# Activity: Breathing (The Lungs)

## Introduction

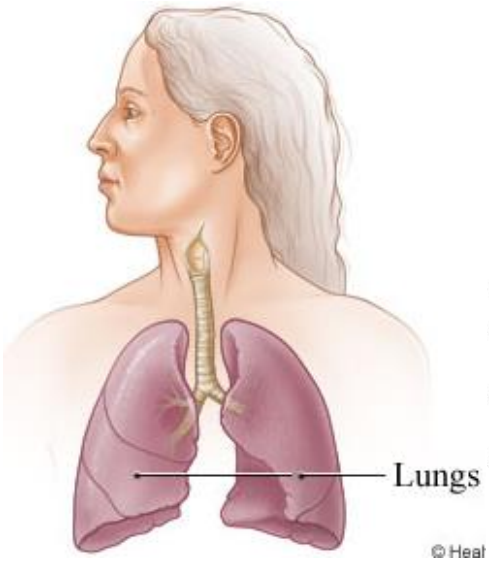
| Materials | |
|---|---|
| • 1 balloon  | • 2 rulers  |

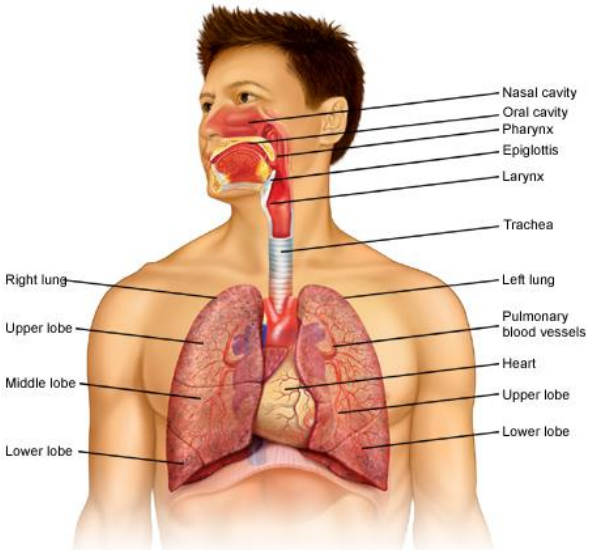
Bioengineers often create experiments to monitor and test the workings of the human body. However, measuring something inside the body can be difficult. Try measuring the length of your foot with a ruler. Easy enough, right? Now try measuring how large you lungs are. With this activity, you are going to do exactly that—measure the capacity of your lungs!

Teamwork is very important for bioengineers, because they often work with doctors, nurses, and other engineers. Your team will work together to help measure each other's lung capacities.

Your lungs are essential to breathing. But why is breathing important? Our bodies need oxygen to survive. Oxygen comes from the air around us, and our lungs help "suck in" this important molecule from our surroundings.

**Did you know?** Not only do our lungs help bring oxygen into our bodies, they also help get rid of another gas called **carbon dioxide** every time we breathe out or exhale! Carbon dioxide is created as a by-product of reactions in our bodies and is useless to us, but necessary to plants. Plants produce oxygen as a by-product of the reactions inside of them, which is essential to humans and animals.



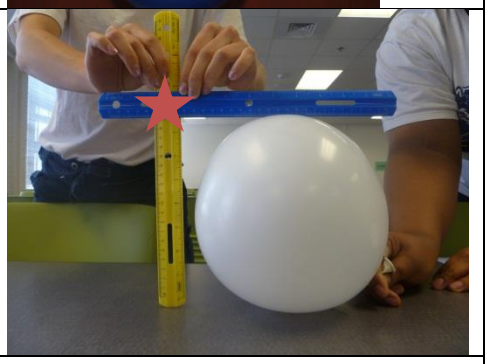

The most important factors for a bioengineer measuring lung capacity are:

