

# Forever Wild?

## Activity 1: Grades 5-8

### Input/Output

**A**tmosphere, whether it is the blanket of air surrounding the Earth or the air trapped within Biosphere II, (which we saw in "[The Second Earth](#)") is a closed system.

Because the atmosphere systems are closed, the metabolic processes that occur within these systems affect their composition.

Respiration removes Oxygen as it releases Carbon Dioxide. Photosynthesis performs the reverse exchange, removing Carbon Dioxide and releasing Oxygen. It is this delicate balance of processes along with non-organic reactions that accounts for stability within the atmospheres of closed systems.



This activity page will offer:

- Experience with acid/base indicators
- Opportunity to germinate seedlings
- Chance to observe the effects of biological processes on closed systems

### MATERIALS

- Bromthymol blue\*
- Straw
- Scissors
- Safety goggles
- Cup
- Pumpkin Seeds
- Cotton
- Two shallow plastic containers with lids (from deli-section of grocery store)
- Two container caps (from plastic soda container)
- Medicine dropper

\*This indicator solution is often sold in pet stores as a testing tool for

aquarium acidity levels.

## **Part 1 - Exploring Indicators**

### **PROCEDURE**

1. Use your scissors to place a small opening in the side of a plastic straw. The hole should be placed about midway along the straw's length. Create the openings by placing two snips (opposite each other) in the straw. Make sure that you don't cut through the straw while using the scissors
2. Fill a plastic cup 1/4 full with tap water. Add several drops of bromthymol blue to dye the water deep blue.
3. Put on your safety goggles. Place one end of the straw into the cup. Slowly blow into the free end of the straw so that a steady stream of bubbles rises in the solution. Observe any changes in the appearance of the liquid.

**CAUTION:** Do not suck up the bromthymol solution. It can be harmful if swallowed.

### **Questions**

1. What happened when your exhaled breath bubbled through the solution?
2. What component of your exhaled breath caused this change?
3. How was this carbon dioxide produced?

### **CRITICAL THINKING**

Why did you place a snip in the side of the straw?

### **Shifting the Balance**

As seeds germinate, they use oxygen to breakdown molecules of sugar. This reaction (respiration) releases the energy needed for the seeds to wake from dormancy. As sugar is metabolized, Carbon Dioxide and water vapor are released. In this activity, you will observe how respiration affects the gas composition of a closed system. As seeds become metabolically active, the released Carbon Dioxide diffuses into an indicator dye solution. The dye responds with a radical change in color.

### **Part 2 - Shifting the Balance**

As seeds germinate, they use oxygen to breakdown molecules of sugar. This reaction (respiration) releases the energy needed for the seeds to wake from dormancy. As sugar is metabolized, Carbon Dioxide and water vapor are released. In this activity, you will observe how respiration affects the gas composition of a closed system. As seeds become metabolically active, the

released Carbon Dioxide diffuses into an indicator dye solution. The dye responds with a radical change in color.

## **PROCEDURE**

1. Work in groups of two. Clean and dry two shallow plastic containers and airtight lids. Label one container "Bromthymol blue" and the other "Non-Bromthymol blue."
2. Place a length of fluffed cotton along the inner margin of each container.
3. Insert about one half dozen fresh pumpkin seeds into the space between the cotton and each containers' wall.
4. In the center of each container, place a small bottle cap. Position the cap so that its well faces upwards.
5. Use a medicine dropper to fill each cap with water
6. Add several drops of bromthymol blue to the water-filled caps.
7. Use the medicine dropper to dampen the cotton in one of the containers. Keep the cotton within the other container dry.
8. Seal both containers and place them side-by-side in a location that is out of direct sunlight.
9. Each day, observe the color of the indicator solution. Also compare the appearance of the seeds.
10. As the seeds germinate, observe and record any changes in the indicator's appearance.

## **Questions**

1. What was the role of the bromthymol indicator?
2. Why was water added to the cotton?
3. Why was the cotton in only one container dampened?
4. Describe any changes in appearance of the indicator solution.
5. Critical Analysis What can you infer from your observations?

## **Critical Analysis**

What are the advantages in using a bathing cap for creating this model?  
What are the disadvantages?

## **EXTENSIONS**

### **Greening of Inquiry**

Now that you are familiar with the action of bromthymol blue, it's your turn to create a strategy for inquiry that would explore the effects of photosynthesis within a closed air system. With access to the same materials and small green plants, design a controlled experiment that shows how photosynthesis affects the composition of the air trapped within a sealed container.

### **An Historic Connection**

In the eighteenth century, the English chemist, John Priestly, explored the metabolic needs of living things. In doing so, he uncovered the intimate relationship between plants and animals. When a healthy mouse was placed in a sealed chamber, the animal showed signs of distress caused by breathing "spoiled air". However, when a green plant was placed into the sealed container with the mouse, the air seemed to be purified. How can you explain these observations in terms of the products of respiration and photosynthesis?

