

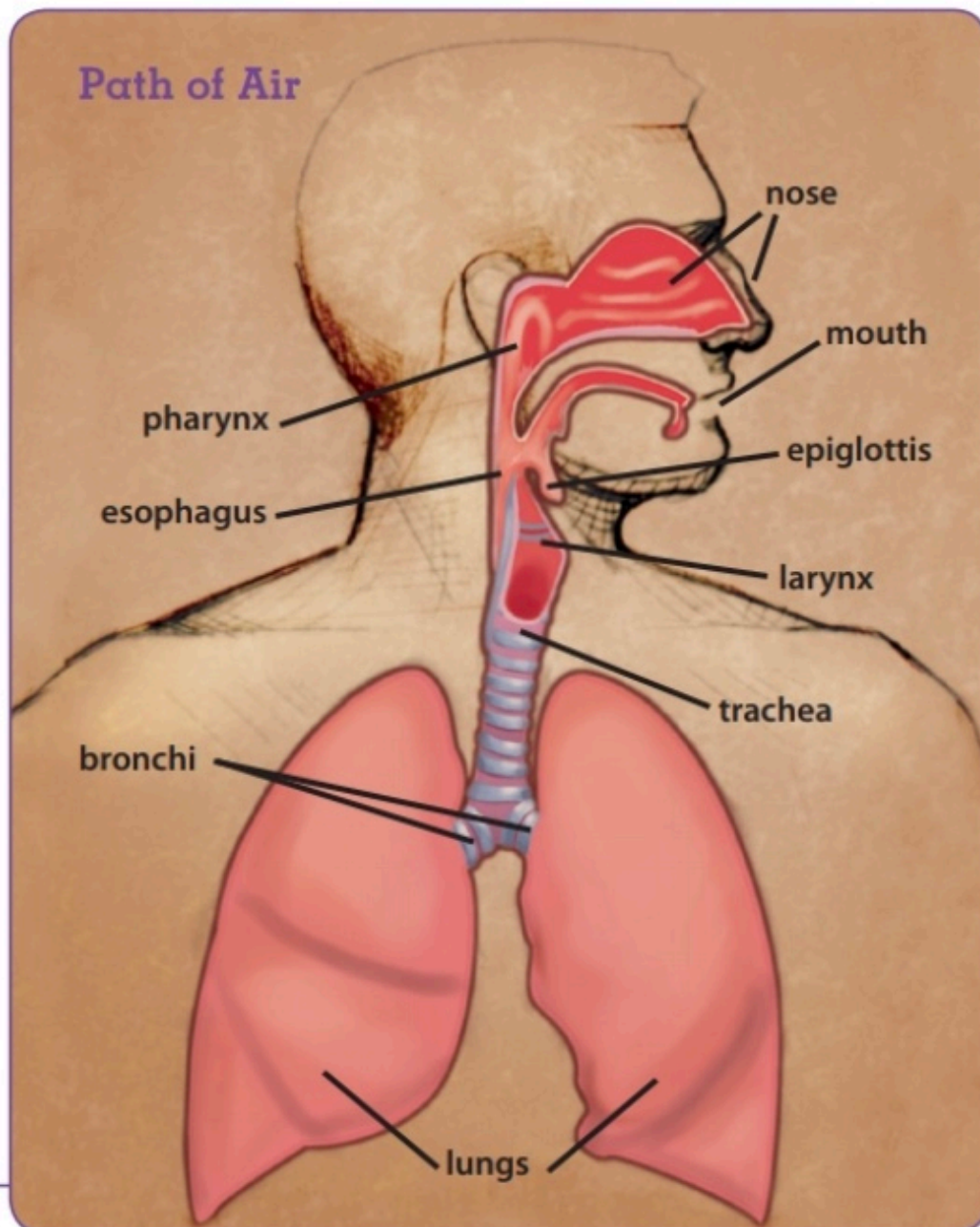
The Path of Air

Your Nose

Most of the air you breathe comes in through your nose. Your nose has two openings that are separated by a wall of cartilage and bone. These openings are called *nostrils*. Air enters through your nostrils and passes into your nasal cavity. The *nasal cavity* is

a large air space located behind your nostrils. The open spaces from the front of the nose to the beginning of the throat are called the *nasal passages*.

