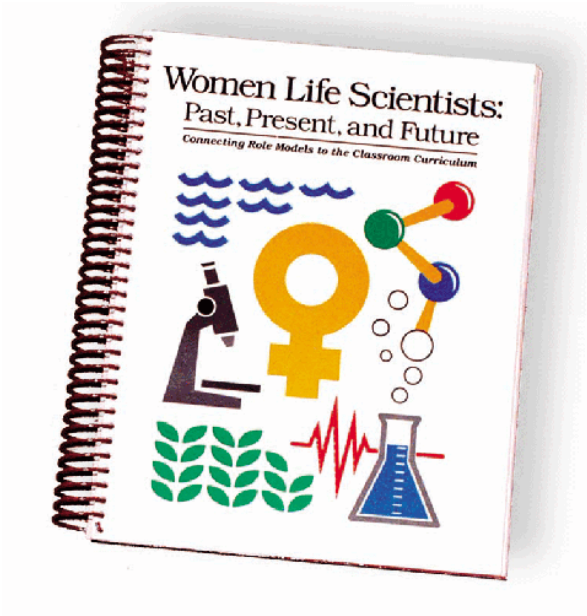

Gerty Cori

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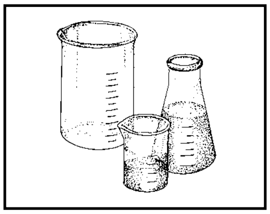
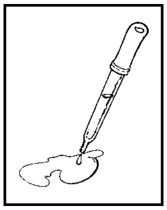
Copies of the activities from *Women Life Scientists: Past, Present, and Future* can be found at http://www.the-aps.org/education/k12curric/index.asp. To purchase bound copies, visit the APS store at http://www.the-aps.org/cgi-bin/ecom/productcatalog/Product_catalog.htm.

Visit the APS Education Online Website for more resources: http://www.the-aps.org/education/





Gerty Cori
Biochemist
1896-1957

Unit developed by
April L. Gardner
University of Northern Colorado, Greeley, Colorado

Who is Gerty Cori?

Gerty Theresa Radnitz was born in Prague, in what was then Austria, in 1896. In 1947, she and her husband became the first Americans to win the Nobel Prize in physiology and medicine for their work on carbohydrate metabolism. The laboratory exercise you will do as a part of this unit is an example of the type of work they did in their research.

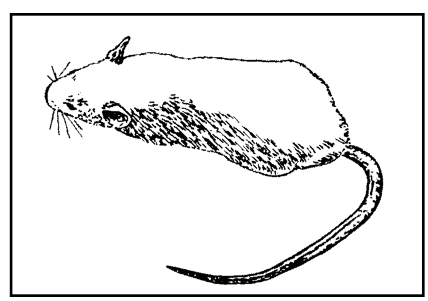
Gerty Radnitz, like most young girls in Prague at the beginning of the 20th century, received private tutoring until the age of 10. She then attended a girls' school where she received the social and cultural training which was believed at the time to be most important for young women. Although she accepted and enjoyed this part of her education, by the time she graduated at the age of 16 she had decided to study medicine. Gerty was dismayed to discover that she would need eight years of Latin, five more years of mathematics, and chemistry and physics before she could even apply to medical school! But Gerty was determined to be a doctor and, encouraged by an uncle who was a professor of pediatrics, she decided to complete the prerequisites at a *gymnasium*, a type of preparatory school attended primarily by boys. During her summer vacation before gymnasium she was tutored in Latin and completed enough to reduce that requirement to five years. Her intellectual skills and self-discipline enabled her to complete the remaining requirements for medical school in just one year.

Gerty enrolled in the medical school at the University of Prague at the age of 18. She was a beautiful young woman with reddish-brown curls. She soon met another young medical student, Carl Cori, who was attracted by her intelligence as well as her beauty. They teamed up to do laboratory research in biochemistry, then discovered they were a good team outside of the laboratory as well, enjoying mountain climbing, swimming, and tennis. They were married soon after their graduation from medical school in 1920.

