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Lungometer: Vital Lung Capacity

The Science of Air: Activity 6

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Lungometer: Vital Lung Capacity

This activity's objectives are aligned with the National Science Education Standards, specifically those related to Science as Inquiry and Physical Science. Lungometer uses guided inquiry to illustrate that the amount of air we normally inhale and exhale is only part of the total amount of air that the lungs can hold. This activity uses guided inquiry to illustrate that our lungs can hold much more air than we typically inhale and exhale. Students will learn that the maximum amount of air that can be blown out of the lungs after taking a deep breath is known as vital lung capacity, and they will build a "Lungometer" to measure their own vital lung capacity. They will predict, model, observe and measure, graph, and draw conclusions based on their investigation.

Concepts

•Air takes up space.
•The lungs hold air.
•Air travels in and out of the lungs.
•People differ in vital lung capacity (the amount of air they can blow out of their lungs).
•Some air always remains in the lungs.

Reference

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Institutes of Health to Baylor College of Medicine.

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

Key Words
lesson, teaching slides, lesson demonstration, life science, biology, air, lung, lungs, breath, breathing, vital lung capacity, exhale, inhale, respiration, lung disease, asthma

Materials

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Materials

Materials per Student Group

- 1 clean plastic gallon milk jug, with lid
- 1 plastic tub (10-quart size) filled halfway with water
- 1 piece of plastic tubing (0.5 to 2.0 cm in diameter, 45 cm/18 inches in length)
- 1 dark colored crayon or permanent marker
- 1 beaker (500 to 1000-ml)
- Self-adhesive notepad (1½ x 2-inch)
- Water (a little more than 3.8 liters or 1 gallon)

Materials per Student

- Copies of the “Lungometer Data Sheet” and “Make a Lungometer” student sheet
- Prepared mouthpiece (see Setup, below), made from half of a plastic drinking straw

Setup

1.This activity requires two class periods and is appropriate for students to conduct in small groups of four. Have students rotate jobs, so that each has an opportunity to measure his or her vital lung capacity.

2.As an alternative, present the lungometer as a demonstration or have each student measure his/her vital lung capacity on a lungometer you have made. Most students will find it helpful to see a pre-constructed lungometer before attempting to make one themselves.

3.Cut plastic drinking straws in half to serve as mouthpieces.

4.Each student will use his or her own clean mouthpiece, inserted into the plastic

tubing of the lungometer.

CAUTION: Students with asthma or other breathing problems should not measure their vital lung capacities. Before each student uses the lungometer, he or she should insert his or her own clean mouthpiece into the plastic. Be sure to wash tubing before storing. Use antibacterial soap or soak the tubing in a 10% mild bleach solution).

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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 appropriate safety equipment, such as safety goggles, is available.
- Continually monitor the area where the investigation is being conducted.

References

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 Institutes of Health to Baylor College of Medicine.

