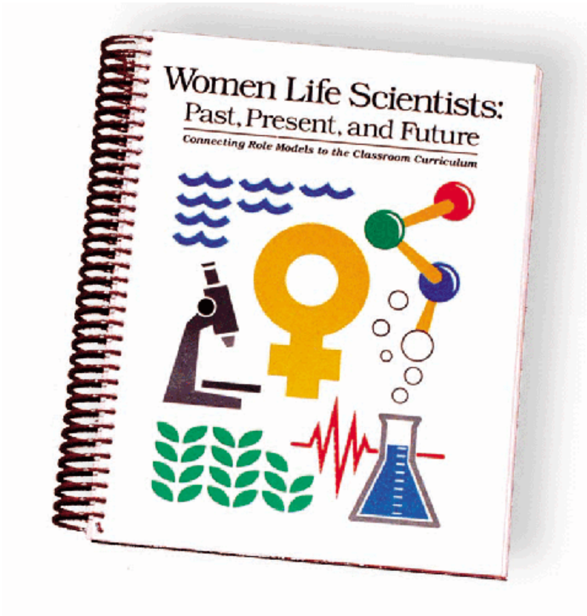

Maria Mayorga

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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.

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http://www.the-aps.org/education/

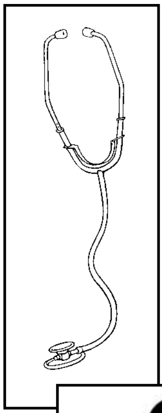
Maria Mayorga
Medical Researcher
1952-

Unit developed by
Marsha Lakes Matyas
The American Physiological Society

Who is Maria Mayorga?

Maria Mayorga was born in San Antonio, Texas, on October 30, 1952. While growing up, she attended an all-girls school in San Antonio. Maria's love for biology began through her science studies at school. She remembers that her biology teacher was very dynamic. "She didn't just teach from the textbook. She always brought in articles and tied in current events. We did laboratories to illustrate the science concepts we were learning. She made science exciting and fun, not just something in a textbook." Maria was inspired by her teacher and decided she wanted to become a physician, but she also decided that she always wanted to keep doing some type of research because she loved exploring and making discoveries.

Finishing her education despite a difficult path



At the age of 16, Maria married her high school sweetheart. By the time she finished high school, their first child was born. Nevertheless, she enrolled immediately as a freshman at St. Mary's University in San Antonio. Soon after, she went to see the undergraduate counselor about her courses, but he was far from encouraging. At the time, she had a 3-month-old infant and was pregnant with her second child. The counselor barely listened to Maria. He thought she would never finish her undergraduate degree. She was determined and said, "You watch me!" With help from her husband and family, she continued to take undergraduate courses and work several part-time jobs. Maria completed her bachelor's degree with a major in biology and a minor in chemistry in four years.

Maria wanted to go on to medical school. Unfortunately, her husband did not support her goals. Soon after, they divorced. Maria then entered medical school at the University of Texas-San Antonio; she chose the school so she could be close to her family. They were very supportive of Maria's studies and took care of her two children while she was in class. In 1978, she earned her M.D. and, over the next seven years, she completed an internship and residency in internal medicine and a fellowship in pulmonary medicine.

Joining the army

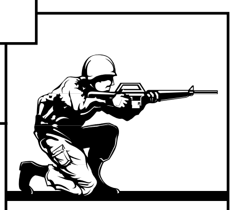
During her internship, Maria met and married another physician, Dr. Al Wehrle, who was an officer in the U.S. Army. Al, Maria, and her two children, Raquel and Emiliano, became a family. Soon after, Al was scheduled to move his new family to Germany. Maria decided to join the Army as well, since that would allow her to continue her medical practice while in Germany, something she could not do as a private citizen. Throughout her medical practice, she kept involved in medical research activities. She felt it would provide her with greater career flexibility for the future.

After returning from Germany in 1989, Maria decided to pursue her research interests further. She applied for and received a Medical Research Fellowship to work and study at the Walter Reed Army Institute of Research (WRAIR) in Washington, DC. There, she was able to learn additional research techniques that allowed her to pursue her medical research interests more intensively. She became a member of the Department of Respiratory Research at

WRAIR. One year later, she became chief of the department and was promoted to lieutenant colonel (LTC).

