Breathing Machine

Activity from My World: Air *Teacher's Guide*

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BioEd℠

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Breathing

Life Science Basics

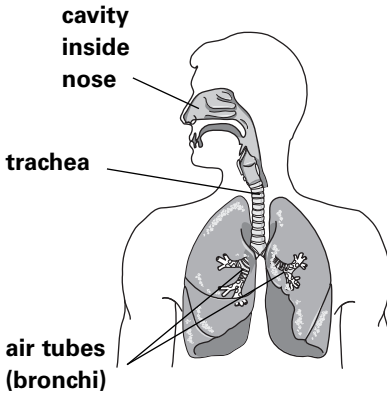
The cells in our bodies require oxygen to complete the reactions that allow energy to be released from food. This process, known as aerobic (from aeros = air) respiration, produces carbon dioxide as a waste product.

Many different systems have evolved to supply cells within large organisms with oxygen and to provide a way to eliminate carbon dioxide. Fish, for example, to have gills, which draw water across thin membranes and allow dissolved oxygen to be transferred into the bloodstream. Insects have a network of small tubes that branch throughout the body and carry air directly to individual cells. Most other land animals use lungs and a blood transport system to take in oxygen and send it to all parts of their bodies, while removing carbon dioxide at the same time.

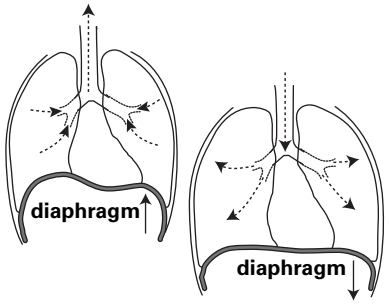
The human respiratory system is similar to that of all other mammals. Air enters the nose, where it is warmed and filtered. It passes through the region at the back of the throat (pharynx) and enters the larynx (also called the Adam's apple), or voice box. From there it passes through the trachea into the chest cavity. The trachea branches into two tubes (plural, bronchi; singular, bronchus), each leading to one of the lungs. Each bronchus branches and rebranches, forming smaller and smaller ducts. These terminate in tiny pockets, called alveoli, which are surrounded by minute blood vessels. Within the alveoli, oxygen moves into the blood stream and carbon dioxide diffuses out.

Breathing, the actual process of drawing in and expelling air, is a partially passive process controlled by changes in the volume of the chest cavity. The work of breathing is accomplished by the muscles of the walls of the chest and the diaphragm, a thin layer of muscles at the base of the chest cavity. When these muscles tighten, they increase the size of the space inside the chest. This causes air to rush into the lungs. When the muscles relax, the space becomes smaller and air moves out of the lungs.

When we breathe, all components of air (including pollutants) are drawn into the lungs. Some harmful substances can be expelled from the body by coughing or sneezing. Others are trapped and eliminated in mucus. A few, however, remain in the lungs, where they can cause permanent irritation or damage. Some chemicals in air even are absorbed into the bloodstream through the lungs and are transported to other parts of the body.



Air enters the body through the nose. It reaches the lungs, where oxygen is taken out and carbon dioxide, a waste product, is released.



Breathing is controlled by changes in the size of the chest cavity. When the chest expands, air moves into the lungs. When the volume of the chest becomes smaller, air moves out.

Breathing Machine

Life Science

CONCEPTS

Air moves in and out of the lungs in response to volume changes in the chest cavity.

OVERVIEW

Students will create a model that approximates how the lungs, chest and diaphragm interact during breathing.

SCIENCE, HEALTH & MATH SKILLS

- Predicting
- Observing
- Modeling
- Drawing conclusions

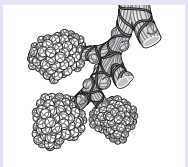
TIME

Preparation: 20 minutes
Class: 30–45 minutes

MATERIALS

Each group or student will need:

- 2 balloons, 9-in. round
- Pair of scissors
- Prepared small or medium-sized clear plastic bottle (soft drink , water or detergent bottle, see Setup)



If you spread out all the tiny pockets in the lungs, they would cover an area the size of a tennis court.

Did you know that the speed of a cough can reach 340 miles per hour?