Your nose is good for much more than breathing. When you inhale, the air that passes through your nose is warmed, moistened, and even filtered. Special cells in your nose and



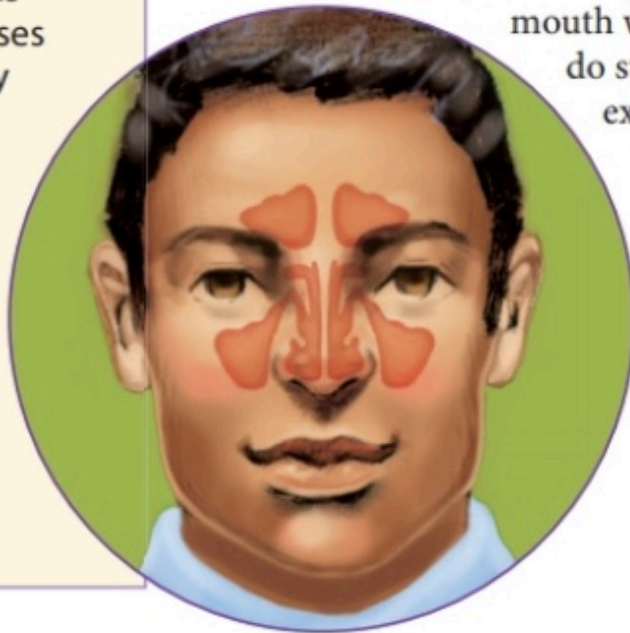
your lungs produce *mucus*, a sticky substance that captures bacteria, dust, and other particles in the air. Tiny hairlike structures called **cilia** line your nasal passages as well as most of the respiratory system. The cilia within your nose move in waves to transport the mucus into the body. Scientists are imitating this movement that God designed in their artificial cilia.

