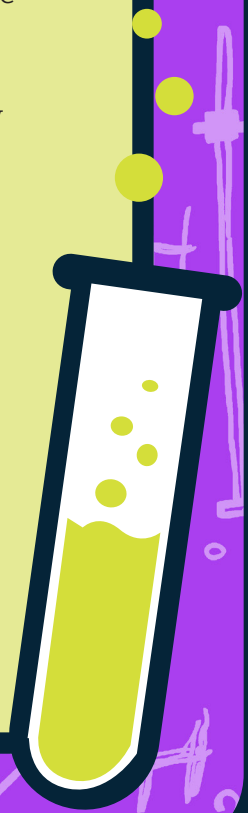
UNLOCKING SCIENCE HANDS ON!

LUNG CAPACITY

Our lungs are an amazing part of the body God has created for us. Not only do they allow us to breathe in oxygen and get rid of carbon dioxide, but we couldn't talk or sing without them. Our lungs are absolutely essential to living—they are vital organs. A normal, healthy lung works to keep you alive whether you are sitting on the couch, riding a bike, or sleeping in a cozy bed. Exercise can expand the capacity and efficiency of your lungs, but disease and exposure to toxic substances can damage and limit lung capacity and function. We should work to keep our lungs healthy to honor God who gave us our lungs. And we can use the breath in or lungs to offer him praise and tell others about the hope of salvation in Jesus Christ.

As you grow, your lungs grow with you and their capacity increases. As you age to an older adult, your lungs will lose their flexibility and capacity. You can measure the volume of your lungs using various tools, and that's what you will get to explore in this activity.

Extra Family Fun: You will need a 2-liter bottle for this activity, so make it a root beer and grab a tub of ice cream. Enjoy some root beer floats as a family before you test your lung power.



Lung Capacitometer

Supplies

- 2-liter bottle
- Large container 3–4 inches deep
- 3–4 feet tubing (approx. ¼ inch diameter or less)
- Marker
- 50 mL graduated cylinder/ ¼ cup measuring cup
- Balloons
- Cloth tape measure (cm)/ string and tape measure (cm)

Figure 1: Supplies

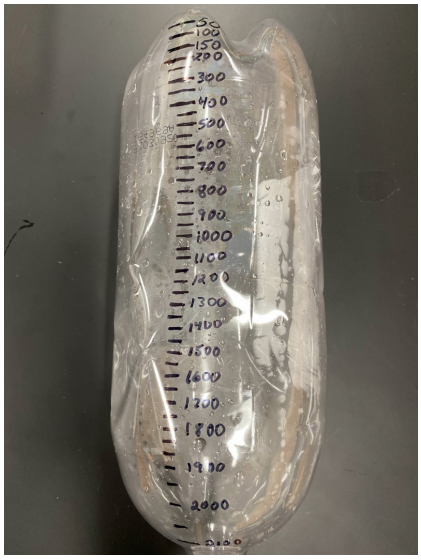


Figure 2: Bottle with 50 mL graduations

Construction

1 Pour 50 mL of water (¼ cup) into the bottle and use a marker to draw a line at the water level. Repeat this process until the marks go all of the way to the top of the bottle.

2 Turn the bottle over so the bottom is up and begin labeling each line in increments of 50 mL (50, 100, 150, etc.). There should be approximately 2,000 mL in the bottle.

3 Add water to the container to about 2 inches deep. Adding too much water will cause the container to flood.

4 Fill the bottle completely full. Place your hand/ fingers over the mouth and quickly flip the bottle upside down, submerging the mouth below the water in the container. The goal is to have as little air in the bottle as possible.

5 Have someone hold the bottle while you slip one end of the tube into its mouth, making sure there are several inches of tubing in the bottle.

Taking Measurements

1 You are now ready to take your measurements with your capacitometer by blowing in the tube and recording the volume to the nearest 10 mL based on your marks.

2 Refill the bottle each time you take a new measurement. Clean the tube if a different person uses it.

3 Make sure you empty some water from the container each time so it does not flood, or do it in a sink or outdoors where spills won't matter.