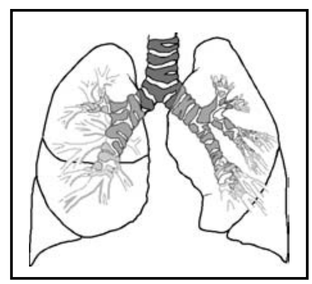
Protecting workers

The research in LTC Mayorga's department contributes to ensuring the safety of people who work in a variety of very dangerous situations. Her department is especially interested in two areas — the shock waves that accompany explosions and the effects of potentially toxic gases.



In LTC Mayorga's first area of research, her department is developing computer models to depict how shock waves affect the body's organs. Whenever a firefighter or petroleum worker is exposed to a fire or explosion, or a soldier fires a weapon, toxic gases are released and the body is subjected to pressure, including sound waves, from the explosion. Those organs that normally contain air or have open spaces, such as the heart, lungs, stomach, and intestines, are especially susceptible to damage. This research will be used to modify safety equipment for firefighters and petroleum workers, and weapons for soldiers, to minimize the impact of blast pressure on the body.

LTC Mayorga's second area of research is on the toxic gases released during explosions, including carbon dioxide and nitrogen dioxide. How much of these gases is produced? How do they affect the respiratory system? How can we minimize the production of the gas and, more importantly, its effects on nearby persons? LTC Mayorga's department is working on a computer model that will predict these effects. Since these same gases are produced during home and forest fires and during fires in petroleum wells, such as in off-shore drilling, the research is important for people in a variety of occupations.



LTC Mayorga continues to enjoy balancing her involvement in research with her medical practice. She says, "Research is always interesting. You answer one question and there is always another question waiting for someone to discover the answer. I take pleasure from knowing that what I do contributes to world health and to the world's scientific progress."

A busy home life

LTC Mayorga also places a high priority on spending plenty of time with her family. She and her husband and their three children, John Paul, 14, Elizabeth, 9, and Michael, 7, live in a wooded area in rural Maryland outside of Washington, DC. Raquel and Emiliano, now adults, are frequent visitors to their home. Organization is LTC Mayorga's key to managing her busy household. She also sets aside some time for herself. After taking her children to school, LTC Mayorga uses her half-hour drive to work to have her morning coffee and work on voice lessons and language tapes. Her favorite hobbies are gardening and taking care of the family's dogs. She also is interested in national and international politics, enjoys watching the news, and reads historical fiction and self-improvement books. Music has a special place in LTC Mayorga's life too; she sings in a choir and takes voice and piano lessons.

What is LTC Mayorga's advice for students?

LTC Mayorga encourages students to "...love and be good to yourself. Develop a positive self-image. Whatever goals you set for yourself, give yourself time to accomplish them. Don't allow others to dissuade you from your goals. Finally, be sure to develop outside friendships and cultivate them. They provide both support and perspective."

SUGGESTIONS FOR TEACHERS

ACTIVITY #1: Exploring Diffusion

Purpose

To provide students with an opportunity to apply their basic understanding of diffusion to problems involving the separation of solutes by molecular weight.

Objectives

1) To improve students' skills in experimental design.
2) To learn how to test solutions for protein, starch, and sugar unknowns.
3) To gain skills in using dialysis as a tool for purifying solutions.

Materials

For each student working individually or for each group of two to three students

- 1 envelope of gelatin (e.g., Knox)
- 5 g D-glucose (dextrose)
- 1 tablespoon cornstarch
- 15- to 18-cm piece of cellulose dialysis tubing
- several drops of Biuret reagent
- 3-4 glucose test strips (available at any pharmacy)
- Lugol's iodine or tincture of iodine
- 9 eyedroppers or disposable pipettes
- 500-ml beaker or clear plastic cup
- 3 vials for unknown solutions
- 6 small test tubes (plastic or glass)
- glass rod or straw for stirring
- string or tubing clamps (white embroidery floss works well; use 2 single 15-cm strands)
- scissors