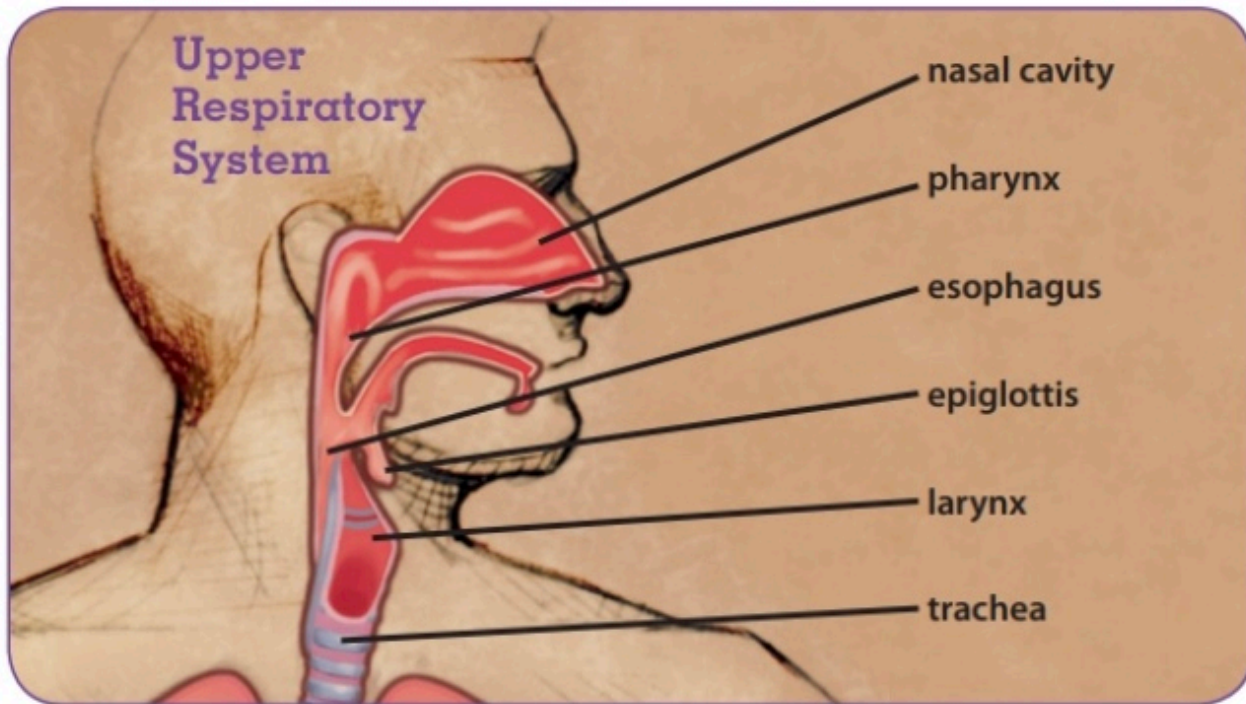
FANTASTIC FACTS

Have you ever wondered why your voice sometimes sounds different when you have a bad cold? The answer is that your sinuses are blocked. Your sinuses are the empty spaces in the bones around your nose. Like the nose, each sinus is lined with a mucus membrane. Because sinuses are empty air spaces, they help reduce the weight of the skull. They also amplify sound. When you are sick and your sinuses get blocked with extra mucus, the air cannot circulate freely through the nasal passages. This makes your voice sound different.

The cilia sweep the trapped particles toward your throat, and you swallow them. There, the acid in your stomach destroys the particles. Sometimes, though, the particles do not reach your stomach. Instead, they may irritate the lining of your nose or throat and cause you to sneeze or cough.

Air can also enter your body through your mouth. However, your mouth cannot protect your respiratory system as the cilia in your nose can. For this reason, it is best to breathe through your nose. At times, though, you may have to breathe through your mouth. When you have a cold, for instance, your nasal passage may become blocked. In this case, the only way to get air is through your mouth. You also tend to breathe through your mouth when you do strenuous exercise.





Your Throat

The air moves from your nose or mouth into your throat, or **pharynx**. At the end of your pharynx are two separate tubes, each with a different purpose. One tube is your **trachea**, or windpipe. It leads to your lungs. The other tube leads to your stomach and is called your esophagus, or food pipe.

When you swallow your food, a flap of tissue called the **epiglottis** closes automatically over your trachea. The epiglottis keeps food from going down the trachea to your lungs. When you are breathing, the epiglottis stays open. This allows the air to enter your lungs instead of going to your stomach.

Talking or laughing with food in your mouth may cause your epiglottis to work improperly. It may stay open

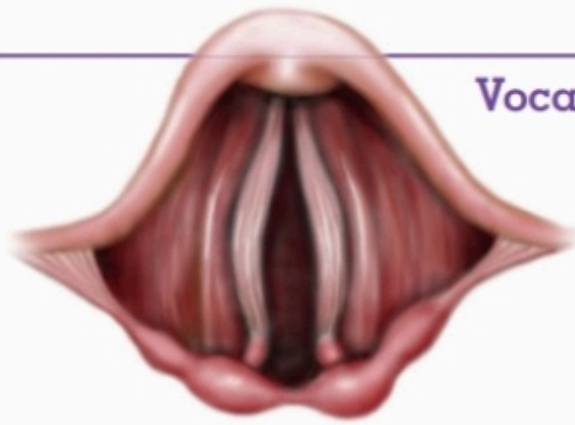
because you are talking though it needs to close so you can swallow your food. Instead of the food going down your esophagus, the food may accidentally go down your trachea and cause you to choke. Choking occurs when an object, such as a piece of food, goes down the wrong "pipe."

