A bag valve mask can be used to manually help a person breathe. Photo © Mike6271, CC-BY-SA 4.0.

Breathing Machine

The Science of Air: Activity 5

Nancy Moreno, PhD.
Barbara Tharp, MS.
Judith Dresden, MS.

Center for
Educational Outreach

Baylor College of Medicine

BioEd Online

Breathing Machine

This activity's objectives are aligned with the National Science Education Standards, specifically those related to Science as Inquiry and Physical Science. Breathing Machine uses guided inquiry to illustrate how air moves in and out of the lungs in response to volume changes in the chest cavity. Students will create a model that demonstrates the interaction among the lungs, chest and diaphragm during breathing. Students will make predictions, investigate, record observations, and draw conclusions based on their investigations. They will learn that the diaphragm and rib muscles change the size of the chest cavity and control whether air enters or exits the lungs.

Concepts

- Volume changes in the chest cavity cause air to move in and out of the lungs.
- When we breathe in, oxygen moves from the air in our lungs to our blood and carbon dioxide is released from the blood to air.

Reference

Moreno N., B. Tharp, and J. Dresden. (2011). *The Science of Air Teacher's Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-74-3. Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National Institutes of Health to Baylor College of Medicine.

Image Reference

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http://commons.wikimedia.org/wiki/File:Ambu_Bag_valve_mask.jpg

Key Words
lesson, teaching slides, lesson demonstration, physical science, air, breathing, breath, lung, lungs, diaphragm,

Materials

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Materials

Material per Student Group

- 2 balloons (9-in., round)
- Pair of scissors
- Prepared small or medium-sized clear plastic bottle (soft drink, water, or detergent bottle; not liter-sized bottles)

Setup

1.This investigation works best with groups of two to four students. Each group may build a single Breathing Machine, or every student may build his/her own. At least one day before beginning this activity, ask each student or group of students to bring a small or medium-sized clear plastic bottle from home (half-liter water or soft drink bottle, or liquid dishwashing detergent bottle). **Note:** Liter-sized soft drink bottles are too large for this activity.

2.Cut off and discard the bottom third of each bottle, leaving about six inches (15 cm) remaining. If the cut edges are sharp or jagged, cover them with clear plastic packaging tape.

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Photo by Christopher Burnett © Baylor College of Medicine.

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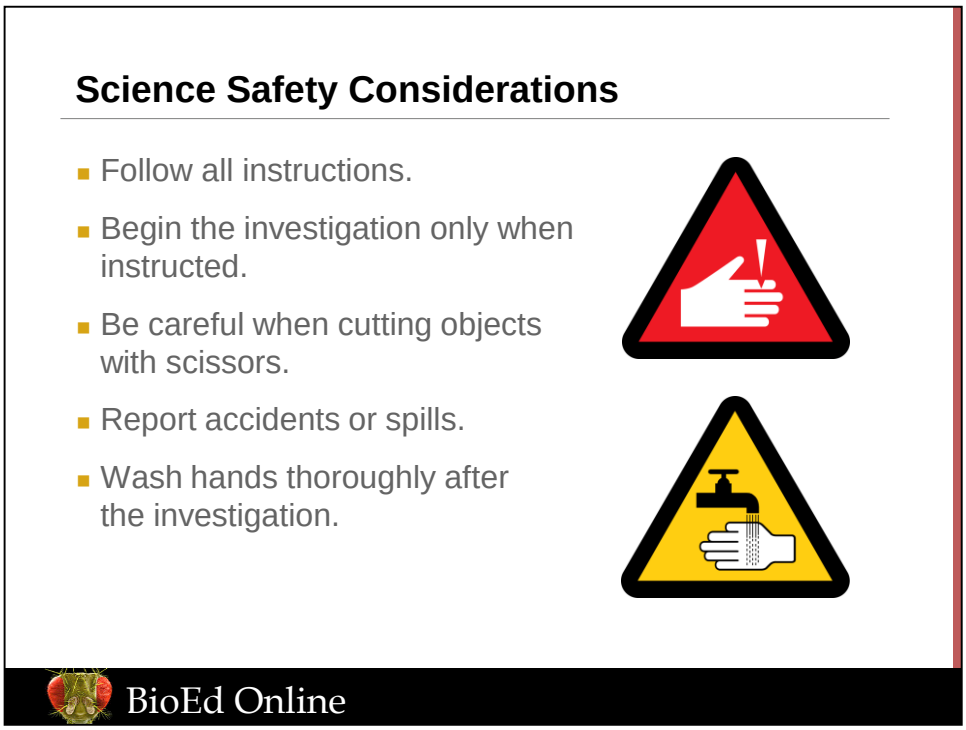

Science Safety Considerations

Safety first! Students always must think about safety when conducting science investigations. This slide may be used to review safety with your class prior to beginning the activity.