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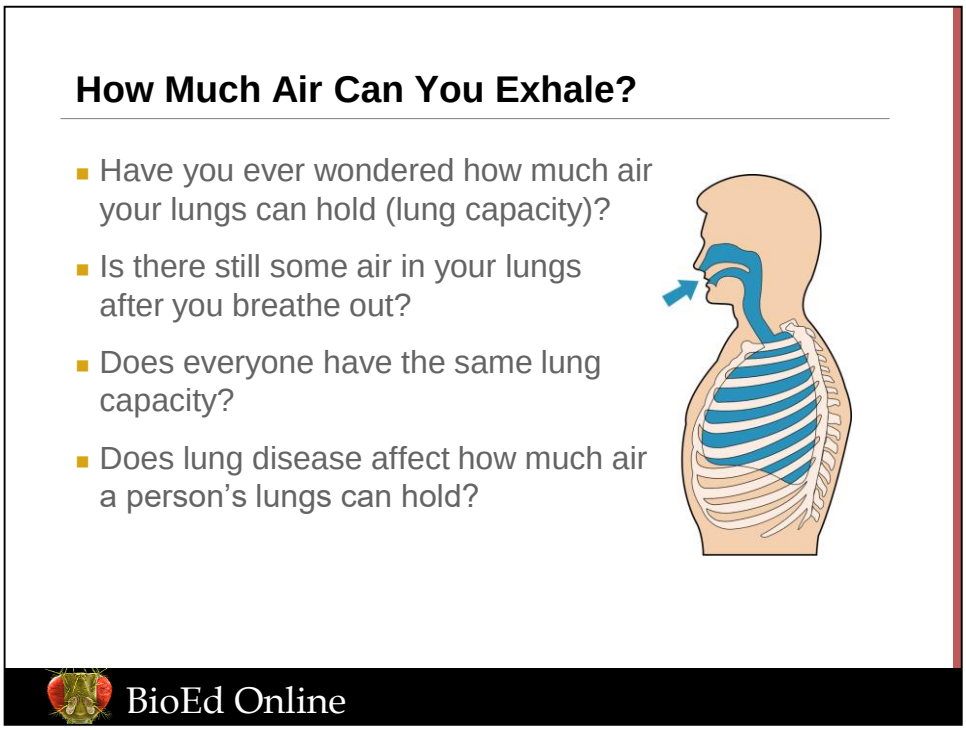

How Much Air Can You Exhale?

To focus students' attention, ask, *Have you ever wondered how much air your lungs can hold?* Instruct students to take a deep breath and notice how large their chests become as their lungs fill with air. Then have students exhale completely and notice how their chests decrease in size as air leaves their lungs.

Being a discussion about lung capacity by asking, *Is there still air left in your lungs after you breathe out?* Tell the students that there always is some air in the lungs and airways.

Ask, *Can everyone hold the same amount of air in their lungs?* Tell students that each person has a different lung capacity and mention that lung disease and smoking decrease a person's lung capacity.

Finally, tell students that they will be measuring their own lung capacity using "lungometers" that they will build.

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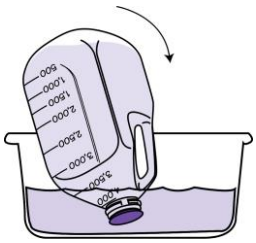
Let's Get Started: Prepare the Lungometer

1. Collect materials.
2. Fill the plastic jug with water, 500 mL at a time. After adding each 500 mL, mark the jug to show how high the water is.
3. When the jug is full, replace the cap.
4. Carefully turn the jug upside down (be sure the cap remains secured on the jug) and lower it into the tub of water.



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Let's Get Started: Prepare the Lungometer

In this activity, students will make a lungometer to measure their vital lung capacity (the amount of air that can be forced out of the lungs in a single breath). Students will learn that the maximum amount of air that can be blown out of the lungs after taking a deep breath is known as vital lung capacity. They also will discover that people have different vital lung capacities. They will predict, model, observe and measure, graph, and draw conclusions based on their investigation.

Setup

See PDF for complete setup instructions and safety cautions.

Divide students into groups of four. If desired, each student may perform the investigation individually. This activity also can be conducted as a class demonstration.

1.Have the Materials Managers collect the materials for their groups.

2.Direct each group to calibrate the volume of its plastic jug by adding water, 500 mL at a time. One student should pour and another should use a crayon or permanent marker to label each level (500 mL, 1,000 mL, 1,500 mL, etc.). The total volume of a standard gallon milk jug will equal approximately 4,000 mL.

3.Have students replace the cap when the jug is full. Then, have two students from each group turn the milk jug upside down and lower it into the tub of water, submerging the top. Students should be careful to make sure the cap remains secured on the jug.

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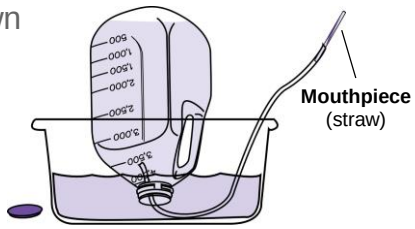
Begin the Experiment

1. Keeping the jug upside down in the water, carefully remove the cap.
2. Insert one end of the plastic tubing into the jug.
3. Secure your mouthpiece (straw) in the other end of the tube.
4. Take a deep breath and blow as much air as you can into the mouthpiece.
5. Put the cap back on the jug, remove the jug from the water, and turn the jug right side up.