Your Larynx

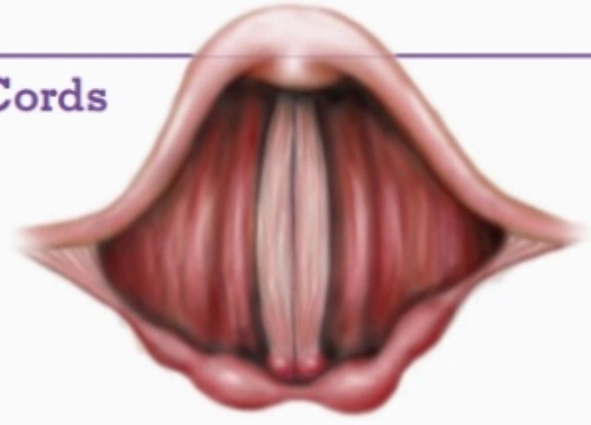
At the top of your trachea is your **larynx**, or voice box. It is made up of nine pieces of cartilage and many small muscles. Two small bands of elastic tissue stretch across the inside of the larynx. These soft bands are called your **vocal cords**.

The vocal cords form a V, with a small gap between them. When you are not talking, your vocal cords are relaxed. The gap stays open so that you can breathe. When you start to

Vocal Cords



Your vocal cords are open and relaxed when you breathe.



Your vocal cords tighten and narrow when you talk or sing.

talk, sing, or scream, your vocal cords tighten and narrow, leaving only a small opening.

Speech happens when air is exhaled. As you exhale, the air moves upward from your lungs and goes into your trachea. The air pushes through the closed vocal cords and makes them vibrate. This creates sound waves. Your throat, mouth, nose, sinus cavities, teeth, tongue, lips, jaw, and cheeks then work together to shape the sound into understandable speech.

The pitch of the sound depends on the thickness and length of the vocal cords. Long, thick vocal cords vibrate slowly and produce a deep sound. Short, thin vocal cords vibrate faster and produce a higher-pitched sound. Men have thicker vocal cords than women do. This is why men's voices are usually deeper than women's voices are.

TRY IT YOURSELF

Your larynx changes the pitch of your voice by changing the thickness and the length of the vocal cords. You can model this with a balloon. Inflate a balloon and let the air escape. While the air is escaping, stretch open the mouth of the balloon. This will change the length and thickness of the opening. Try this several times. Predict whether the sound will be higher or lower as the size of the opening changes.



QUICK CHECK

1. Why is it better to breathe through your nose?
2. What is the name of the flap of tissue that keeps food out of your trachea?
3. What body parts work together to produce the sound waves of your voice?

Your Trachea and Bronchi

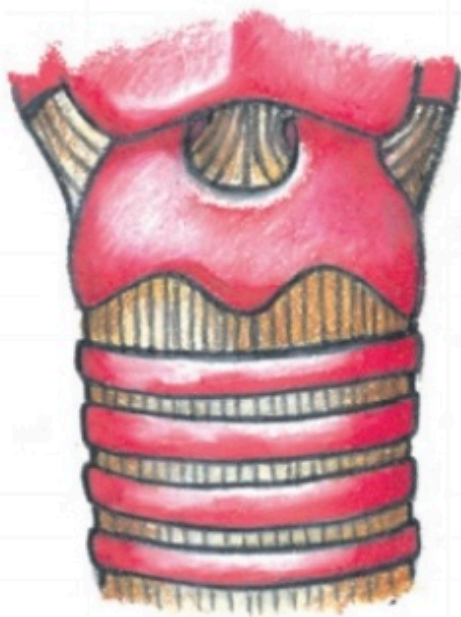
Your respiratory system is divided into two parts. The nose, throat, and larynx make up the *upper respiratory system*. Below the larynx, from the trachea into the lungs, is the *lower respiratory system*.

The trachea stretches from the larynx into the upper chest. It is about 10–11 cm (4 in.) long in most adults. The trachea branches off into two tubes called the **bronchi**. One tube goes to the left lung. The other tube enters the right lung.