Each of us breathes about eight to ten times per minute. When we exercise, the rate increases to 15 or 20 times per minute. Surprisingly, our lungs have no muscles of their own. How, then, is the work of breathing done?

The diaphragm 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.

Unit Links

Mr. Slaptail's Secret
Story, pp. 18–26

Explorations
Breathtaking Fun!, p. 4;
Where Does the Air Go?, p. 8

The diaphragm is responsible for about 75% of the air flow in breathing. It is a broad, thin muscle that stretches across the body between the chest and the abdomen. At rest, the diaphragm actually bulges upward. When we are about to take a breath of air or inhale, the diaphragm moves downward and, in the process, increases the space available (and decreases total pressure) within the chest. The rib muscles move upward and outward at the same time and increase the space available for air flow by another 25%. Outside air rushes in to fill this space. Breathing out, or exhaling, is normally a passive process. As the muscles of the chest and diaphragm relax, the space inside the chest becomes smaller and air moves out of the lungs. When we exhale forcibly, some of these muscles actively help push the air out.

SETUP

One or more days before you begin this activity, ask each student or group of students to bring a small to medium-sized clear plastic bottle from home (half-liter water or soft drink bottle or liquid dishwashing detergent bottle). *You will need to cut off and discard the bottom third of each bottle.* The remaining top part of the bottle should be about six inches (15 cm) tall. If the cut edges are sharp or jagged, cover them with clear plastic packaging tape.

This investigation works best with groups of two to four students. They may make one Breathing Machine per group or assist each other as they each make their own.

Note. Liter-size soft drink bottles are too large to work effectively in this activity.

PROCEDURE

1. Begin by asking each student to notice his or her own breathing. Ask, *How many times are you breathing per minute? How can you tell? Which parts of your body move when you breathe?* Tell students that they will investigate how air moves in and out of the body by making a simple model.

2. Have the Materials Managers pick up plastic bottles (bottom halves already removed) and balloons for their groups.
3. Direct the students to slide a balloon into the top of each bottle and roll the open end (mouth) of the balloon over the top edge of the bottle. This will be the "lung" in the model.
4. Another student should 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.
5. Ask students to predict what might happen when the bottom balloon is pulled downward. Have students try pulling the bottom balloon gently. Ask, *What happened to the inside balloon?* Point out that this 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?*
6. Using the diagram on p. 8 of the *Explorations* mini-magazine, help students understand that the balloon inside their model is like the lungs and that the bottom balloon is like thediaphragm (a dome-shaped muscle below the lungs). Discuss ways in which their models are similar and different to the actual respiratory system.
7. Have students stand and each take a deep breath. They should be able to notice that their chests expand when they inhale and contract when they exhale.

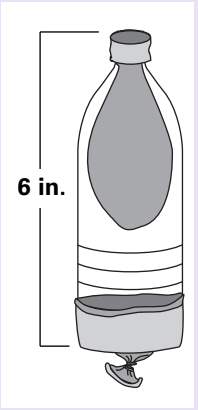
VARIATIONS

- Before beginning this activity, have students make predictions about how air might be drawn into and out of the lungs.
- Challenge your students to make their lung models cough or sneeze. For a more dramatic effect, place 1/2 teaspoon of baking soda or baby powder inside the balloon "lung" and make the lung model cough or sneeze.
- The breathing machine also is described in this unit's *Explorations* mini-magazine. You may prefer to have students make their breathing machines at home with a family member or friend.
- Try making a more accurate model by filling the inside of the breathing machine with water.

QUESTIONS FOR STUDENTS TO THINK ABOUT

Tell 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 things in air when we breathe in? Do we breathe nitrogen and other gases in and out? What about harmful things in air? Do we also breathe them in?*

Students will make a breathing machine. It will show them how changes in volume affect air flow into or out of the lungs.



ABOUT THE MODEL

The "breathing machine" model shows students how changes in pressure draw air into the lungs. However, there are several differences between real lungs and the model.

- Humans have two lungs.
- Lungs actually fill the entire space available within the chest.
- Each lung has a spongy appearance inside, instead of being hollow.
- The thin space between the lungs and the chest wall is filled with liquid.
- The chest cavity itself is divided into two spaces, one for each lung.