

Kim Barrett

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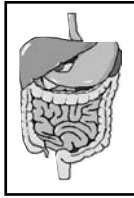
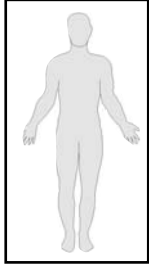
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**Kim Barrett
Physiologist
1958-**

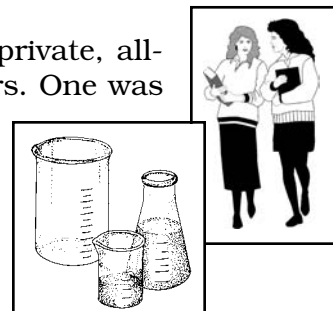


*Unit developed by
Marsha Lakes Matyas
The American Physiological Society*

Who is Kim Barrett?

Kim Elaine Barrett was born in 1958 in London, England. For as long as she can remember, she has been fascinated with science. Her parents were somewhat surprised by her strong interest in science. They were a working class family, and not only was no one in their family a scientist, but no one had attended a university.

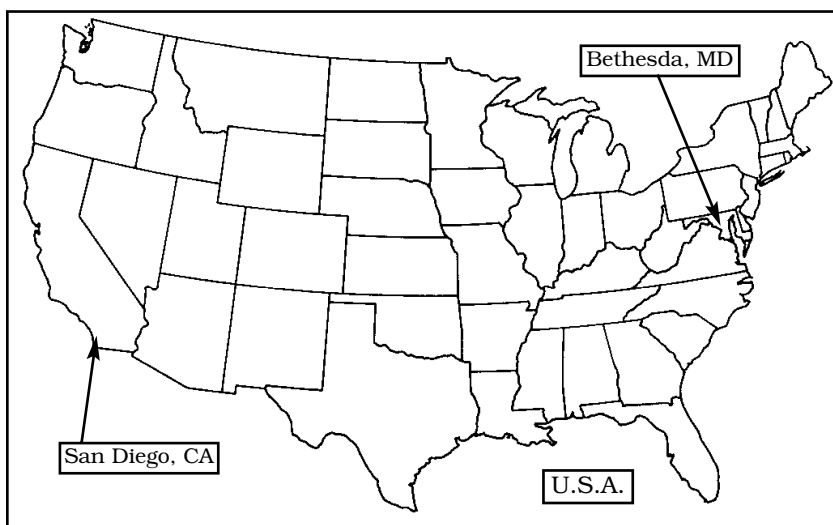
When Kim was 11 years old, she received a scholarship to attend a private, all-girls school. At the school, she had three wonderful chemistry teachers. One was the school's headmistress. These three women were very excited about science and conveyed that excitement to their students. Kim and one of her friends would often go to the science teachers' preparation room and do additional experiments over their lunch hour. Her third chemistry teacher helped Kim when the time came for her to select a university and gave her advice for her interview.



Earning her degrees

When she was in high school, Kim attended a summer program at the University of London. During a reception with students and faculty members, Kim became terribly embarrassed when she spilled a cup of tea on a professor! Several weeks later, Kim received a telephone call from another faculty member, inviting her to come for an interview at the university. She was very excited; students usually actively sought these interviews and rarely did someone personally call a student to invite him/her for an appointment. When Kim went to her interview, the faculty interviewer was none other than the man on whom she had spilled the tea! Soon after, Kim entered the University of London and that professor became her faculty advisor for both her undergraduate studies in medicinal chemistry and her graduate studies in biological chemistry. Kim received her Ph.D. in 1982 and became Dr. Kim Barrett.

After graduate school, Dr. Barrett decided to “do a post-doc,” that is, to expand her research skills before taking a regular faculty or research position. The United



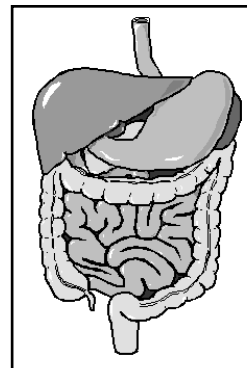
States was the logical place to look for a postdoctoral position because so much of the work in her particular research field was being done at U.S. universities. She was a postdoctoral fellow at the National Institutes of Health in Bethesda, Maryland, and then moved to California, where she is now an Associate Professor in the Department of Medicine at the University of California, San Diego School of Medicine.

