

# Breathing and Holding Your Breath

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## Introduction

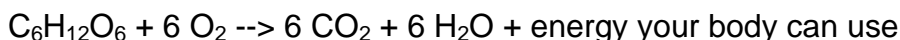
Everybody breathes all day, every day. Why?

First, answer this question based on your current knowledge. Then, discuss each of the following questions to develop a more complete understanding of why and how we breathe all day every day.

### 1. Why do your muscles and other parts of your body need oxygen?

All parts of your body need energy to do their work. For example, muscles need energy to contract, and all parts of your body need energy to synthesize needed molecules.

Your body gets the energy it needs by combining food molecules with oxygen in a process called cellular respiration. For example, in your body, the sugar glucose is combined with oxygen to release energy your body can use. This is shown in the following chemical reaction.



You know that a fire needs fuel and oxygen from the air to keep burning. Similarly, your muscles and other parts of your body need to have a continuous supply of glucose (or other high-energy molecules) and oxygen to provide the energy for muscle contraction and other body functions.

When your body breaks down glucose, carbon dioxide is produced. Too much carbon dioxide can result in damage to muscles or other body parts, so there must be some way to get rid of this carbon dioxide.

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<sup>1</sup> Teachers are encouraged to copy this student handout for classroom use. A Word file (which can be used to prepare a modified version if desired), Teacher Preparation Notes, comments, and the complete list of our hands-on activities are available at [http://serendip.brynmawr.edu/sci\\_edu/waldron/](http://serendip.brynmawr.edu/sci_edu/waldron/).

**2. How does oxygen get to your muscles and other parts of your body?  
How is the carbon dioxide carried away from the muscles?**

Use the diagram of the circulation at the end of this handout to demonstrate how the blood transports oxygen from the lungs to the muscles and carbon dioxide from the muscles to the lungs.

- To start the demonstration, place on the lungs 7 red chips to represent the oxygen in the lungs and 3 blue chips to represent the carbon dioxide. Also, put 5 red chips and 5 blue chips near the capillaries in the muscles and other parts of the body to represent the oxygen and carbon dioxide in that region.
- Demonstrate how the circulating blood picks up oxygen in the lungs and brings it to the muscles, and how the blood picks up carbon dioxide in the muscles and brings it to the lungs.
- Alternately with this demonstration of gas transport in the circulating blood, another group member should demonstrate the effects of the chemical reactions that provide energy in the muscles, by removing an oxygen from the muscle and replacing it with a carbon dioxide.

As the blood keeps circulating and cellular respiration continues in the muscles, what happens to the oxygen levels in the lung?

What happens to the carbon dioxide levels in the lung?

**3. How does the body get new oxygen into the lung?  
How does the body get rid of carbon dioxide that has accumulated in the lung?**

When you inhale, this brings fresh air with high oxygen levels into your lungs. When you exhale, this moves stale air with high carbon dioxide levels out of your lungs.

Air is moved into your lungs by suction. To understand how this works, use the baby bottle model of a very simplified respiratory system. The balloon on the bottom of the bottle represents a breathing muscle, and the little balloon inside the bottle represents a lung.

Pull down gently on the balloon on the bottom of the bottle. What happens to the little balloon inside the bottle?

Does this show what happens during inhalation or during exhalation?

What happens when you let go of the bottom balloon?

This demonstrates what happens during \_\_\_\_\_ .

To understand how these same basic processes result in inhalation and exhalation in your body, consider the diagram below, which shows the lungs and the most important breathing muscle, called the diaphragm. This figure shows that when the diaphragm is relaxed, it is dome-shaped.

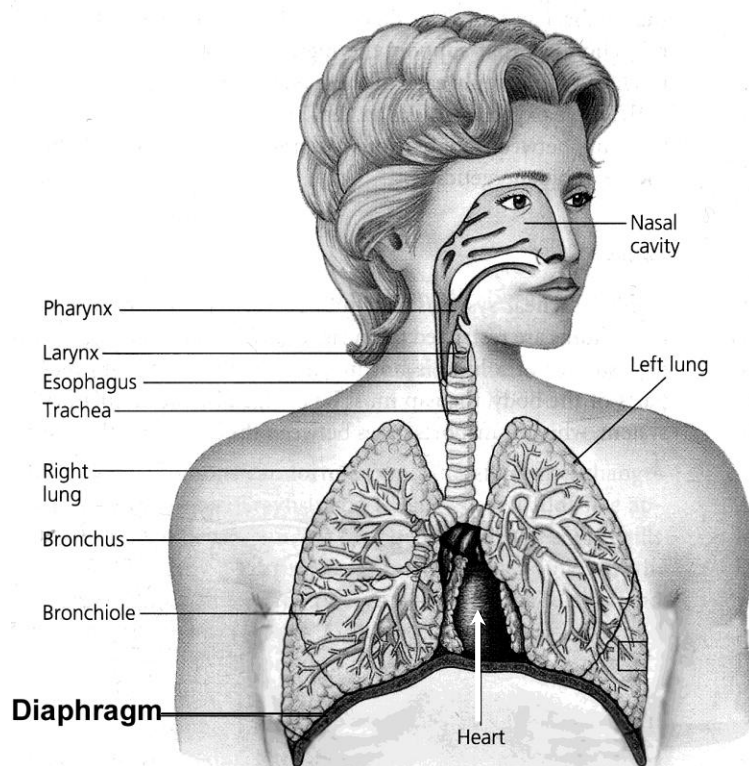
What happens when the dome-shaped diaphragm contracts?