Also, keep the following points in mind.

- Always follow your district school safety guidelines.
- Have a clear understanding of the investigation in advance. Practice any investigation with which you are not familiar before conducting it with the class.
- Make sure the appropriate safety equipment, such as safety goggles, is available.
- Continually monitor the area where the investigation is being conducted.

Reference

1.Dean, R., M. Dean, and L. Motz. (2003). *Safety in the Elementary Science Classroom*. Arlington, VA: National Science Teachers Association.

2.Moreno N., B. Tharp, and J. Dresden. (2011). *The Science of Air Teacher's Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-74-3. Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National

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Breathing Machine © Baylor College of Medicine.

How Does Air Move Into and Out of Our Lungs?

Focus students' attention by asking*, Have you ever wondered how your lungs work?* Next, ask the students how many times they breathe each minute and whether they breath faster when they run. Mention that humans normally breathe about 8-10 times per minute when at rest. When we exercise, our breathing rate increases to 15–20 breaths per minute. (You may consider having students count how many times they breathe in one minute while sitting still in their chair. They can compare this result to the number of breaths they take in one minute after jumping in place for 30 seconds.)

Stimulate a discussion about the lungs' role in breathing. Ask, *Do our lungs have their own muscles?* Tell students that, surprisingly, our lungs have no muscles. The diaphragm (a thin layer of muscles at the base of the chest cavity) and rib muscles of the chest wall work for the lungs. By changing the size of the chest cavity, these muscles control whether air enters or exits the lungs.

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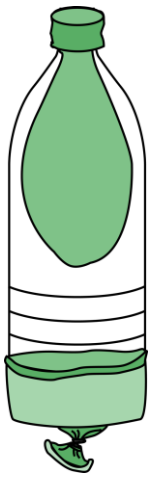
Let's Get Started

1. Slide one balloon into the top of the bottle. Roll the mouth of the balloon over and outside of the top edge of the bottle.
2. Cut off the bottom of the second balloon, tie a knot in the mouth of the balloon. Slide the open end over the bottom of the bottle as shown to the right.
3. Predict and observe what happens when:
   - The bottom balloon is pulled downward.
   - The bottle is squeezed and the bottom balloon is pushed upward



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Let's Get Started

In this activity, students will build a breathing machine that models how the lungs, chest, and diaphragm interact during breathing. Students will make predictions, build a model, make observations, and draw conclusions during this investigation to discover how changes in volume affect air flow into or out of the lungs.

Divide the class into groups of 2–4 students. (If desired, each student may perform the investigation individually.) Have the Materials Manager from each group collect the necessary materials.

Tell students they will be making a model of a lung. Direct the students to slide a balloon into the top of the bottle and roll the open end (mouth) of the balloon over the top edge of the bottle. The balloon will represent a lung. Cut off the bottom of the second balloon and tie a knot in the stem (mouth) of the remaining piece (see illustration). While one student holds the bottle, another should slide the cut end of the balloon around the cut end of the bottle.

Ask students to predict what might happen when the bottom balloon is pulled downward. Have students try pulling the balloon gently, while making sure not to pull it off the bottle. Ask, *What happened to the inside balloon?* Explain that what they just observed is similar to what happens when each of us breathes in.

Next, direct the students to squeeze the sides of the bottle gently and push the bottom balloon into the space in the bottle. Ask, *What happened?*

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Image Reference

Illustration by M.S. Young © Baylor College of Medicine.

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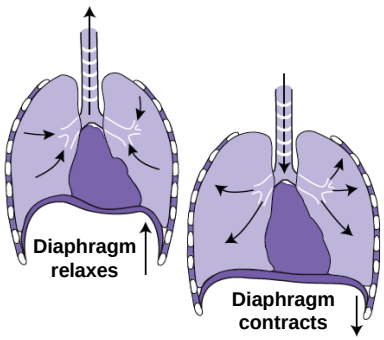
Let's Talk About It

- The balloon inside the bottle represents our lungs.
- The bottom balloon represents our diaphragm.
- When the diaphragm moves downward, the volume in the chest cavity increases, causing air to enter the lungs.



- As the diaphragm moves up, the volume of the lung cavity decreases, causing air to leave the lungs.