Before You Begin

1) Purchase Biuret solution, Lugol's iodine or tincture of iodine, and glucose test strips (see "References and Resources" below).
2) Prepare protein solution. Dissolve gelatin in warm water. Use 1 teaspoon per 100 ml warm water. Stir frequently.
3) Prepare starch solution. Dissolve 1 tablespoon of cornstarch in 100 ml cold water. Stir frequently. Not all of the cornstarch will dissolve.
4) Divide protein and starch solutions into two beakers each. Add D-glucose (1 g per 100 ml solution) to one beaker of each solution.
5) Prepare unknown vials of protein solution and starch solution for each pair of students (10 ml each). Code each vial so that you can identify its contents; for example, even-numbered vials could be protein and odd-numbered vials could be starch. Be sure you can identify which vials contain sugar.
6) Cut dialysis tubing into 15- to 18-cm (6-7 in.) lengths. Wet tubing with water before use.

Safety Considerations

- Biuret solution and iodine solutions are toxic and should not come in contact with the eyes or mouth. Students should wear safety goggles and laboratory coats or aprons.
- Students should wash their hands following the experiment.
- Both of these solutions can stain clothing.

Questions to Ask

- How do you know that your solution is becoming "cleaner," that is, contains less sugar? What is your evidence for this?
- How can you tell when your solution is "clean," that is, free of sugar?
- Do molecules move through the membrane both ways? How can you tell?
- Which is larger, sugar or protein? sugar or starch? What is your evidence for this?
- How could you speed up the dialysis process (e.g., stirring, using fresh dialysis solution to keep the concentration gradient high)?
- In this activity, we used molecular weight to separate different substances. What other characteristics of a substance might you use to separate them (e.g., solubility, positive or negative charge, etc.)?

Where to Go From Here

- Do *Activity #2*, "Diagnosing the Damaged Lung."
- Interview a biomedical researcher to learn how dialysis is used in research. This is a

very common research technique, used to reduce the amount of salt, sugar, or water in a mixture of substances.
- Conduct a study of red blood cell permeability and hemolysis, such as the one developed by Cusker (1991).
- Try the activity, *Membrane Permeability with Beets* by P. Vavala (see “References and Resources” section).

Ideas for Assessment
- Students’ initial experimental design and laboratory reports can serve as one assessment tool.
- Teams of students also can provide verbal reports as they are working on their conclusions or prepare research posters showing their results.

References and Resources
Cusker, J. (1991). Hemolysis of red blood cells: A study of cell permeability. In: D.S. Sheldon, & J. E. Penick (Eds.). *Favorite Labs from Outstanding Biology Teachers*. Reston, VA: National Association of Biology Teachers.

Daniel, A. B. (1994). I’m passing through! In: Y. S. George, A. B. Daniel, V. L. Worthington, & S. M. Malcom (Eds.). *The AAAS Black Church Health Connection Project: Hands-on Life Sciences Activities*. Washington, DC: American Association for the Advancement of Science.

Membrane Transport Kit. (1993). Chippewa Falls, WI: Hubbard Scientific, Inc.

Vavala, P. (1995). Membrane permeability with beets. 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.

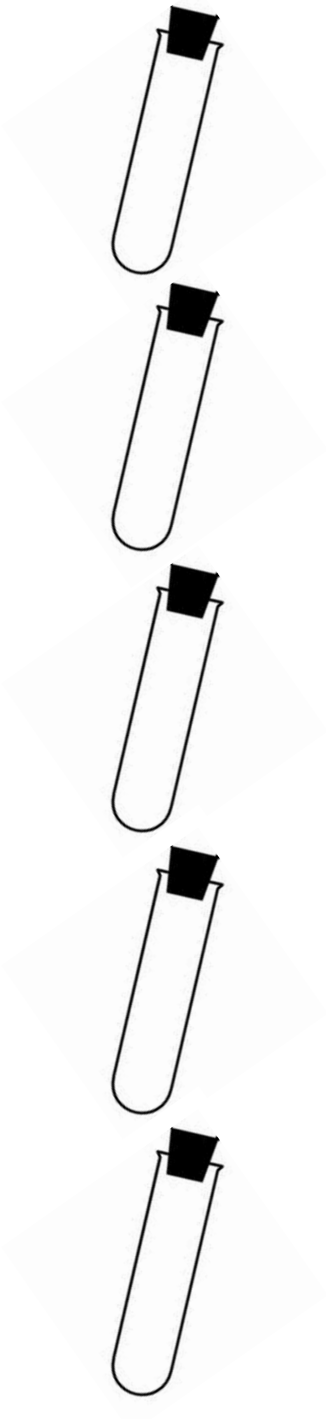
Flinn Scientific, P.O. Box 219, Batavia, IL 60510, (630) 761-8518.