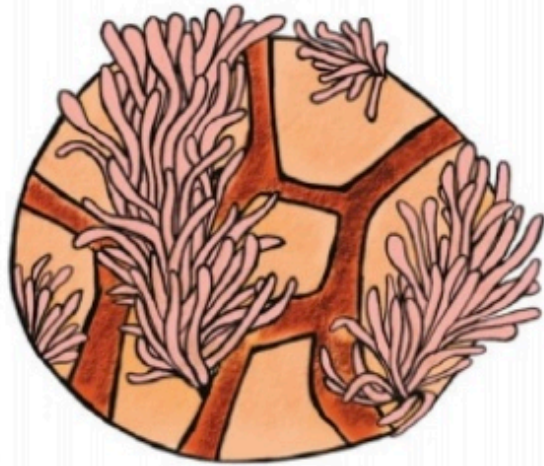
Both your trachea and your bronchi have C-shaped rings of cartilage on their outsides. The rings keep them

from collapsing and allow them to move as your neck and chest move. If a piece of food gets past your epiglottis, the muscles in your trachea walls react. The muscles can squeeze the rings together to try to keep the food from going into your lungs.

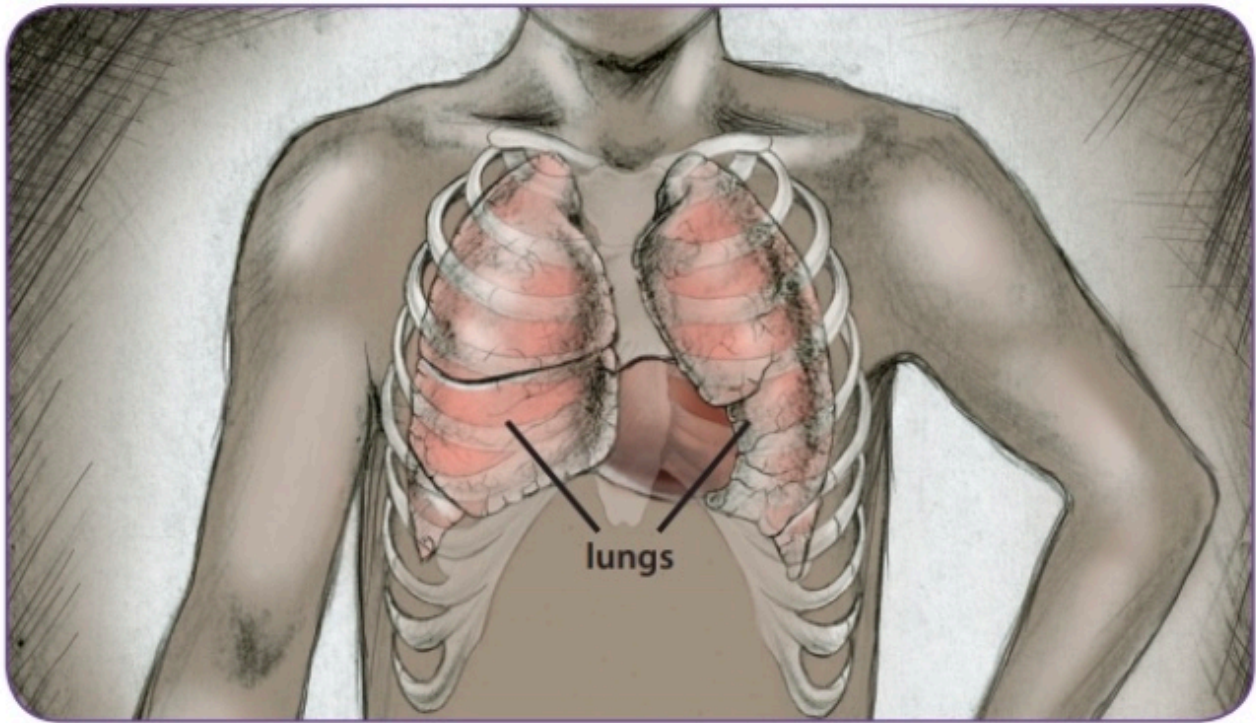
Just like in your nasal passages, the lining inside your trachea and bronchi has mucus and cilia. The mucus and cilia trap particles of dust and dirt. The particles are pushed back up to your throat, and you usually swallow them down your esophagus. If you have ever coughed to clear your throat, you have experienced those particles moving out of your trachea.