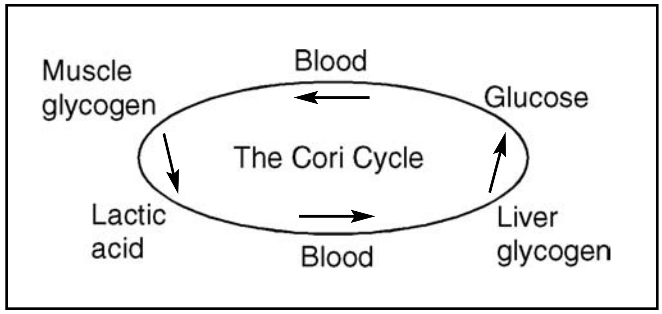
New opportunities in the United States

By that time, World War I was over and the Cori's Austrian homeland was changed forever. Prague was now the capital of a new country, Czechoslovakia. The young couple continued their research in Vienna, Austria, for a time, but soon decided that the United States offered the most promise for their work. Gerty later credited the education she received in Prague and the opportunities available to her in the United States for her success in her scientific endeavors.

The “Cori Cycle”



In 1922, Carl and Gerty found positions in biochemistry in Buffalo, New York, and they resumed their collaborative research. They chose to study carbohydrate metabolism, since the then recent discovery of insulin offered a new tool for investigating the chemical processes of the human body. The Coris examined the way white rats used sugar by feeding them known amounts of glucose and administering insulin to some of the rats. Then they studied various tissues from the rats to determine what happened to the sugar. They discovered that about half of the sugar was converted to *glycogen* (a storage form of carbohydrates in animals)



and stored in the liver and muscles; some was converted to fat; and the rest was used to produce energy by breaking it into carbon dioxide and water. Gerty and Carl also discovered that insulin decreased the amount of sugar stored in the liver as glycogen but increased the amount of sugar used by the muscles. Their work revealed a cycle in which glycogen in the muscles is degraded to produce lactic acid. This lactic acid is carried by the blood to the liver where it is changed back into glycogen. When needed, the glycogen is broken down into glucose and the blood carries the glucose to the muscles. Here, the glucose is once again changed into glycogen to complete the cycle. This cycle is now known as the *Cori Cycle* in honor of its discoverers.

Gerty and Carl Cori became naturalized citizens of the United States in 1928. In 1931, they moved to St. Louis, Missouri, to continue their work at Washington University. It was there that their son, Tommy, was born in 1936. Carl Cori devoted his nonresearch time to teaching and administrative duties, while Gerty Cori spent her nonresearch hours in homemaking and cultural pursuits. A true Austrian, she loved music and art, once saying, “I believe that in art and science are the glories of the human mind.” The two shared the raising of their son, which allowed both of them to continue their research work.

New scientific discoveries

Gerty and Carl continued to investigate the various transformations of glucose in the human body. They discovered two new enzymes and deciphered the molecular structure of glycogen. Gerty also described the causes of four different glycogen storage diseases. The Cori laboratory at Washington University attracted many highly respected scientists who were interested in carbohydrate metabolism. St. Louis became a hub for this type of research, producing several Nobel Prize winners in addition to the Coris.

By the 1940s, Gerty and Carl were receiving many honors, both together and individually. In 1947, the Coris shared the Nobel Prize in Physiology and Medicine with Bernardo Houssay of Argentina for their pioneering work on glucose metabolism. In the same year, Gerty became the fourth woman elected to the National Academy of Sciences. She received honorary doctorates in science from Boston University, Yale University, Smith College, the University of Rochester, and Columbia University. In 1952, President Truman appointed Gerty Cori to the board of the National Science Foundation, a position that she held until her death.