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

✓*Photo credit:*

Photos on pages 51 and 54 courtesy of Maria Mayorga, Walter Reed Army Institute of Research, Washington, DC.

ACTIVITY #1: Exploring Diffusion



The Problem

You ordered two vials of fluid from a chemical company to use in a future experiment. One vial contains a **protein** solution (protein and water) and the other contains a **starch** solution (cornstarch and water).

The salesperson who sent you the fluids told you over the telephone which code number referred to the **protein** solution and which referred to the **starch** solution. She also told you that one of the solutions was contaminated by a **sugar** (D-glucose).

For the experiment you want to do later, you need these solutions “cleaned up” — with most of the **sugar** removed. Although you knew you should have entered this information into your laboratory notebook, instead you wrote it down on a scrap of paper…and lost it!

Now you don’t know which code number refers to **protein** and which refers to **starch** or which solution was contaminated with **sugar**!

Your Missions

1. Use the chart and procedures on the following page to determine which solution contains **protein**, which contains **starch**, and which contains **sugar**.

2. Use what you know about diffusion and osmosis to show how you can reduce the amount of **sugar** in the contaminated sample without losing the **protein** or **starch**.

Mission #1: Identifying Unknown Solution

Testing Procedures for Unknown Solutions
(Be sure to use separate eyedroppers for each substance!)

Substance	To test Control (known) Solution	What do you see in the Control tube?	To test Unknown Solution	What do you see in the Unknown tube?		What can you conclude about what the Unknown contains?	
				Tube # ____	Tube # ____	Tube # ____	Tube # ____
Protein	Place 3 drops of protein solution into a small test tube. Add 3 drops of Biuret reagent.		Place 3 drops of unknown solution into a small test tube. Add 3 drops of Biuret reagent.				
Starch	Place 3 drops of starch solution into a small test tube. Add 1 drop of iodine reagent.		Place 3 drops of unknown solution into a small test tube. Add 1 drop of iodine reagent.				
Glucose	Cut 0.5 in. piece of glucose test paper. Place 1 drop of glucose solution on paper.		Cut 0.5 in. piece of glucose test paper. Place 1 drop of unknown solution on paper.				

What did you conclude was in each of your samples?

Tube #_____ :

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Tube #_____ :

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NOTE:
Before you continue to "Mission #2," confirm your findings with your instructor!

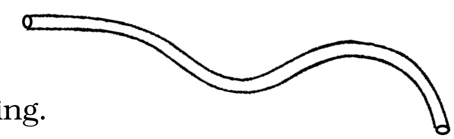
Mission #2: Reducing Contamination

Now that you know which solution is contaminated, how will you "clean it up," that is, remove some of the sugar? Fortunately, you have some dialysis tubing handy. Dialysis tubing is a clear tubing, made of cellulose (from plants). The tubing has tiny holes in it, just large enough to let smaller molecules pass through, but holding most larger molecules inside. How can you make use of this characteristic to help reduce the amount of sugar in your sample? (See the Instructions, "Using Dialysis Tubing," below.

Devise a "Plan for Completing Mission #2" on page 62. Use what you know about diffusion and osmosis to complete this mission. Show how you can reduce the amount of sugar in the contaminated sample without losing the protein or starch.

INSTRUCTIONS:
Using Dialysis Tubing

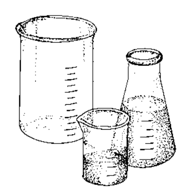
1. Cut a piece of tubing about 15-18 cm (6-7 in.) long.