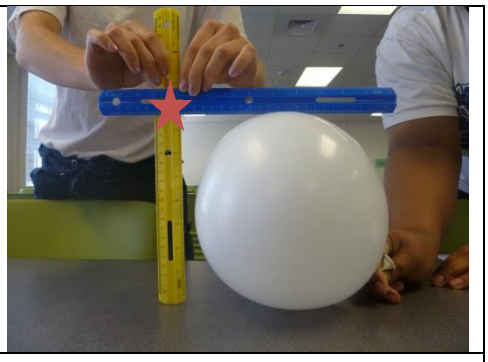
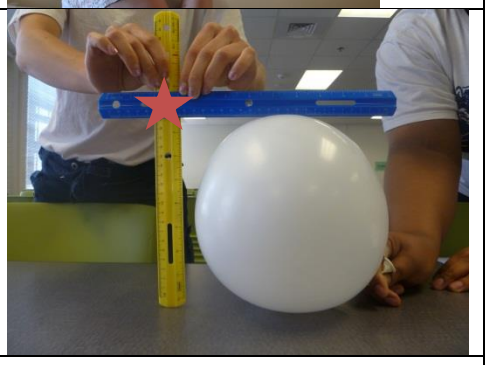
1. **Vital capacity (VC):** the largest amount of air that can be exhaled after a deep breath.
2. **Expiratory reserve (ER):** the amount of air that remains in the lungs after exhaling normally.
3. **Tidal volume (TV)**: the amount of air taken in (or inhaled) during normal breathing.

**Vital Capacity = Expiratory Reserve + Tidal Volume**

In the following activity, you will measure all three.

## Building a Model Lung

| | | |
|---|---|---|
| **1** | Find a partner and decide who will go first. Have the person going first stretch his or her balloon several times. |  |
| **2** | Take as deep a breath as possible, and **exhale all the air you can into the balloon**.<br><br>*This is your vital capacity (VC) diameter measurement.* |  |
| **3** | Pinch the balloon closed to prevent air from escaping. |  |
| **4** | Ask your partner to help hold the two rulers while you measure the diameter of the balloon (in cm) where the rulers overlap (at the red star). Make sure the vertical ruler touches the table at zero cm/inches, and the horizontal ruler's zero edge lines up with the far side of the balloon (away from the vertical ruler). The intersection of the two rulers should be at the same number, which is the balloon's diameter. |  |
| **5** | Record the diameter of the balloon in centimeters in the table below (VC). Make sure you round your result up or down. | |
| **6** | Use the graph on the last page to find the lung volume that corresponds with the balloon's diameter, and add that number to the table. | |
| **7** | Now, inhale normally and exhale normally. **Then exhale the REST of the air still in your lungs into the balloon.**<br>*This is your expiratory reserve (ER) diameter measurement.* |  |

| | | |
|---|---|---|
| **8** | Measure the diameter of the balloon (in cm) and record the number in the table (ER), as you did previously for VC. Make sure you round your result up or down.<br>Note: The diameter of the balloon will be smaller for the ER measurement than for the VC measurement. |  |
| **9** | Use the graph on the last page to find the lung volume that corresponds with the balloon's diameter and record this number too. | |
| **10** | Take in a normal breath. Exhale into the balloon only as much air as you would normally exhale. **DO NOT force your breathing.**<br>*This is your tidal volume (TV) diameter measurement.* |  |
| **11** | Measure the diameter of the balloon (in cm) and record the number in the table (TV), as you did previously for VC and ER. Make sure you round your result up or down. |  |
| **12** | Use the graph on the last page to find the lung volume that corresponds with the balloon's diameter and record this number too. | |

| | **Balloon diameter measurement (cm)** | **Lung Volume (from graph, $cm^3$)** |
|---|---|---|
| Vital capacity (VC) | | |
| Expiratory Reserve (ER) | | |
| Tidal Volume (TV) | | |

Compare your results with your partner's. Do you notice any differences? What is different?

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Circle the option you think completes the sentence best:

1. An athlete who plays sports every day has *larger/smaller* lungs than someone sitting in front of the TV every day.
2. A short person has *larger/smaller* lungs than a tall person.
3. A smoker has *stronger/weaker* lungs than a non-smoker.
4. My lungs are about the size of two *golf balls* / *melons* / *soccer balls*.