Dr. Barrett's research

Dr. Barrett currently does research in two main areas. First, she examines how signals are sent inside individual cells that control their function. For example, how do cells turn on their

ability to secrete a substance and later turn it off? When a hormone binds to a receptor on the surface of a cell membrane, how is that signal passed on through the membrane and to the nucleus? How does it stimulate the production of certain proteins?

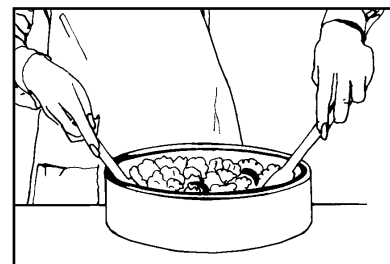
Dr. Barrett's second research interest is how epithelial tissue (such as the lining of the gut) changes when it becomes inflamed. These changes cause the symptoms and problems we see in inflammatory bowel disease, ulcers, and even asthma, since the respiratory system is lined with epithelial cells, too. These diseases affect hundreds of thousands of people each year. Recently, researchers studying ulcers found that bacterial infection plays a major role in the formation of ulcers; it is believed that these bacteria may interfere with the cell's ability to pass along signals from the cell surface to the interior of the cell (Tompkins & Falkow, 1995) (see the summary of research on peptic ulcers on Resource Sheet #3).



On a typical day, Dr. Barrett picks up coffee on her way in to work. She likes to come in early to have some quiet time to think. Her days are filled with meetings, revising manuscripts, writing papers, travel, interviews, and working with national committees. Dr. Barrett does not do her research alone. Like most biomedical researchers, she manages a team of researchers including graduate students, medical students, and post-doctoral fellows. She and her team also are part of the much larger team of scientists around the world who work in the same field of research. Each team makes discoveries which provide small pieces of knowledge. As each research team shares its findings, the pieces come together like a puzzle to create a picture of how living systems, such as human beings, work. Dr. Barrett and her research team enjoy contributing to the pool of knowledge gained through scientific research.

Dr. Barrett has many outside interests

Outside of work, Dr. Barrett enjoys dancing (especially her jazz classes), shopping, cooking, and entertaining. She loves to invite a group of friends for dinner and spend a whole day cooking for them. She also enjoys travel and, as a scientist, she gets to travel quite often to present her work at scientific meetings and to work with committees and panels of professional societies and federal agencies. This allows her to meet many scientists from around the world. In fact, Dr. Barrett says that a side benefit of being a research scientist is that "there are very few cities where I don't have a friend or two to visit on my trips."



Reflecting on career barriers

As she looks back on the path she took to her research career, Dr. Barrett admits that there were some barriers to overcome. First, although her family never created any obstacles for her studies or career, they could not provide her with role models for attending college or becoming a scientist. They also did not always understand how important or impressive her academic accomplishments were. Dr. Barrett also remembers overhearing a science department head at her university say that he would never allow a woman to be appointed to his faculty. Each time Dr. Barrett accomplished one of her career or research goals, she remembers thinking,

“See, Dr. X..., you were wrong!” On the other hand, Dr. Barrett has found that younger faculty members, including her advisor, encouraged her with her career and she feels that most departments now support the participation of women and minorities in science.

What is her advice for students?

Dr. Barrett encourages students to consider a career in science, “You can do anything with a science career. It gives you great flexibility to do many things, pursue many careers. You’re not pigeon-holed. It leaves many doors open to you. People with science degrees can often work in humanities professions, but the reverse seldom happens.” She also encourages students to be persistent, “Don’t let people tell you that you can’t do it. You have to work hard, but you shouldn’t be put off by that. Science is such an exciting thing to be involved in!”

SUGGESTIONS FOR TEACHERS

ACTIVITY #1: Just Passing Through?

Purpose

To develop and review a model of the digestive system, particularly with regard to the parts of the digestive system and their functions.

Objectives

- 1) To be able to discuss the functions of the major components of the digestive system.
- 2) To create a model for the physical processes involved in digestion.
- 3) To create a model for the physical processes involved in water reabsorption.
- 4) To discuss the relative volumes of water that are excreted and reabsorbed during the digestive process.