2. Wet the tubing with water.

3. Fold up one end of the tubing and tie it tightly with string.

4. Partly fill the tube with whatever solution you choose.



5. Tie off the top end of the tube by tying a piece of string tightly around it.

6. Rinse off the tube under running water.

7. Place the tube into a 500-ml beaker half filled with whatever fluid you choose (for example, water or protein solution). Be sure the tube is covered with the solution.

8. Gently stir the solution around the dialysis bag every minute or so, being careful to not poke a hole in the bag.

9. Take samples every 10-15 minutes to check for the presence of sugar, protein, etc. From which solution do you want to take samples...inside the bag or outside?

Plan for Completing Mission #2

NOTE:
Show your plan to your instructor before you execute it!

Experimental Design

Problem: ______________________________

Hypothesis: ______________________________

Materials: ______________________________

Methods: ______________________________

Results (What evidence do you have that you are succeeding in removing the sugar?):

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Conclusions

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For future experiments, how could you speed up this process?

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SUGGESTIONS FOR TEACHERS

ACTIVITY #2: Diagnosing the Damaged Lung

Purpose

To strengthen students' skills in developing hypotheses, designing experiments, and analyzing results.

Objectives

1) To design and conduct an experiment that will distinguish between damaged and normal "lung tissue."
2) To use dialysis tubing as a model and to employ principles of diffusion.

Materials

For each group of two to three students

- 2 pieces of dialysis tubing, one "damaged" (see below) and the other undamaged
- 10 ml protein solution (see below)
- several drops of Biuret solution (protein detector)
- 10 ml starch solution (see below)
- several drops of Lugol's iodine or tincture of iodine (starch detector)
- 500-ml beakers or small cups
- string or tubing clamps (white embroidery floss works well; use 2 single 15-cm strands)
- scissors
- several eyedroppers
- 4-8 small test tubes or small cups (such as souffle cups)
- 2-3 glass rods or straws for stirring

Before You Begin

1) Cut dialysis tubing into 15- to 18-cm (6-7 in.) pieces. Soak tubing in water before use. Divide the pieces into two groups, damaged and normal. For the damaged pieces, use the tip of a sharp needle to poke small holes through each piece of tubing; be sure to make holes all the way through each piece but don't make the holes large and conspicuous.
2) Prepare the protein solution by dissolving gelatin (such as Knox) in warm water. Use approximately 1 teaspoon per 100 ml warm water. Stir frequently.
3) Prepare the starch solution by dissolving 1 tablespoon of cornstarch in 100 ml cold water. Stir frequently. Not all of the cornstarch will dissolve.
4) Purchase Biuret solution and Lugol's iodine or tincture of iodine (see the section, "References and Resources," below). Use in a well-ventilated area.

Safety Considerations

- Biuret solution and iodine solutions are toxic and should not come in contact with the eyes or mouth. Students should wear safety goggles and laboratory coats or aprons.
- Students should wash their hands following the experiment.
- Both of these solutions can stain clothing.

Questions to Ask

- Does protein leak through the damaged lung tissue? through the normal tissue? What is your evidence for this?
- Do complex carbohydrates such as starch leak through the damaged and normal lung tissues? What is your evidence for this?
- What is your "control" in this experiment?
- What conclusions can you draw from your findings?
- Now that you have done your experiment, can you think of ways to improve your experimental design?
- What other experiments would you want to do to explore this further?
- What types of things come into your lungs that normal tissue would prevent from getting into your system (e.g., bacteria, viruses, certain gases, etc.)?

Where to Go From Here

- Teams of students could explore and develop a poster or presentation on different respiratory diseases: What causes them? How do they affect the respiratory system at the tissue or cellular level? What are the symptoms? How can they be prevented? How can they be treated? Who is most at risk for developing this disease? Good possibilities include emphysema, "walking" pneumonia, tuberculosis, cystic fibrosis, lung cancer, asthma, chronic obstructive pulmonary disease (COPD), or sarcoidosis. Your local American Lung Association and public library health section are good sources of information.

Ideas for Assessment

- Students' initial experimental design and laboratory reports can serve as one assessment tool.
- Teams of students also can provide verbal reports as they are working on their conclusions.