Even before winning the Nobel Prize in 1947, Gerty Cori had been diagnosed with myelosclerosis, an incurable bone marrow disease. Throughout her illness she continued her research, working in the laboratory when she was able, and reading scientific research articles, biographies, and history and art books when she had to remain at home. Her courage and grace in the face of her illness led many of her friends to suggest that she should be honored with a second cycle: a cycle of courage. She continued her work and her correspondence with friends until her death in 1957.

SUGGESTIONS FOR TEACHERS

ACTIVITY #1: Charting Your Blood Glucose Level
ACTIVITY #2: Making a Diagnosis (Versions 1 & 2)

Purpose
To read about a scientist who contributed to our understanding of how our bodies use carbohydrates, to learn about a common disease, *diabetes mellitus*, and to explore techniques for diagnosing and monitoring this disease.

Objectives
1) To graph the blood glucose levels of normal and diabetic individuals before and after eating.
2) To understand the antagonistic effects of insulin and glucagon.
3) To explain one way that diabetics test themselves for high blood glucose levels (urinalysis).
4) To perform a simple test for the presence of reducing sugars (Benedict's test).

Materials
Activity #1
- graph paper

Activity #2
Per group of two to four students
- solutions prepared according to the "Instructions and Table for Activity #2" on page 301 (each solution makes 100 ml, each team should receive a 2-ml sample)
  NOTE: Be sure you use glucose and not sucrose (table sugar) for this!
- 4 test tubes, small beakers, or specimen cups
- glucose test strips (available in drug stores as Diastix, Tes-Tape, Clinistix, etc.; be sure to get those designed for testing urine and not blood)
  AND/OR
- Benedict's solution: weigh out 17.3 g sodium citrate and 10 g sodium carbonate; dissolve in 70 ml water; dissolve 1.73 g copper sulfate in 10 ml water; slowly add this copper sulfate solution to first solution; bring to total volume of 100 ml (this is enough for approximately 10 groups of students; each group needs about 10 ml)
  NOTE: Benedict's solution can also be purchased already prepared!
- hot plate and beaker with water for boiling water bath
- 4 test tubes, 1 test tube holder and 1 test tube rack
- 5-ml pipette and pipette bulb or pump

Before You Begin
1) Gather the materials and prepare the solutions listed above.
2) Directions for two versions of *Activity #2* are provided: the first version uses glucose urinalysis test strips and the second version uses the Benedict's test for reducing sugars. You may wish students to complete either or both versions.
3) For the first version, student stations will need cups or beakers with the three "urine" samples plus a control sample (no glucose), four glucose test strips, and a color chart for interpreting the results (the test strip container includes such a color chart).
4) For the second version, student stations will need the three "urine" samples plus a control sample (no glucose). Place 2 ml of each sample in test tubes. Student teams will also need a boiling water bath, a test tube holder, 10 ml of Benedict's solution, a 5-ml pipette, and a pipette bulb or pump.
5) Discuss the Resource Sheets on pages 299-300, "Diabetes Mellitus," and "Important Points About Diabetes Mellitus," either before or during the activities.

Safety Considerations
- *Activity #2* uses synthetic urine to avoid using human body fluids in the classroom.
- Typical laboratory precautions should be taken, including the use of safety goggles.
- Be sure that the boiling water baths are set up where students are not likely to bump them.
- Students should carefully use test tube

holders to remove the hot test tubes from the boiling water baths.
- No mouth pipetting is permitted; students should use the pipette pumps or bulbs for measuring and dispensing their "urine" samples and Benedict's solution.
- Spills should be wiped up immediately, and students should wash their hands thoroughly if they spill anything on themselves. They should also wash their hands after completing the lab.

Questions to Ask
- Several questions for students to answer as they complete the activities are included in the procedure.
- What do the shapes of the curves generated from the data in *Activity #1* tell you?
- How can doctors diagnose diabetes in an individual?
- What do you predict will happen to the level of glucose in the urine samples from a normal person? A diabetic? A borderline diabetic?