Materials

For the class

Obtain food samples from the major food groups such as:

- bread (wheat bread, whole wheat crackers, cooked pasta or rice)
- meat (pre-cooked, sliced luncheon meat such as turkey or ham — lower fat is better)
- fruits (banana, apple, pear, orange)
- vegetables (raw carrots or celery; canned green beans, corn)
- dairy products (hard cheese, yogurt)
- fats (butter, margarine, soft cheeses)

For each student group

- the “Data Table” on page 18
- measuring teaspoon or regular teaspoon
- table (butter) knife or dissection scalpel
- ruler (in inches and centimeters)
- 5-ml measure (graduate cylinder or pipette)
- mortar and pestle or food grinder
- wax paper, paper cup, or wide-mouth funnel
- three 50-ml beakers or cups
- three 25-cm (10 in.) pieces of dialysis tubing
- white embroidery floss (two single strands), strong thin thread, or dialysis tubing clips
- 500 ml beaker
- stirring rods, straws, or spoons

- paper towels
- 250-300 ml of concentrated PEG solution (see the “Before You Begin” section)

Before You Begin

- 1) Set food samples out in bowls or beakers. Cut fruit, vegetables, and meat into teaspoon-sized pieces.
- 2) Make polyethylene glycol (PEG) solution. PEG is available in a variety of molecular weights (see “References and Resources” for suppliers). When ordering, be sure to order PEG with a molecular weight of 15,000 to 20,000 daltons (or grams/mole). This molecular weight PEG is very water soluble, whereas larger-sized PEG is not very soluble. Make a thick, syrupy solution (at least 110 grams/1,000 ml water). The thicker the solution, the faster the experiment will run. You can even do this on dry PEG — pack it around the dialysis tubing in a beaker. If students’ dialysis bags have not leaked significantly into the PEG solution, you can collect it at the end of class, add more PEG, and use it for the next class. Store PEG solution in the refrigerator (short-term storage).
- 3) If time is a constraint, students can allow dialysis bags to incubate overnight in the PEG solution. They should cover the beakers with plastic wrap and refrigerate them overnight.
- 4) You may want to assign students to read the three Resource Sheets on pages 12-15 before the laboratory.
- 5) Suppliers of dialysis tubing are listed in “References and Resources.”

Safety Considerations

- PEG is nontoxic. However, the concentrated solution is very sticky. Students should wear eye protection and lab aprons. Lab benches should be wiped with very wet paper towels to wash off spilled PEG solution.
- Students should not eat any of the food samples.

Questions to Ask

- Where do bacteria get introduced into the gut? (Note: most, but not all, bacteria are destroyed by stomach acid).
- Why do we need an immune system in the gut?
- What are some ways that you might have experimental error in your weight measurements (bags could leak at the tied areas, not rinsing off all the PEG, etc.)

Where to Go From Here

- Try Vivian Lee Ward's activity, *A Walk Through the Gut* (see "References and Resources" section).
- Have student groups select one of the question sets in the "Think About It! — Digestion" handout on pages 21-23 and do a poster or presentation.
- Have student groups design and carry out a digestion model focusing on the chemical processing of food, for example, using amylase to model enzymes, weak acids to model stomach acid, and bases to model the bicarbonate in the small intestine.
- Try the activities in the module on Maria Mayorga. They focus on the transport of solutes across membranes, especially in the lung.

Ideas for Assessment

- Groups can submit a formal laboratory report or informal verbal class report on their findings from the activity.
- Groups or individuals can submit answers to the "Think About It! — Digestion" handout on pages 21-23 as a report.
- See #2 in the "Where to Go From Here" section above.
- Ask individual groups to explore the function of one portion of the digestive system (mouth and esophagus; stomach, small intestine; and large intestine) and prepare a report for the class. They should include information on common diseases that affect these organs and their treatments.

References and Resources

Allison, L. (1976). *Blood and Guts: A Working Guide to Your Own Insides*. Boston, MA: Little, Brown.

Barrett, K. E., & Dharmasathaphorn, K. (1991). Secretion and absorption: Small intestine and colon. In: Yamada, T. (Ed.), *Textbook of Gastroenterology*. Philadelphia, PA: J. B. Lippincott.

Parker, S. (1993). *Eyewitness Science: Human Body*. New York: Dorling Kindersley.