References and Resources

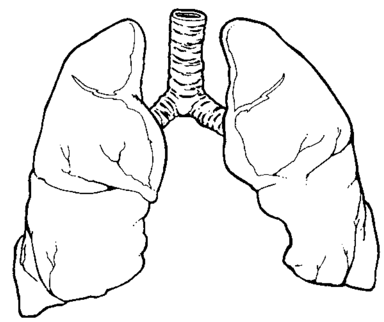
See listing at end of *Activity #1*, "Suggestions for Teachers."

ACTIVITY #2: Diagnosing the Damaged Lung

The Problem

Workers at a manufacturing plant have been accidentally exposed to small amounts of a particular gas and considerable dust over a period of several weeks. Although the gas is not known to be poisonous in small amounts, some workers have complained of coughing and irritation in their throats and chests.

You suspect that the gas has caused some damage to the lung tissue — actually creating tiny tears in the tissue. Normal lung tissue would regulate the substances coming into and out of the blood and tissue, but damaged areas would be unable to do so. Therefore, tissues would lose important materials (such as proteins, carbohydrates, and salts) and would be exposed to damaging materials (such as toxins, bacteria, and viruses).



Your Mission

You have obtained samples of lung tissue from patients who were exposed to the gas and from patients who were not exposed. Under the microscope, you think you can see damage to the tissue, but you want more proof.

Use what you have learned about diffusion to design and perform an experiment to prove or disprove that the samples from the damaged lungs are "leaking" larger molecules (such as protein or starch) that the undamaged lungs do not.

Procedure

1. Rather than use actual lung tissue, we will use dialysis tubing as a model for the cell membranes that separate the lung tissue from the air spaces in the lung. The inside of the tubing can represent the space inside the lung and the area surrounding the dialysis tubing can be the lung tissue itself — or vice versa. Be sure to indicate in your final report which space you used to represent the lung tissue and which represented the space inside the lung.

2. Brainstorm with your partner or group about possible ways to determine whether or not the damaged tubing will “leak” larger molecules such as protein and starch.

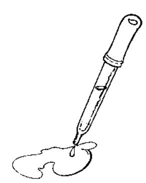
3. Design a “Plan for Completing Your Mission” on page 67. Be sure to write out your purpose and hypothesis, what your procedures will be, what materials you will need, and what your dependent and independent variable(s) are. Develop a data chart where you can write down your findings. Be sure your experimental design takes into account the “Questions to Answer” on page 67.

4. BEFORE you do the experiment, review your experimental design with your teacher.

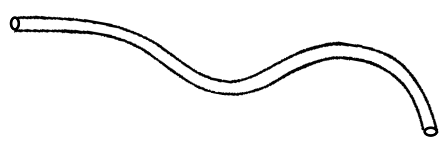
5. Perform the experiment and record your findings.

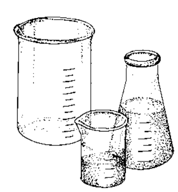
6. Prepare a report on your experimental design and your findings. Be sure to include the following: purpose, hypothesis, materials, procedures (including description of dependent and independent variables and controls), results, conclusions, and further research needed.

Materials



- dialysis tubing (keep it wet, please)
- protein solution
- Biuret solution (protein detector)
- starch solution
- Lugol’s iodine (starch detector)
- 50-ml beakers or small cups
- string (white embroidery floss) or dialysis clamps
- scissors
- eyedroppers
- small test tubes or small cups
- glass rod or straw for stirring





Plan for Completing Your Mission

NOTE:
Show your plan to your instructor before you execute it!

Questions To Answer

1. Does protein leak through the damaged lung tissue? through the normal tissue?
2. Do complex carbohydrates such as starch leak through the damaged and normal lung tissues?
3. What is your "control" in this experiment?
4. What conclusions can you draw from your findings?
5. What other experiments would you want to do to explore this further?

Experimental Design

1. Describe how you plan to do your experiment:

____

____

2. Purpose:

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3. Dependent variable(s):

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4. Independent variable(s):

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5. Draw a chart for your data: (use a separate sheet of paper)

6. What can you conclude from your experiment?

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____