Where to Go From Here
- Interview diabetics about their use of insulin or oral drugs to control their disease, their daily diet, and how they adjust their diets, activities, and insulin dosage when necessary.
- Gerty Cori investigated and explained diseases other than *diabetes mellitus* that are related to impairment of glucose metabolism. What are they and what are the causes of these diseases? Report findings to the class.
- Interview a doctor or nurse who treats diabetics. Ask them about diagnosis, treatment, the way diabetics monitor their own glucose levels, and new treatments (e.g., pancreas transplants). Report findings to the class.
- Do a research paper on the variety of physical disabilities that result from *diabetes mellitus* (e.g., vascular disease, kidney problems, blindness).
- Investigate the cloning of the human insulin gene. How has this development helped diabetics? (This is an especially good assignment after a genetics unit).
- Interview a doctor or nurse about other conditions that can be detected by urinalysis.

Ideas for Assessment
- Students' graphs and responses to questions for both activities can serve as assessment tools.
- Ask students to justify their diagnosis in *Activity #2.*

References and Resources

✓*About Gerty Cori and other women in science:*

Herzenberg, C. (1986). *Women Scientists From Antiquity to the Present: An Index.* West Cornwall, CT: Locust Hill Press.

Opfell, O. S. (1978). *The Lady Laureates: Women Who Have Won the Nobel Prize.* Metuchen, NJ: Scarecrow Press.

Rossiter, M. W. (1982). *Women Scientists in America: Struggles and Strategies to 1940.* Baltimore, MD: Johns Hopkins University Press.

Yost, E. (1959). *Women of Modern Science.* New York: Dodd, Mead.

✓*About the urinalysis lab and Benedict's test:*

Kaskel, A., Hummer, P. J., Kennedy, J. E., & Oram, R. F. (1986). *Laboratory Biology: Investigating Living Systems.* Columbus, OH: Charles E. Merrill Publishing.

Brittain, T. M., & Courts, G. (1986). *Biology Laboratory Manual.* Morristown, NJ: Silver Burdett.

(NOTE: Most secondary biology laboratory manuals have a procedure for the Benedict's test).

✓*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.

✓*Photo credit:*

Photo on page 291 courtesy of Federation of American Societies for Experimental Biology,

Bethesda, MD.

Photo on page 294 courtesy of Bernard Becker Medical Library, Washington University School of Medicine, St. Louis, MO.

Resource Sheet #1
Diabetes Mellitus

What is *diabetes mellitus*?
Diabetes is a serious, lifelong disorder that has no cure yet. Most of the food we eat is broken down by digestive juices into chemicals, including *glucose*, a simple sugar. After digestion, glucose passes into the bloodstream where it is available for body cells to use for growth and energy. For the glucose to get into the cells, *insulin*, a hormone produced by the pancreas, must be present. In most people, the pancreas automatically produces the correct amount of insulin. In people with diabetes, the pancreas produces little or no insulin or the body's cells do not respond to the insulin produced. So, the glucose builds up in the blood, overflows into the urine, and passes out of the body, and, therefore, the body loses its main source of fuel.

What medical conditions does it cause?
A leading cause of death and disability in the United States, diabetes can cause blindness, heart disease, strokes, kidney failure, amputations, nerve damage, and birth defects to babies born to women with diabetes.

How many people are affected?
Diabetes affects 16 million people in the United States, but almost half do not know they have the disease. The disease occurs most often in older adults — seven to eight million adults have been diagnosed with diabetes. However, about 100,000 children aged 19 or younger have been diagnosed as well.

How is it treated?
Daily injections of insulin are the basic therapy to control levels of blood glucose. Dosages must be constantly adjusted according to diet and mealtimes, exercise, and blood or urine glucose testing. Some people also take drugs to keep their blood glucose levels lower.