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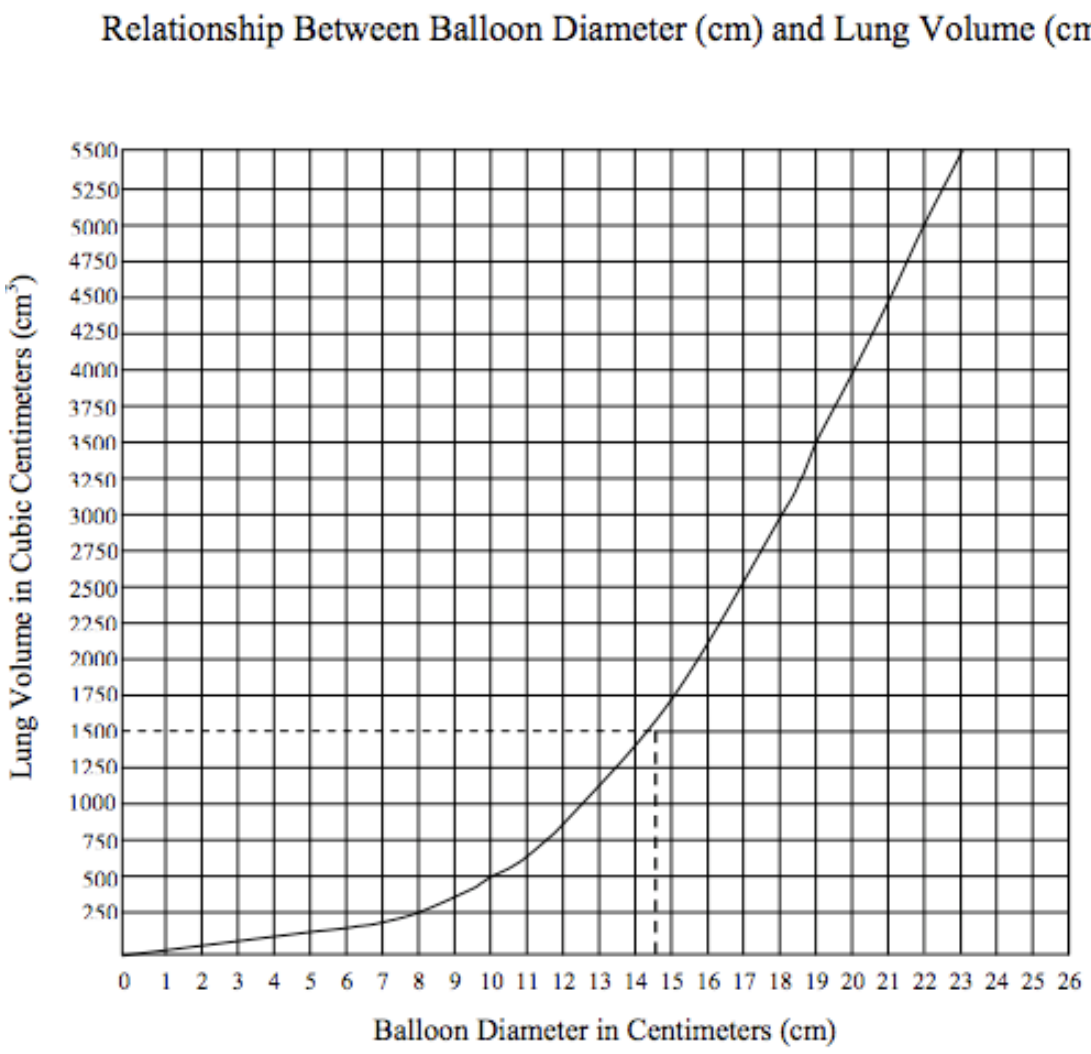
**How to use the graph below:**
Find your balloon diameter measurement on the X-axis; then follow the graph up to the point of intersection with the line. From that point on the line, follow the graph left to find the lung volume approximation that corresponds with your balloon diameter. *For example if your balloon diameter is 14.5cm, your corresponding lung volume is 1500$cm^3$ (dotted line).*

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