict what will happen.  
Keep the bags in the refrigerator and check them in several days.  
Compare the liver with enzyme to the control with no enzyme.  
(Liver will be turned into a liquid by the meat tenderizer.)  
Throw out the bags after results are evident.
3. **WHAT ENZYMES ARE IN THE STOMACH?**  
The enzymes pepsin and trypsin break down protein to a liquid in the stomach.  
Papain is an enzyme from papaya in meat tenderizer.  
If you eat too much papaya, this enzyme breaks down some of your stomach lining, resulting in stomach distress.

**MATERIALS:**

*For the Class*

- |                     |                                      |
|---------------------|--------------------------------------|
| 18 paper towels     | 1 knife                              |
| 20 cups             | 1 celery stalk                       |
| 1 stethoscope       | ½ cup sand                           |
| 1 jar               | 23' dialysis tubing (from Section 7) |
| green food coloring |                                      |

**DEMONSTRATE:**

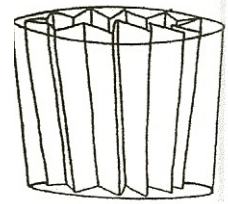
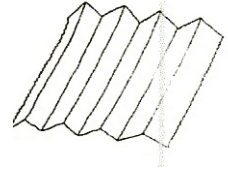
**SMALL INTESTINE: LIQUID FOOD IS ABSORBED INTO BLOOD THROUGH THE VILLI**

1. **HOW LONG IS THE SMALL INTESTINE?**  
The small intestine is 23' long and 1" in diameter.  
Measure and cut a 23' piece of dialysis tubing from the package in Section 7. (After this lesson, roll this tubing neatly, put in a zip-lock bag labeled 23 foot small intestine model, and store.
2. Have 2 students stand apart, holding tubing to show how long the small intestine is. (Or use a 25' garden hose) The intestine is pressed flat, like dialysis tubing, except where food is moving through it. Fold the dialysis tubing to show how little space it takes up when empty and flat like the intestine. Twenty three feet of intestines fits into your body.
3. **HOW DOES FOOD MOVE THROUGH THE INTESTINE?**  
Hold a stethoscope below your waist to the right of your navel to hear the food move through the intestine.

Food is pushed through the intestine with rhythmic contractions called peristalsis. The outside of the intestine is muscle. When your stomach growls, you are hearing this peristaltic movement.

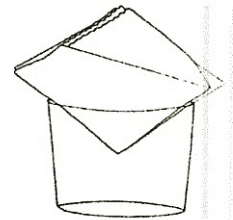
**4. WHAT ARE VILLI? HOW DO THEY HELP ABSORB LIQUID FOOD INTO BLOOD?**

- Give each student a paper towel to fold accordion style.
- Note that the same amount of paper now is only 1” thick but still has the same amount of surface area as it did flat.
- How many folded accordion sheets fit on top of 1 flat towel?
- Villi are folds in the intestine to increase area for absorbing liquid food into the blood vessels.
- Line 1 cup with 1 flat paper towel and a second cup with many accordion-folded towels. Put ¼ cups of water in each cup.
- Observe absorption speed and how much water is absorbed in each cup.
- Villi provide more surface area for absorption of liquefied food.



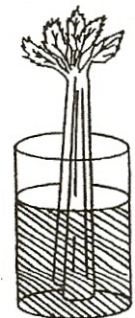
**5. WHAT CAN BE ABSORBED THROUGH THE VILLI WALL INTO THE BLOOD?**

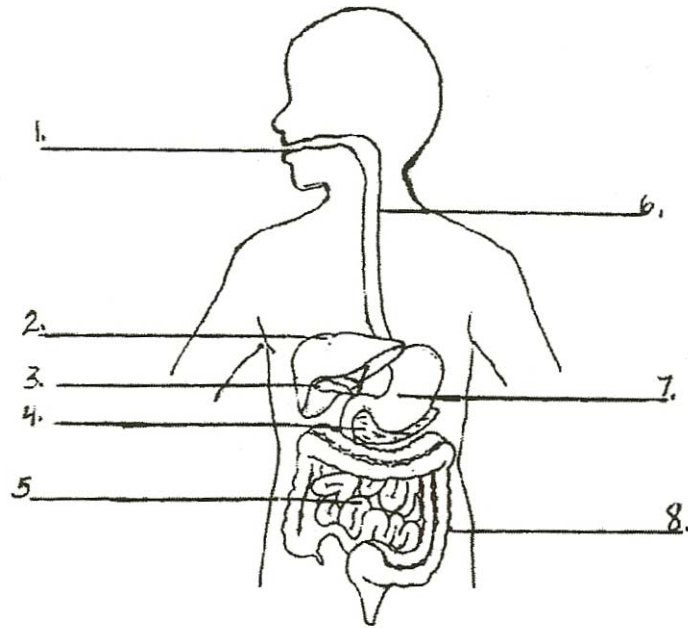
Pass out 1 cup and 1 towel to each pair of students. Fold towel in fourths and open 1 side to make a filter pocket. Place this paper pocket over the cup. Mix sand and water in a jar to represent food particles and water in the intestine. The teacher pours sandy water into each paper pocket. Observe. Only liquid drips through the paper, leaving solid ‘food’ on the paper, or inside the intestine. Food that is not turned to liquid is not absorbed by the villi and cannot be used by the body. These remaining solids leave the body as solid waste.



**6. HOW DOES LIQUID FOOD GET TO THE CELLS?**

- Place 1 celery stalk in a jar of colored water. Observe the next day.
- How did coloring get to leaves? Cut slices of celery and pass out to students to observe the tubes that carry the water to the leaves.
- In the body, blood vessels in the intestine absorb liquid food from the villi and carry it to every cell.





**DISCUSS:**

**LARGE INTESTINE:** Any food not absorbed by the villi travels through the large intestine where all remaining liquid is absorbed into the body. Unabsorbed solids in the large intestine continue to the colon where they are eliminated from the body as waste