How can I get more information about it?
You can contact the following organizations:

- American Association of Diabetes Educators, 444 N. Michigan, Suite 1240, Chicago, IL 60611, (800) 832-6874
- American Diabetes Association, 1660 Duke Street, Alexandria, VA 22314, (800) 232-3472
- Juvenile Diabetes Foundation International, 432 Park Avenue South, New York, NY 10016, (800) 223-1138
- National Diabetes Information Clearinghouse, 1 Information Way, Bethesda, MD 20892, (301) 654-3327
- National Institute for Diabetes and Digestive and Kidney Diseases site on the World Wide Web, http://www.niddk.nih.gov

Resource Sheet #2
Important Points About Diabetes Mellitus

- When the glucose level in our blood rises above a certain point (e.g., after eating a carbohydrate-rich meal), pancreatic islet cells secrete the hormone *insulin*.
- Insulin reacts with receptor molecules in the cells of target tissues and stimulates them to take up glucose from the blood and transform it into the storage form *glycogen* (a polysaccharide of glucose subunits).
- When the glucose level in our blood drops below a certain point, other pancreatic islet cells secrete the hormone *glucagon*.
- Glucagon has the opposite effect of insulin: it stimulates cells to degrade glycogen into its glucose subunits and release them into the blood.
- The result of insulin and glucagon activity is that glucose levels in the blood normally remain stable at about 80 mg to 100 mg per 100 ml of blood.
- The disease *diabetes mellitus* results in higher than normal levels of glucose in the blood. Diabetics may have blood glucose levels of 300 mg to 1,200 mg per 100 ml of blood.
- Diabetes mellitus results when the pancreatic islet cells do not produce insulin and/or when the number of insulin receptors in target tissues is greatly reduced.
- As the blood glucose level rises, it reaches the renal threshold at about 200 mg per 100 ml blood. At this point, the kidneys no longer reabsorb all of the glucose and it "spills over" into the urine. This is the basis for the urine test for diabetics.

Instructions and Table for Activity #2

Instructions

You will need 10 different solutions with varying levels of glucose.
To make all 10 solutions, first make a "stock" solution of artificial urine:

- 1,000 ml tap water
- 8.5 g NaCl
- 20 drops yellow food coloring

1) Mix well until all NaCl is dissolved.
2) Pour 100-ml aliquots of this stock solution into 10 beakers or containers.
3) Label one *control* and set aside.
4) Label the other nine beakers as indicated in the table below (e.g., *normal-before*, *normal-1 hr after*, etc.).
5) To each solution add the indicated amount of glucose and mix well.
6) Pour 2-ml aliquots and label appropriately for Activity #2.
7) Each student/team should receive four samples: *before*, *1 hr after*, *2 hr after*, *control*. All four samples should be for the same "type" of person (that is, *normal*, *borderline*, or *diabetic*).

Table

Add the following amounts of glucose to 100 ml stock solution:

Time after ingesting cola	Person type			
	Normal	Borderline	Diabetic	Control
Before	80 mg	120 mg	200 mg	No glucose
1 hr after	120 mg	200 mg	400 mg	
2 hr after	80 mg	130 mg	300 mg	

ACTIVITY #1: Charting Your Blood Glucose Level

Procedure

1. Use the data from the table below to prepare a graph (see next page) depicting blood glucose levels after eating a candy bar. Draw the best smooth curves through the data points.

2. Use your graphs and your understanding of glucose metabolism to discuss and answer the following questions with your classmates:

   a. Which individual in the table is an untreated diabetic? Which one is normal? On what do your base your decision?

   b. What happens to the insulin and glucagon levels in the normal individual during the time period shown?