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Begin the Experiment

Before each student uses the lungometer, he or she should insert his or her own clean mouthpiece into the plastic tubing (see “Materials”). Be sure to wash tubing before storing. Use antibacterial soap or soak the tubing in a 10% mild bleach solution).

While two students continue to hold the jug in the water, a third student should carefully remove the lid and insert one end of the plastic tubing up into the mouth of the jug. The tip of the tubing should remain under water inside the the jug. The lungometer is now ready for testing.

To measure vital lung capacity, each student will breathe in deeply and then blow out all the air that he or she can through the tubing into the jug. This will cause air to travel into the jug, forcing water out of the jug and into the plastic tub. The amount of air blown into the jug represents each person’s vital lung capacity.

After each student has taken his or her turn, the students holding the jug under water should put the lid back on and carefully turn the jug upright. This will enable the team to measure the amount of water remaining in the jug (and the amount of water displaced by the person blowing through the tube).

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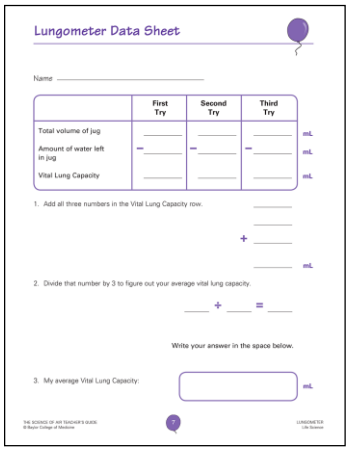
Record Your Data



1. Use the markings on the side of the jug to measure the amount of water remaining.
2. Record this number on your "Lungometer Data Sheet."
3. Repeat the experiment two more times and enter the data from each round.
4. Based on the outcomes of the experiment, calculate your average vital lung capacity.

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Record Your Data

After blowing as much air as possible through the tube, each student should record the amount of water remaining in the jug on his/her Lungometer Data Sheet.

NOTE: The vital lung capacity of elementary school children often falls between 1,300 and 2,300 mL. Have younger students measure their vital lung capacities once. Older students may try three times and calculate the average to establish their vital lung capacity.

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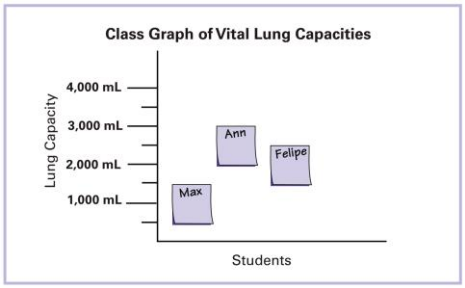
Let's Talk About It

The amount of air in the jug represents your vital lung capacity. Make a graph and compare your vital lung capacity to that of your classmates.



- What was the highest and lowest vital lung capacity?
- What was the class average?

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Let's Talk About It

With younger students, draw a large graph on the board. Label the X axis "Students." Number the Y axis from 0 to 4,000 mL, using 500 mL intervals. Have students write their names and lung capacity measurements on "sticky" notes, and then help each student place his/her note at the appropriate level on the graph (see figure on slide).

Older students should obtain the average value for their vital lung capacities over three trials, as shown on the Lungometer Data Sheet. After students have completed their calculations, have them graph their average vital lung capacities as described in the previous paragraph.

Discuss the class results charted on the graph. Ask, "What was the highest vital lung capacity in the class? What was the lowest? How could we determine the average vital lung capacity for the entire class?"

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The Science of Vital Lung Capacity

- Breathing is accomplished by muscles of the chest and diaphragm that change the volume and pressure of the chest cavity.
- Your vital lung capacity is the amount of air that you can force out of your lungs in one breath.
- People differ in the amount of air they can blow out of their lungs.