### **Carbon Dioxide, the Atmosphere, and Song Lyrics**

It's time to write the lyrics for a song. Work with a partner. Select a familiar poem or song - or write an original one. Research the effects of increased amounts of carbon dioxide on our atmosphere. Identify the major sources of this gas. Find out what natural processes (both chemical and biological) help to buffer any quick changes in the atmosphere's composition. Communicate this information as lyrics to a song or poem. Share your creation with others in a classroom "Concert for the Earth".

### **WEB CONNECTION**

#### **Acid Base Indicators**

<http://www.carlton.paschools.pa.sk.ca/chemical/equilibrium/abindicators.htm>

A non-intimating primer on acid/base indicators.

#### **Seed Germination**

<http://koning.ecsu.ctstateu.edu/seedg/seed.html>

This site offers an introduction to germination and seed dormancy.

#### **CO<sub>2</sub> Science Magazine**

<http://www.co2science.org/>

This rich, online resource offers a weekly review of topics that addresses a variety of issues related to Carbon Dioxide and climate change.

The activities in this guide were contributed by Michael DiSpezio, a Massachusetts-based science writer and author of "Critical Thinking Puzzles" and "Awesome Experiments in Light & Sound" (Sterling Publishing Co., NY).

#### **Academic Advisors for this Guide:**

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[www.pbs.org/saf/1304](http://www.pbs.org/saf/1304)

# Forever Wild?

*Activity 1: Grades 5-8*

## **Input/Output**

### **Part 1 - Exploring Indicators**

1. What happened when your exhaled breath bubbled through the solution?  
**(The solution changed from blue to yellow).**
2. What component of your exhaled breath caused this change?  
**(Carbon dioxide)**
3. How was this carbon dioxide produced?  
**(In order to meet energy needs, cells combine oxygen with sugar and release this waste gas.)**

### **CRITICAL THINKING**

Why did you place a snip in the side of the straw?

**(It lessened that chance that if you accidentally drink the liquid if you sucked in on the straw. Liquid rising in the straw would exit through the snipped hole.)**

### **Part 2**

### **Questions**

1. What was the role of the bromthymol indicator?  
**(It was used to indicate increasing carbon dioxide levels within the chamber)**
2. Why was water added to the cotton?  
**(Water was needed to germinate the seeds.)**
3. Why was the cotton in only one container dampened?  
**(The activity was setup as a controlled experiment. The seeds only germinated in the dampened cotton container.)**
4. Describe any changes in appearance of the indicator solution.

**(In the container in which the seeds germinated, the indicator turned from blue to yellow. In the other container, it remained blue.)**

5. Critical Analysis What can you infer from your observations?  
**(Germinating seeds release sufficient amounts of carbon dioxide to produce a color change in bromthymol blue indicator solution.)**

## **EXTENSIONS**

### **Greening of Inquiry**

Now that you are familiar with the action of bromthymol blue, it's your turn to create a strategy for inquiry that would explore the effects of photosynthesis within a closed air system. With access to the same materials and small green plants, design a controlled experiment that shows how photosynthesis affects the composition of the air trapped within a sealed container.

**(Create two parallel setups, each containing a green plant and bromthymol blue that has already turned yellow. Place one setup in light. Keep the other in darkness. As photosynthesis proceeds, it should turn the solution in the lit container back to blue)**

### **An Historic Connection**

In eighteenth century, the English chemist John Priestly, explored the metabolic needs of living things. In doing so, he uncovered the intimate relationship between plants and animals. When a healthy mouse was placed in a sealed chamber, the animal showed signs of distress caused by breathing "spoiled air". However, when a green plant was placed into the sealed container, the air seemed to be purified. How can you explain these observations in terms of the products of respiration and photosynthesis?

**(By itself, the mouse consumed the chamber's limited oxygen supply to meet its respiration needs. The plant, however, used the waste carbon dioxide in photosynthesis. The product of this process was oxygen gas. Therefore, the plant maintained a renewed supply of oxygen to meet the animal's respiratory needs.)**

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## **CURRICULUM LINKS**

### **Life Science**

Photosynthesis  
Germination  
Chemical change  
Hydrosphere  
Atmosphere  
Closed systems

## **NATIONAL SCIENCE STANDARDS (Grades 5-8)**

### **Science as Inquiry- Content Standard A**

Students will conduct an investigation with controlled variables.

Students will explain cause and effect relationships based on observational data.

### **Physical Science - Content Standard B**

Students will investigate substances that react chemically to form new substances.

Students will appreciate the sun as a major source of energy for Earth.

### **Life Science - Content Standard C**

Students will explore the structure and function of organisms.

Students will understand the importance of reproduction as a necessity for survival of the species.

Students will study an organisms need for nutrients and ability to provide energy for cells.

Students will investigate the relationship between living things and the physical factors with which they interact.