The rings of cartilage on the trachea and bronchi help keep the airways open.



Cilia line the inside of the nasal passages, the trachea, and the bronchi.



Your Lungs

Your **lungs** are two saclike organs that replace the carbon dioxide in your blood with oxygen. A flexible “cage” of bones protects your lungs. This cage is formed by your ribs, breastbone, and backbone. The top of your lungs reaches above your shoulder bones and is behind your collarbone. The base of your lungs rests on the diaphragm.

Healthy lungs are a pinkish-gray color. Each lung is about the size of a football. Your left lung is slightly smaller than your right lung. That is because your left lung has a space next to it for your heart. Your heart and main blood vessels are located between your lungs.

Lungs do not have any muscles of their own. Instead, your diaphragm and chest muscles control how your lungs move. When you breathe in, your lungs stretch and fill with air. When you breathe out, air is pushed out of your lungs, and they return to their smaller size.

The amount of air that can be taken into the lungs with one breath is called *lung capacity*. A normal breath for an average man is about half a liter of air. Lungs can hold more air if necessary, though. When a man breathes in as much air as possible, his lungs can hold about 6 L (6.4 qt) of air. A woman’s lungs can hold about 4.2 L (4.5 qt) of air.

Bronchial Tubes

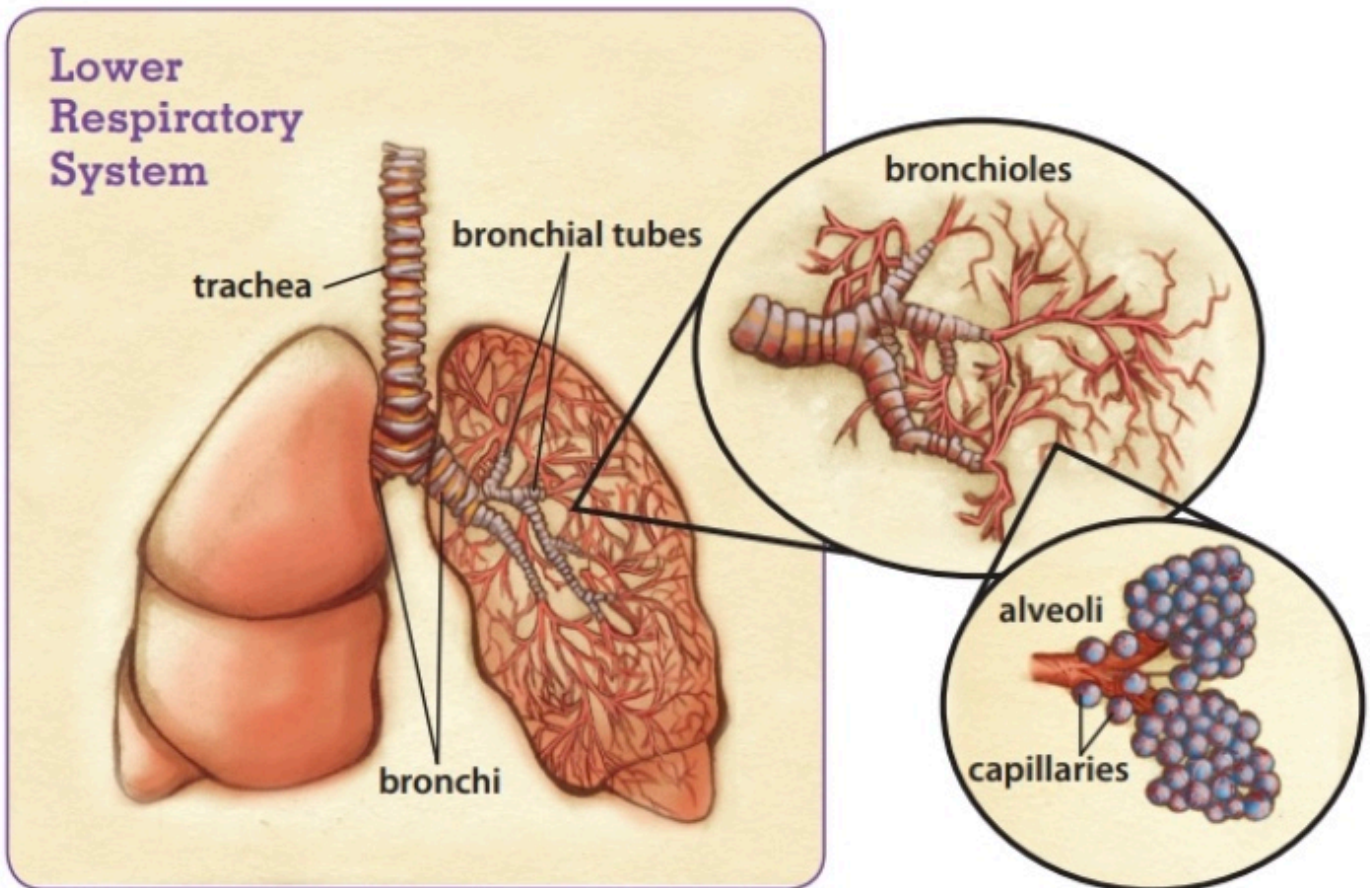
Inside your lungs, your bronchi branch off into many smaller *bronchial tubes*. These tubes get smaller and smaller as they spread to all the parts of your lungs. Many of these tubes are less than 1 mm wide. Some are thinner than human hairs. All of the bronchial tubes, though, have muscles and rings of cartilage to keep them open wide. The smallest tubes are called *bronchioles*.

Alveoli

The bronchioles end in tiny air sacs called **alveoli**. The alveoli look like bunches of grapes. Each lung has about 300 million alveoli. They