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Let's Talk About It

This activity allows students to model how the lungs, chest, and diaphragm interact during breathing. The "Breathing Machine" shows students how changes in volume and pressure within the chest cavity affect air flow into or out of the lungs.

Help students understand that the top balloon inside the bottle represents our lungs, while the bottom balloon represents our diaphragm (a dome-shaped muscle below the lungs). Stimulate a more in-depth discussion by challenging students to think of ways their "Breathing Machines" are similar to and different from the human respiratory system. Some examples are listed below.

•Humans have two lungs.

•Our lungs fill the entire chest cavity, and are surrounded by a thin pleural membrane and thin liquid environment. There is no air space.

•Our lungs are not hollow; they have a spongy appearance inside.

•The chest cavity is divided into two spaces—one for each lung.

Have students stand up and take a deep breath. Ask, *What happens to your chest when you inhale, or breathe air in? What happens when you exhale, or breathe air out?* Students should notice that their chests expand when they inhale and contract when they exhale.

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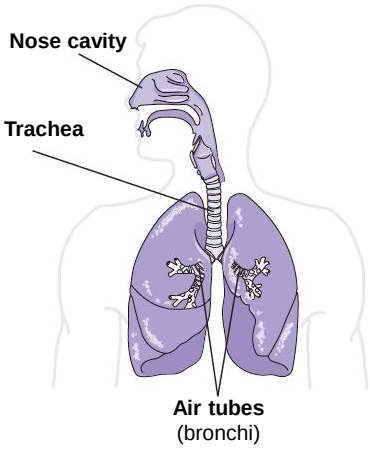
The Science of Breathing

- Breathing is controlled by changes in the size of the chest cavity.
- Air enters the nose, passes down the trachea, through a series of tubes and into small tiny pockets called alveoli.
- Oxygen, within the alveoli, moves into the blood and carbon dioxide diffuses out of the blood into the alveoli (to be exhaled).



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The Science of Breathing

Breathing is the drawing in and expelling of air. Students observed the following properties of air during this activity.

- **Volume changes in the chest cavity cause air to move in and out of the lungs.** Breathing is partially a passive process controlled (by the brain) and involves changing the volume of the chest cavity. The work of breathing is accomplished by the diaphragm (a thin layer of muscle at the base of the chest cavity) and muscles in the walls of the chest. The diaphragm is responsible for about 75% of the air flow in breathing. At rest, it is relaxed and bulges upward. When we are about to take a breath, the diaphragm muscles tighten, move downward, and increase the space available (and decrease total pressure) within the chest. Outside air rushes in to fill this space. As we exhale, the muscles of the chest and diaphragm relax, the space in the chest cavity contracts, and air is forced out of the lungs.
- **When air enters the lungs, oxygen is exchanged between the atmosphere and blood.** The cells of our body require oxygen to complete the reactions that allow energy to be released from food. This process, known as aerobic respiration, produces carbon dioxide. Air enters the body through the nose, where it is warmed and filtered. It travels down the throat and trachea, and into the chest cavity, where the trachea branches into bronchi. Bronchi branch into many alveoli, which are surrounded by very small blood vessels. This allows oxygen to move into the bloodstream and carbon dioxide to move out of the bloodstream.

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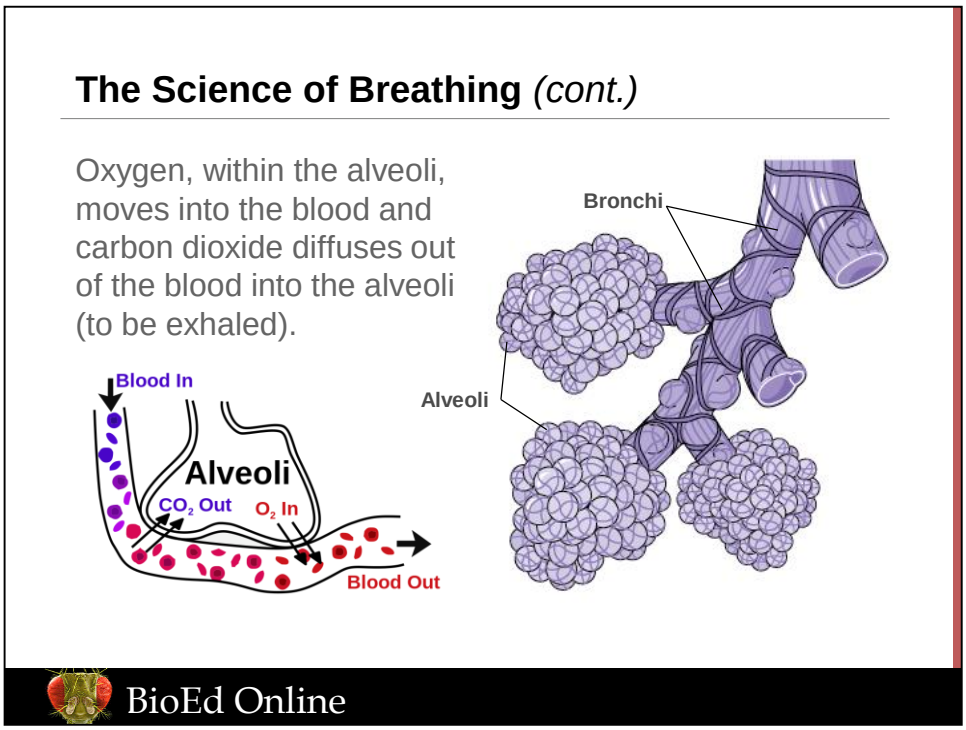