Activity: Measure Your Lung Capacity

Use the capacitometer to measure the volume of different types of breaths: Take a normal breath in and exhale gently as you normally would; Take a deep breath and exhale to a normal resting point; Take a full, deep breath and exhale as much air as possible. Refill the bottle between each measurement.

Record the results for each person in the data table.

Person	Breath	Air Volume (mL)	Percent of Lung Capacity
	Normal		
	Deep		
	Full		100%
	Normal		
	Deep		
	Full		100%
	Normal		
	Deep		
	Full		100%
	Normal		
	Deep		
	Full		100%
	Normal		
	Deep		
	Full		100%

Activity: Hanging on Every Breath

You can use a balloon to measure the relative capacity of your lungs in different conditions or compared to others. In this experiment, you are going to determine your lung capacity under normal conditions and then while hanging with your hands above your head. There is space to record capacities for multiple people if you like.

Write a hypothesis in the form of an "If . . . , then . . ." statement to predict the relative volumes of the balloons.

Hypothesis: If lung capacity is measured while hanging from a bar,

_____.

1 Take a deep breath and exhale as much air as you can into a balloon. Tie the balloon off so it is as circular as possible.

2 Measure the circumference of the balloon in cm at the largest part. Full breath:

_____

3 Hang from a bar or other object so your feet are off the ground and your hands are above your head. Take a deep breath and exhale as much air as you can into a balloon. (You might need someone to help hold the balloon.) Tie the balloon off so it is as circular as possible. Measure the circumference of the balloon in cm at the largest part. Hanging breath:

_____

Analysis Questions and Discussion

1 How much different were the normal, deep, and full lung volumes? *Discuss the various values and use the full breath value to find the difference by subtraction.*

2 Calculate the percentage of normal breath and deep breath compared to full breath (normal/full x 100 = %; deep/full x 100 = %) and compare them across different people. *Those values should be fairly close to one another for various people even if the volumes are different because of size.*

3 Why do different people have different lung capacities? *Lung capacity will vary based on the size of the individual, relative healthiness, and age in adults. A person who regularly exercises will have a larger lung capacity than someone of the same size and age. Older people have reduced lung capacity as tissues become less elastic with age.*

4 Why can't the balloon give you a volume of your lung capacity? *The balloon is made of a rubber or elastic material that pressurizes the air inside of it, so the volume is lower than if it were at the same pressure outside the balloon.*

5 Using the circumference measurements of the balloon, did your lungs hold more or less air while you were hanging? *The hanging balloon should be smaller than the full breath balloon.*

6 Optional: Calculate the volumes of each balloon using the circumference (c) in cm and the formula $\frac{4\pi}{3} \cdot \left(\frac{2\pi}{c}\right)^3$. This will give you the volume in mL since 1 cubic centimeter = 1 mL. Why is the difference in the volumes so much greater than the difference between the circumferences? *Since volume is a cubed measurement (length x width x height), a small change in the circumference (or radius) of the balloon will produce a much greater volume.*

7 Why was the volume of air lower in the balloon while you were hanging? *When the arms are over the head, the rib cage cannot move in its normal way, so the volume of air the lungs can move is smaller.*

8 Read the account of Jesus hanging on the cross in John 19:17–37. How does what Jesus and the thieves faced on the cross connect to your experiment with the balloons? How could breaking the legs of those on a cross speed up their death? *With their legs broken, the men on the cross would have no way to push up and draw a deeper breath. They were essentially trying to breathe while hanging from their arms, which is very difficult, as you saw.*

"Thus says God, the LORD, who created the heavens and stretched them out, who spread out the earth and what comes from it, who gives breath to the people on it and spirit to those who walk in it: 'I am the LORD; I have called you in righteousness; I will take you by the hand and keep you; I will give you as a covenant for the people, a light for the nations, to open the eyes that are blind, to bring out the prisoners from the dungeon, from the prison those who sit in darkness.'" (Isaiah 42:5–7, ESV)