When a muscle contracts it gets shorter. In the diagram, draw the shape of the diaphragm when it is contracted.

Will the lungs be larger or smaller when the diaphragm is contracted?

When the diaphragm is contracted, will air be pulled into the lungs or pushed out of the lungs? Explain.

When the diaphragm relaxes, will a person inhale or exhale? Explain.



(Adapted from Campbell and Reece, *Biology*, Sixth Edition, 2002)

**4.** Your breathing consists of a regular rhythm of alternately inhaling air into the lungs and exhaling air out from the lungs. Your diaphragm alternately contracts to inhale air into your lungs and relaxes so air is pushed out of your lungs. Thus, breathing depends on rhythmic contraction and relaxation of the diaphragm.

What stimulates the regular rhythm of contractions of the diaphragm muscle?

Like most muscles in your body, the diaphragm contracts when it receives a signal from the brain. The signal from the brain travels via the spinal cord to the diaphragm.

If the upper part of the spinal cord is broken, the signals to contract cannot get from the brain to the breathing muscles. Consequently, the breathing muscles are not active, and the injured person can not breathe without the help of a ventilator.

## Holding Your Breath Experiment

1. Normally, you breathe automatically, without even thinking about it. However, you can control your breathing voluntarily when you want to. For example, you can stop breathing and hold your breath for a while.

However, you cannot hold your breath forever. Obviously, it would be very unhealthy to hold your breath for too long! Why?

All parts of your body, including the muscles and the brain, depend on the breathing muscles and the circulation working together to deliver the oxygen needed by all body cells and to remove the carbon dioxide produced by all body cells.

The part of your body that is the most sensitive to lack of oxygen is your brain. If the brain is deprived of oxygen for a few minutes, parts of the brain can be permanently damaged. If oxygen deprivation continues, the person can become "brain dead".

Because it is so important to maintain a continuous supply of oxygen, in a healthy person the part of your brain which controls breathing will not let you hold your breath forever. When you try to hold your breath for a long time, after a while this part of your brain will automatically start the breathing rhythm again, even if you try very hard to hold your breath.

How long do you think you can hold your breath? \_\_\_\_\_  
(Specify if your estimate is in seconds or minutes.)

Now, take a deep breath and hold your breath as long as you can, while someone in your group times you. Be sure to hold your nose while you hold your breath. How long did you hold your breath?

\_\_\_\_\_

2. How do you think that your brain detects when you should not hold your breath any longer and you must start breathing again? What signals might stimulate your brain to make you start breathing again, even though you are trying to hold your breath?

3. Next, you will carry out a simple experiment to test whether changes in the levels of oxygen and carbon dioxide in your blood provide the signal to stop holding your breath. You will breathe into a plastic bag for 1 minute and then hold your breath for as long as you can.

Before you actually carry out this experiment, predict what you think will happen by answering the following questions.

While you are breathing into the plastic bag, what happens to the levels of carbon dioxide in the bag? \_\_\_\_\_

What happens to the levels of carbon dioxide in your lungs? \_\_\_\_\_

What happens to the levels of carbon dioxide in your blood? \_\_\_\_\_

What happens to the levels of carbon dioxide in your brain? \_\_\_\_\_

While you are breathing into the plastic bag, what happens to the levels of oxygen in the bag? \_\_\_\_\_

In your lungs, blood, and brain? \_\_\_\_\_

What change would you predict in how long you can hold your breath after breathing into the bag?

Explain why.

In order to make a valid comparison between how long you can hold your breath after normal breathing vs. after breathing into the bag, you need to be sure to hold your breath as long as you can in both conditions. To encourage everyone to hold their breath as long as possible, compare the times that each person in your group was able to hold their breath, and then try again to see if you can hold your breath even longer than your first try.

How long did you hold your breath on this second try? \_\_\_\_\_

Now, breathe normally for a few minutes. Then, open a 13 gallon plastic bag and swish it through the air to fill it with air. Hold the bag over your mouth and nose and breathe into the bag as normally as you can for 1 minute or as close to a minute as you can.

At the end of your time breathing into the bag, take a deep breath of the air from the bag and hold your breath as long as you can while someone in your group times you. How long did you hold your breath?

\_\_\_\_\_

Was there a difference in the amount of time you could hold your breath after breathing into the bag, compared to after normal breathing? How do you interpret your results?

4. Compile the data from all the members of your group in the chart below.

Person's name	<u>How Long They Held Their Breath After:</u>	
	Normal Breathing	Breathing in the Bag
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Make a graph of the data for all your group members.

Describe the results. Were the results similar for all members of your group?

How do you interpret your findings?

5. Finally, you will test whether you breathe differently after holding your breath for as long as you can. First, observe how you breathe during normal breathing. Next, hold your breath as long as you can. Then, observe how you breathe after holding your breath. Describe the differences in breathing after holding your breath, compared to your normal breathing. Also, do you feel your heart pounding?

How do you interpret these observations?