A spirometer is used clinically to measure lung function.
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The Science of Vital Lung Capacity

Students observed the following properties of air while conducting this activity.

- Air takes up space and the lungs hold air.
- Air travels in and out of the lungs. Breathing is controlled by changes in the size 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.
- People differ in the amount of air that they can blow out of their lungs. The lungometer students built for this activity models the machine (called a spirometer, see slide) that doctors use to measure vital lung capacity in their patients. The spirometer is used frequently to assess patients' asthma, emphysema and other respiratory conditions. People with lung diseases often have limited vital lung capacities. Asthma, for example, is caused by inflammation of the lungs and constriction of the airway, which can lead to difficulty in breathing and a reduced vital lung capacity.

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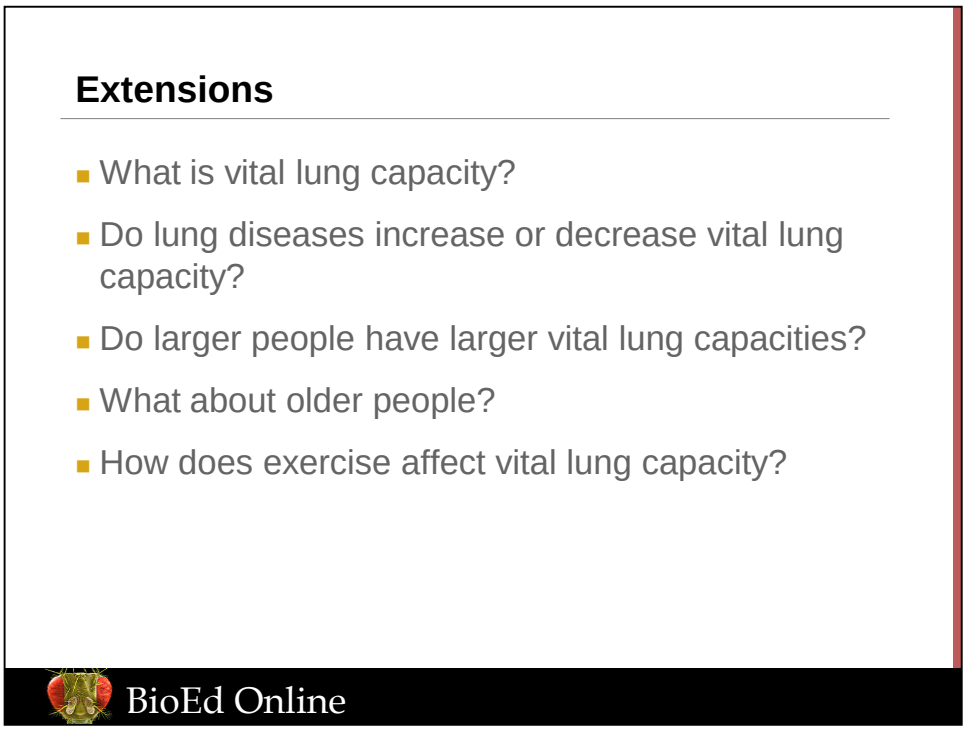

Extensions

Encourage students to suggest variations of the investigation. For example, students might want to group their class data (for example, by student height or by amounts of daily exercise) and investigate whether certain characteristics impact vital lung capacity. Or, students may want to measure vital lung capacity at the beginning and the end of the week, or in the morning and afternoon to see if vital lung capacity changes over time (it should not change drastically in these cases).

Ask, *Which types of diseases might limit a person's ability to blow out much air?* Have students use resources online, or in your classroom or library to investigate diseases of the airways and lungs. Examples include asthma, emphysema, some types of bronchitis, smoking-related lung damage and occupational lung diseases caused by prolonged exposure to asbestos or certain kinds of dusts. In the unit story, *Mr. Slaptail's Secret*, Mr. Slaptail improves his ability to blow air into a lungometer like the one constructed in this activity. Ask, *What lifestyle changes did Mr. Slaptail make to improve his vital lung capacity?*

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