Vander, A. J., Sherman, J. H., & Luciano, D. S. (1994). *Human Physiology* (6th ed.). New York: McGraw-Hill.

Ward, V. L. (1995). *A walk through the gut*. Activity on the Access Excellence Home Page at <http://www/gene.com:80/ae/>.

✓ For science supplies:

Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215, (800) 334-5551.

Fisher Scientific, Educational Division, 485 South Frontage Road, Burr Ridge, IL 60521, (800) 955-1177.

Flinn Scientific, P.O. Box 219, Batavia, IL 60510, (630) 761-8518.

WARD'S, 5100 West Henrietta Road, P.O. Box 92912, Rochester, NY 14692-9012, (800) 962-2660.

✓ For PEG (polyethylene glycol, also known as carbowax):

MG Scientific, (800)343-8338. Order PEG-350, molecular weight 15,000-20,000.

Sigma Chemical Company, (800) 325-3010 or see web site at <http://www.sigma.sial.com>. Order polyethylene glycol, molecular weight 15,000-20,000.

VWR Scientific, (800) 932-5000. Order J. T. Baker flakes PEG, molecular weight 15,000-20,000.

✓ Photo credit:

Photo on page 5 courtesy of Kim Barrett, University of California Medical Center, San Diego, CA.

Resource Sheet #1
Secretions of the Major Digestive Organs

Organ	Secretions	Functions
mouth and pharynx	salt and water	moisten food
	mucus	lubrication
	amylase	polysaccharide-digesting enzyme
stomach	hydrochloric acid (HCl)	dissolve food particles and kill bacteria and other microbes
	pepsin	protein-digesting enzyme
	mucus	lubricate and protect epithelial surfaces
pancreas (secretes fluids into small intestine)	enzymes	digest carbohydrates, fats, proteins, and nucleic acids
	bicarbonate	neutralize HCl entering small intestine from stomach
liver (secretes fluids into small intestine)	bile salts (made in liver, stored in gall bladder)	dissolve fats
	bicarbonate	neutralize HCl entering small intestine from stomach
small intestine	enzymes	food digestion
	salt and water	keep digesting food soft and fluid
	mucus	lubrication
large intestine	mucus	lubrication
rectum		defecation

(Adapted from Vander, et al. (1994). *Human Physiology* (6th ed.). New York: McGraw-Hill, p. 564.)

Resource Sheet #2

Fluid Intake and Output: What Goes In Must Come Out

1. How much fluid goes into the human digestive system?

In the course of a single day, on average, a human puts the following fluids into his/her digestive tract or gut:

- 2 liters of fluid via food and drink (a little more than in a two-liter bottle of soda);
- 1.5 liters of saliva from the mouth;
- 2.5 liters of gastric (digestive) juices from the stomach;
- 0.5 liters of bile from the liver/gall bladder;
- 1.5 liters of pancreatic juice from the pancreas; and
- 1.0 liters of fluid excreted from the small intestine.

All together, then, approximately how many liters of fluid enter your digestive system each day?

2. How much fluid do you think you excrete in your stool each day?

On average, only 100 milliliters (0.1 liter)!

3. Where does all the remaining fluid go?

The water balance in the body is primarily controlled by the kidneys, not by the digestive tract. The digestive tract works to conserve water. Rather than actively “pumping” water out of the digestive tract, the body actively pumps mineral ions (such as sodium and potassium) from the gut into the epithelial cells that line the gut. Almost all of the ions (salts) in the digestive juices are pumped back into these cells. Water then moves into these cells by osmosis because of the higher concentration of ions in the cells compared to inside the gut. All but about 100 ml of water moves back through the epithelial cells and into the blood and lymph each day via this method! Imagine — your gut moves the same volume as 4.5 two-liter soda bottles!

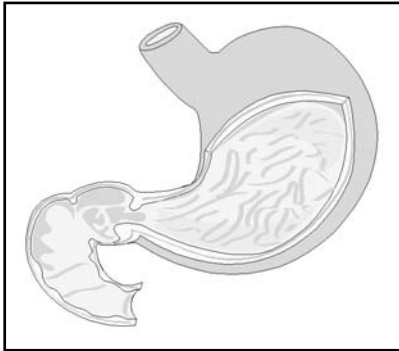
4. What happens when you get diarrhea?