The Science of Breathing *(cont.)*

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Image Reference

1. Illustration of blood flow in alveoli © User:helix84, CC-BY-NC 3.0. http://en.wikipedia.org/wiki/File:Alveoli.svg
2. Illustration of bronchi and alveoli © Williams and Wilkins. Licensed for use.

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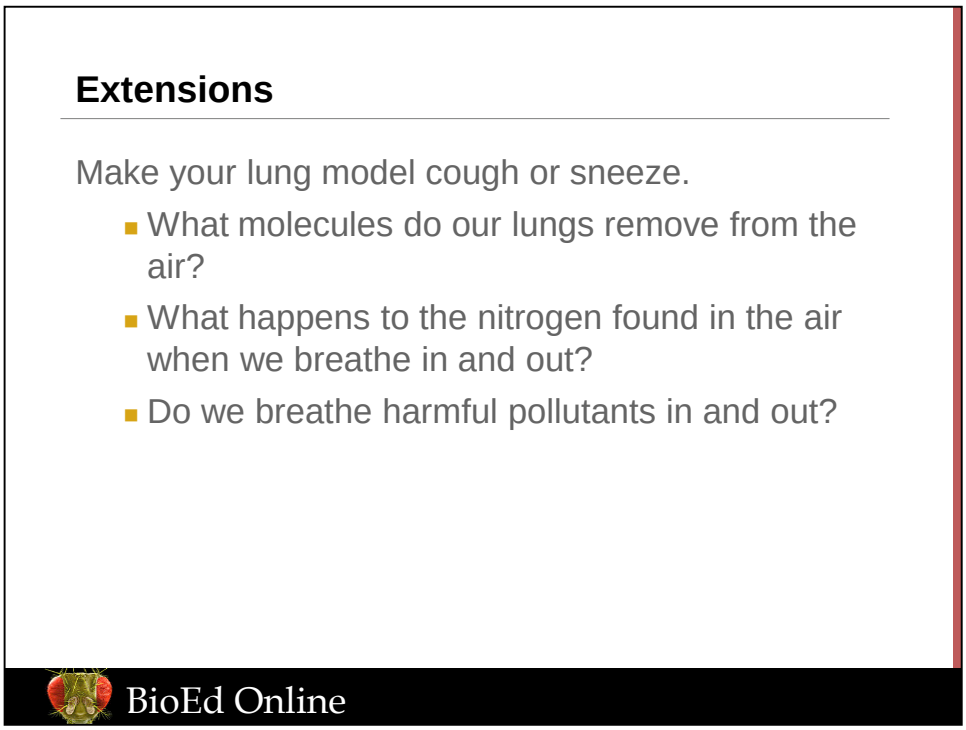

Extensions

Encourage students to suggest variations of the investigation they conducted with their "Breathing Machines." For example, students might want make their lung models "cough" or "sneeze." For a more dramatic effect, place ½ teaspoon of baking soda or baby powder inside the balloon "lung" before making the lung model cough or sneeze. Mention to students that a cough can reach speeds of 340 miles per hour. That's faster than a propeller air plane (which moves at about 135 miles per hour)!

Remind students that when we breathe in, oxygen is removed from the air in our lungs and carbon dioxide is released. Ask, *What happens to the other molecules and particles in air when we breathe in? Do we breathe nitrogen and other gases in and out? Do we also breath in harmful things in air?*

Try making a more accurate model by filling the inside of the "Breathing Machine" with water.

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