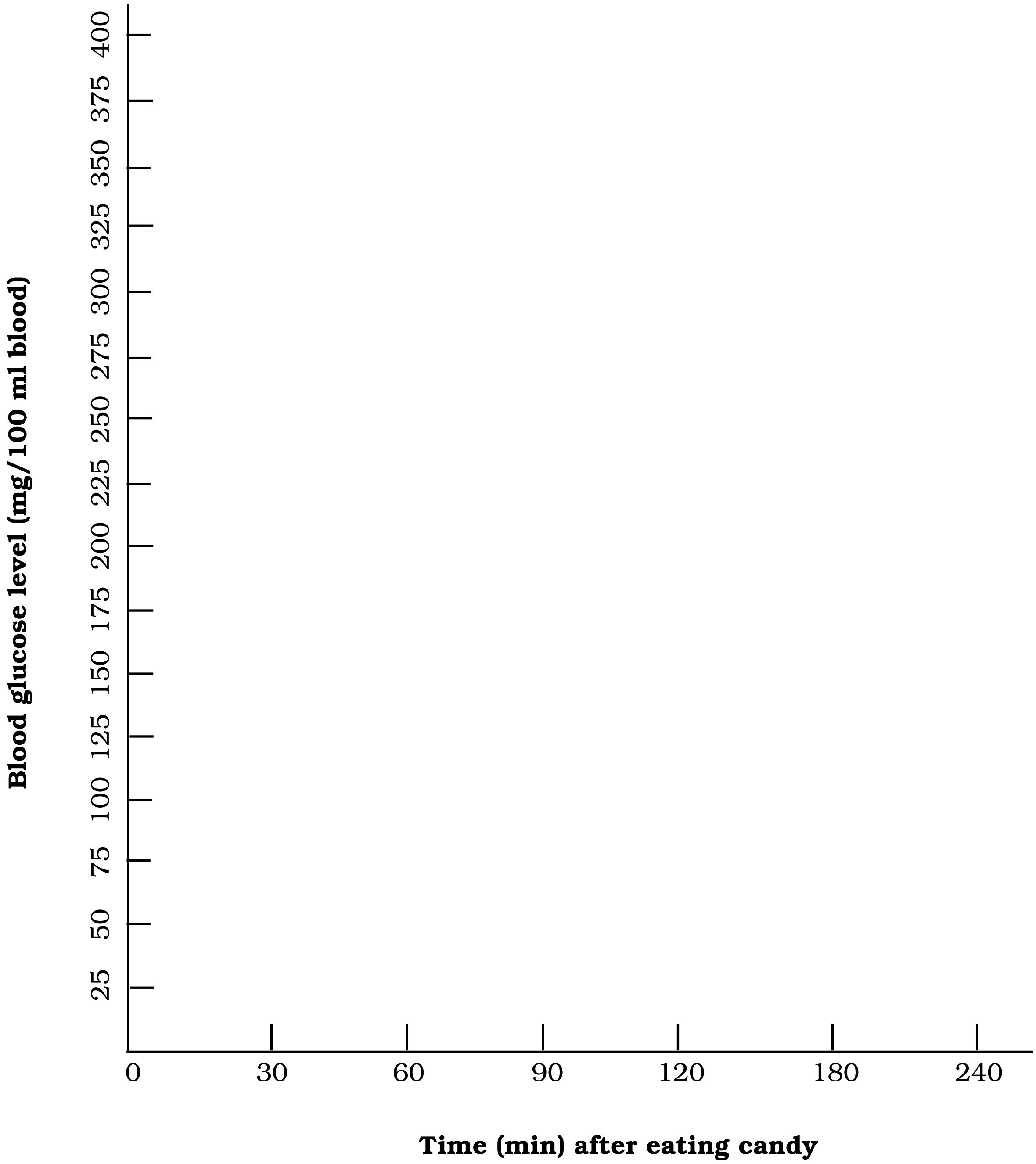
   c. Many diabetics are *insulin dependent*, which means they must give themselves injections of insulin before eating. What would happen to the blood glucose level if a diabetic gave himself/herself an injection but did not eat or accidentally injected too much insulin?

   d. The above condition is called *insulin shock* and can result in death if not corrected quickly. What would help an individual in insulin shock?