If the cells lining the small intestine become damaged by an infection with a virus or bacteria or by coming in contact with a toxin (such as that produced by *Salmonella* or *Cholera*), they may not be able to absorb digested food, ions (salts), and water as they normally do. The small intestine also secretes additional water and mucus when it encounters a toxin. As a result, water that is usually reabsorbed into the body tissues remains in the gut. This additional fluid creates watery stool, that is, *diarrhea*. The results can be dramatic: a person infected with cholera can pass 10-20 liters of fluid in the stool each day — more than 200 times the normal amount! It is easy to understand why cholera victims can die quickly from *dehydration*, or loss of water.

5. What is in feces?

The amount of nutrients absorbed and used by your body is not controlled by the digestive tract. In general, the digestive tract takes as many nutrients as possible from the food that you eat. Similarly, the digestive tract is not the primary route that the body uses to get rid of waste products — the kidneys and lungs serve this purpose. What, then, is feces made up of? We know that it contains about 100 ml of water each day. The bulk of feces is undigestible material — mostly plant fibers, such as cellulose, that our bodies cannot digest. Other material that is difficult or impossible to digest (such as dirt, chewing gum, and fingernails) is also found in feces. Interestingly, about one-fourth of feces is dead bacteria. Each person has a normal population of bacteria that grow in the intestines and, when these die, the undigested ones end up in the feces.

Resource Sheet #3
Causes and Cures for Ulcers: A Research Story in Progress



Peptic ulcers are breaks in the epithelial tissue that line the stomach. These breaks are irritated and inflamed, causing the patient discomfort and pain. If untreated, they can bleed and cause death. For more than 50 years, researchers and physicians thought that peptic ulcers were caused or aggravated by the following factors: stress, spicy or greasy foods, alcohol, and smoking (“Bacteria as the cause...,” 1994). Early treatments focused on reducing stress and changing the diet to eliminate these factors. However, when physicians put patients on bland diets, it often made the problem worse. More recently, drugs designed to reduce the amount of stomach acid (for example, Tagamet and Zantac) have been widely prescribed. This treatment has also been

ineffective: “Half the people on these drugs suffer a relapse at 6 months, and about 95% at 2 years” (“Bacteria as the cause...,” 1994, p. 5). What, then, causes peptic ulcers and what is the cure?

In 1983, a corkscrew-shaped bacteria was discovered in the tissues involved in ulcers — this new bacteria was named *Helicobacter pylori* (Tompkins & Falkow, 1995). Many physicians and researchers did not think that this bacteria had anything to do with the development of ulcers, but studies over the following decade showed that this bacteria is closely associated not only with peptic ulcers but also with some forms of stomach cancer. In 1994, a National Institutes of Health panel confirmed that *H. pylori* plays an important role in peptic ulcer development (NIH, 1994).

How do people become infected with *H. pylori*? According to Tompkins and Falkow (1995), an infected person transmits the bacteria either through saliva or fecal-oral transmission. Infection can occur as early as infancy and can persist throughout the person’s lifetime. Children in developing countries are especially likely to become infected because of crowded living conditions and poor sanitation. About half of the world’s population is infected with this bacterium, but only 1 in 10 people will develop ulcers.

The discovery of *H. pylori* has dramatically changed the way that peptic ulcers are treated. Instead of long-term treatment with antacids, patients now take a 2-week course of antibiotics in combination with bismuth (the active ingredient in Pepto Bismol) (“Bacteria as the cause...,” 1994). This appears to successfully treat about 80% of patients and reduces the rate of recurrence. However, like many other bacteria, *H. pylori* can become resistant to antibiotics (Tompkins & Falkow, 1995). The long-term answer to ulcers — and even some forms of stomach cancer — may lie in the development of a vaccine.

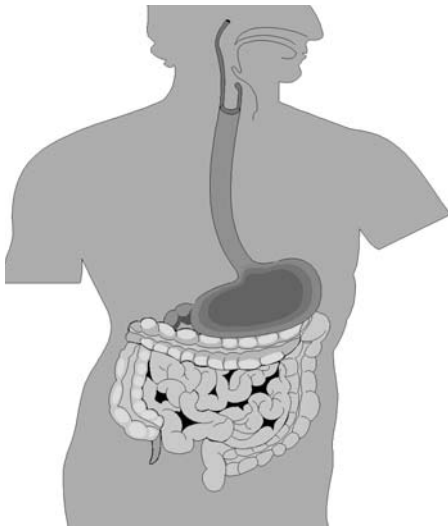
The research story of peptic ulcers, stomach cancer, and *H. pylori* is far from finished. Many research questions remain; How do the bacteria cause ulcerations to occur? How do the bacteria gain resistance to antibiotics? What is the role of this bacterium in the development of stomach cancer? Can a vaccine be developed to prevent infection by the bacterium? Will this immunity prevent ulcers and stomach cancer? Can the vaccine be given by mouth (orally)? One of the barriers to answering these questions is that few animals besides humans develop ulcers or stomach cancer in response to infection by *H. pylori*. Therefore, we have no good animal models to use in exploring the causes and cures for this disease. Recently, a research group developed a new animal model for infection by *H. pylori* in mice and,

have already made important findings about possible vaccinations for this bacterium (Marchetti, et al., 1995). Other research teams — including Dr. Kim Barrett's team — will contribute to our understanding of the specific cellular mechanisms involved.

References

- Bacteria as the cause of peptic ulcer disease — A consensus statement is available. (August 1994). *HealthFacts*, 19 (183), p. 5.
- NIH Consensus Development Conference. (1994). *Helicobacter Pylori in Peptic Ulcer Disease*. Bethesda, MD: National Institutes of Health.
- Marchetti, M., Arico, B., Burroni, D., Figura, N., Rappuoli, R., & Ghiara, P. (March 17, 1995). Development of a mouse model of helicobacter pylori infection that mimics human disease. *Science*, 267, p. 1655-1658.
- Tompkins, L. S., & Falkow, S. (March 17, 1995). The new path to preventing ulcers. *Science*, 267, p. 1621-1622.

Activity #1: Just Passing Through?



The Human Digestive Tract

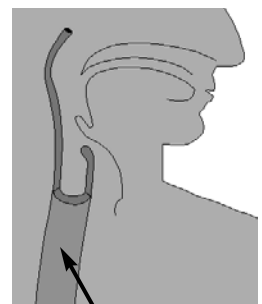
The human digestive tract from mouth to anus is about 30 feet long when totally relaxed. It is an incredible recycling plant — breaking down usable components and placing them on board the body's transport systems (the blood and lymph) and recycling water, salts, and minerals.

In this activity, you will model some of the mechanical and biochemical processes that food undergoes as it passes through your digestive system.

At the beginning...“Chew” your food

First you'll model how food is changed physically in the mouth:

- 1. Obtain food samples from three different food groups.** You can choose from meats; bread, grains, or pasta; fruits and vegetables; dairy products; and fats. You only need about 2 teaspoons of each sample. Try to choose at least one sample that will not become “mushy” when soaked in water.
- 2. Use a table knife to cut each sample piece into small bits.** Use only 15 knife cuts per sample. Record what each sample looks like on your “Data Table” on page 18. Indicate the approximate sizes of the pieces in millimeters.

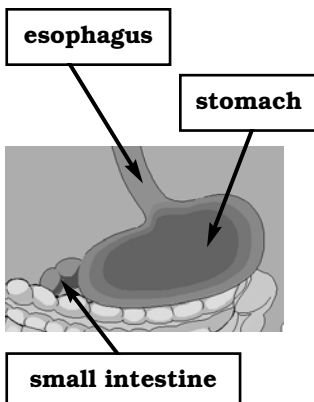


esophagus

The stomach takes over

Continue to model the “digestion” process as the food goes through the stomach:

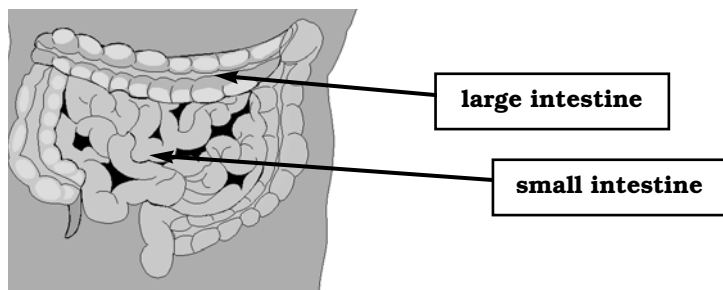
- 3. Add 5 ml water to each sample and grind to make a slurry,** using a mortar and pestle (2 minutes) or a food processor (30 seconds). Be consistent with each sample. Rinse out the mortar and pestle/food processor between samples.
- 4. Write a description for each sample on the “Data Table.”**
Can you measure the size of the pieces of food now?



esophagus

stomach

small intestine



The small intestine: Where does the water go?