Table

Time (min) after eating candy bar	**Blood glucose levels (mg/100 ml blood)**		
	Individual A	***Individual B***	***Individual C***
0	80	260	120
30	120	300	170
60	160	340	210
90	110	370	200
120	75	380	180
180	80	350	120
240	78	300	100

Graph



Note

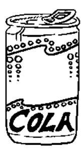
The "in-between" individual is considered a *mild diabetic.* This person has a strong tendency to become a more severe diabetic. He/she would be advised to control his/her weight (obesity reduces the number of insulin receptors), avoid sugary foods (prolonged high blood glucose levels are deleterious to many organs), and watch for the symptoms of diabetes: thirst, hunger, fatigue, and weight loss.

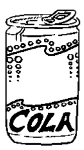
ACTIVITY #2: Making a Diagnosis (Version 1)

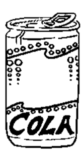
Your Mission

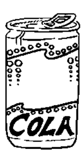
How can we determine whether or not a person has diabetes? One test physicians sometimes run is a glucose tolerance test. Glucose levels in the blood and urine are measured and then the patient drinks a very syrupy, sugary drink. Samples of blood and urine are taken several times over the next few hours. The levels of glucose are checked and charted.

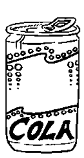
See if you can tell whether your "patient" has diabetes based on the results of the following lab tests.











Procedure

1. Each team will receive three "urine" samples from an individual. The first sample, labeled *before*, was collected just before the individual drank a regular (not diet) cola, the second sample, *1 hr after*, was collected 1 hr later, and the third sample, *2 hr after*, was collected 1 hr after that. The sample labeled *control* is a control that does not contain glucose.

2. Each team will also be given four glucose "test" strips. The strips have a reaction pad on one end that contains enzymes that react with glucose to form a colored product. **If glucose is present, the reaction pad will turn from pink to various shades of purple.** When you are ready to begin, dip one stick in the control sample, tap off the excess liquid, and compare it with the color chart on the box of test strips after exactly 10 seconds. Record your result on the table above. Repeat for each sample.

3. On the basis of your results and comparison with other teams' results, make a diagnosis of normal or diabetic for your individual. Circle your answer below. Explain your reasoning.

Normal	**Diabetic**

Sample	Normal color	Light medium color	Dark color
before			
1 hr after			
2 hr after			
control	X		

ACTIVITY #2: Making a Diagnosis (Version 2)

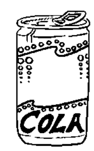
Your Mission

How can we determine whether or not a person has diabetes? One test physicians sometimes run is a glucose tolerance test. Glucose levels in the blood and urine are measured and then the patient drinks a very syrupy, sugary drink. Samples of blood and urine are taken several times over the next few hours, and the levels of glucose are checked and charted.

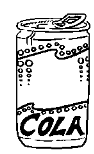
See if you can tell whether your "patient" has diabetes based on the results of the following lab tests.

Procedure

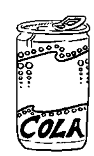
1. Each team will receive three "urine" samples from an individual. The first sample, labeled *before*, was collected just before the individual drank a regular (not diet) cola, the second sample, *1 hr after*, was collected 1 hr later, and the third sample, *2 hr after*, was collected 1 hr after that. The sample labeled *control* is a control that does not contain glucose.



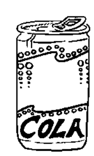
2. Benedict's solution reacts with monosaccharides (specifically with reducing sugars, that is, those containing a free aldehyde group) to form an orange- or red-colored product; therefore, it can be used to detect the presence of glucose in urine. Add 2 ml of Benedict's solution to each sample. Place the test tubes in a boiling water bath for 5 min. Record your results in the table below.



3. On the basis of your results and comparison with other teams' results, make a diagnosis of normal or diabetic for your individual. Circle your answer below. Explain your reasoning.



Normal	**Diabetic**



Sample	Normal color	Light medium color	Dark color
before			
1 hr after			
2 hr after			
control	X