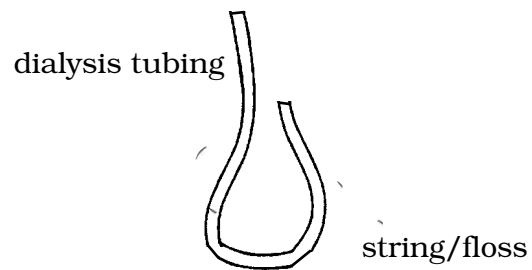
- 5. Prepare a dialysis bag for each sample** as follows (see the Instructions “Preparing Dialysis Tubing” on page 19): Cut a piece of dialysis tubing 10 inches (25 cm) long. Wet the tubing with water — do not allow the tubing to dry out! Tie a knot at one end of the tubing. Repeat for the other two samples.
- 6. Mix each food slurry thoroughly and place it into a prepared dialysis bag.** For easier transfer, make a wide mouthed funnel out of waxed paper or a paper cup. Tie it closed using two strands of embroidery floss, or tie a knot at the other end (again see the Instructions “Preparing Dialysis Tubing”).
- 7. Rinse off each dialysis bag and wrap each in a very wet paper towel** to keep it moist. Weigh a 50-ml beaker. Next, place each bag (one at a time) in the beaker and find out the weight of the bag. Record the weights on the “Data Table.” Be sure to keep the dialysis bags from drying out.
- 8. Place all three bags in a 500-ml beaker** containing 250-300 ml of a concentrated solution of polyethylene glycol. (Note: The molecular weight of polyethylene glycol is 15,000-20,000 g/mole. The molecular weight of water is 18 g/mole). Stir gently, being careful NOT to puncture the bags. Keep bags in solution for 15 minutes.
- 9. While you wait, discuss the questions** in “Think About It — Digestion” on pages 21-23 with your group! Remember to keep stirring gently — take turns.
- 10. After 15 minutes, pull bags from the solution.** Can you note any visible changes? If so, write them on the “Data Table.” Put bags back into solution and continue stirring.
- 11. After a total of 25 minutes have passed (or after bags incubate in PEG overnight), take bags out of the PEG solution.** Rinse each off with water and pat dry with paper towels. Write down your observations about the bags. Weigh each sample, using the same beaker as before. Record your data on the “Data Table” and calculate the amount of water that was lost from each dialysis bag.
- 12. During this laboratory** be sure to answer the questions noted in the Instructions “Questions to Address in Your Laboratory Report” on page 20.

Data Table

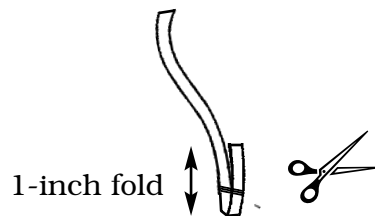
	Food Sample #1: _____	Food Sample #2: _____	Food Sample #3: _____
Describe samples after “chewing”			
Describe samples after “stomach action”			
Weight of empty 50 ml beaker			
Weight of beaker and dialysis bag — before PEG			
Weight of dialysis bag — before PEG (calculate!)			
Note any visible changes after 15 minutes in PEG			
Note any visible changes after 25 minutes (or overnight) in PEG			
Weight of beaker and dialysis bag — after PEG			
Weight of dialysis bag — after PEG (calculate!)			
Amount of water lost from dialysis bag (calculate!)			

Instructions:
Preparing Dialysis Tubing

- 1. Wrap string/floss several times around fold, pulling it tight, then tie a double knot**



- 2. Trim string/floss**



Instructions:
Questions to Address in Your Laboratory Report

In your laboratory report, be sure to address the following questions:

1. Which sample lost the most weight (water)? Why?
2. Which food groups seem to bind or hold onto water? Which do not?
3. From your own experience, what types of food seem to leave the digestive system in whole pieces? Does that agree with your findings in our model of the digestive system?
4. Why doesn't the PEG move into the dialysis bag?
5. How is the food in the dialysis bag different from digested food that reaches the large intestine?
6. Describe two ways that you could improve this model so that it more closely resembles the human digestive system.

Think About It! — Digestion

**Answer the following questions on a separate sheet of paper.
Use the information provided in the Resource Sheets
on pages 12-15 as well as other resources if necessary.**

At the beginning...“Chew” your food

The digestion of food begins with crushing and tearing by the teeth and mouth. In our model, we demonstrated this by chopping the food into small pieces.

1. In addition to this physical change, what is added to food in the mouth?
2. List at least one purpose of this additive.
3. How does the mouth change food chemically?
4. In the course of a day, how much saliva is added to food in the mouth (on average)?

The stomach takes over

In our model, we demonstrated another physical change — more grinding and crushing — and the addition of water as a lubricant. But food also undergoes important chemical treatments in the stomach.

5. In addition to those changes caused by physically mashing the food, what type of chemicals does the stomach use to aid the digestion of the food?
6. What keeps these strong chemicals from digesting the stomach itself?
7. How much gastric juice is released into the stomach in a day (on average)?
8. How long do you think that food remains in the stomach? If you don't know, make a guess based on your own experiences!

The small intestine extracts nutrients

The small intestine is the main area where the digestive system draws nutrients from food into the blood and lymph so they can reach cells throughout the body: amino acids from proteins, carbohydrates, fatty acids from fats, vitamins, and minerals. It uses a variety of enzymes and other biochemicals to accomplish this.

Think About It! — Digestion (continued)

9. What happens to the acid that is added to food in the stomach?
10. Which organs excrete enzymes into the small intestine to help digest carbohydrates, fats, proteins, and nucleic acids?
11. What special chemicals does the body use to digest fats? Where are these chemicals made and stored?
12. How much fluid (total) is added to food while it is in the small intestine (including fluid from the pancreas, liver/gallbladder, and the small intestine)?

The structure of the small intestine also allows it to absorb many nutrients. Instead of being a smooth surface, the lining of the small intestine is formed into millions of tiny “fingers” or villi. These villi increase the overall surface area of the small intestine so that more digested food comes into contact with the wall of the small intestine. Therefore, more nutrients can be absorbed as the digested food moves through the intestine.

13. Hypothesize: Why do you think the body adds a lubricant (mucus) to the food as it is digested? If you were a research scientist, what type of experiment could you design to test your hypothesis?

Where does the water go?

As we have seen, water has been added to the food at several points along the digestive tract: the fluids you drink with your food; saliva in the mouth; and digestive juices in the stomach and small intestine.

14. How is the process that you have been watching (your dialysis bag floating in the beaker filled with PEG solution) similar to the process of water reabsorption in the small intestine? How is it different?

What’s left?

15. Undigestible material, especially plant fibers, make up the bulk of feces. Name at least three foods that you ate in the last 24 hours that included some undigestible plant fibers.
16. Our food, our mouths, and our eating utensils are all contaminated with bacteria. Where do you think most bacteria that enter the digestive tract are killed?

Think About It! — Digestion (continued)

- 17.** Hypothesize: Develop a list of at least two reasons why humans need a good immune system in their digestive tracts.
- 18.** Pick at least one of the following question sets to explore with your team. Find resources and conduct an interview to gather your information.
- Why is it important to eat fruits and vegetables? Is taking a vitamin a reasonable alternative?
 - How do medications like TUMS or Pepto Bismol work? What part(s) of the digestive tract do they affect? Do they treat the same symptoms? Are there side effects if one takes these over long periods of time?
 - Where in the digestive tract might you find parasitic worms (e.g., tapeworms, hookworms)? How do they get there? Do they cause a problem for the host? How do you get rid of them?
 - What is a colostomy? Why would a patient need to have a colostomy done?
 - What is constipation in terms of the digestive system functions you learned about? How do laxatives work? Do all laxatives work the same way? Theorize: Why could some laxatives cause severe health problems when used too frequently? What health problems do bulimics who use laxatives to purge frequently have?