are surrounded by a network of tiny blood vessels called *capillaries*. The walls of the alveoli and the capillaries are very thin. In some places, they are only one cell thick.

It is in the alveoli that the exchange of gases takes place. The air you inhale contains oxygen. The oxygen passes through the walls of the alveoli into the blood in the capillaries. The blood then carries it to all the parts of your body. At the same time, carbon dioxide passes from the blood in the capillaries into the alveoli. There, the carbon dioxide can be exhaled from your body. This exchange of gases is called breathing, or respiration.



Respiratory Sounds

Coughs and Sneezes

Coughs and sneezes often occur whenever something irritates the lining of the airways. The force of the cough or sneeze moves the offending particles out of the respiratory system. When you cough, your diaphragm relaxes while your other muscles contract. This action violently pushes air out through your mouth. In much the same way, a sneeze is triggered by an irritation in the nose. The air is forced out through both the nose and the mouth.

Hiccups

Hiccups are caused by involuntary movements of the diaphragm that disrupt normal breathing. When you have the hiccups, your diaphragm muscle contracts quickly and causes you to take quick, short breaths of air. The epiglottis closes suddenly while the diaphragm is contracting. This causes the hiccup noise.

Many times there is no obvious cause for hiccups. Some people may get hiccups when they are full or when they eat a spicy food. Strong emotions, such as fear or anger, can also cause them. Hiccups can be noisy or quiet, but they cannot be controlled.

Snoring

A person snores whenever air cannot flow freely through the back



Sneezing

of the mouth and the nose. The snoring sound is caused when parts of the mouth and throat vibrate and hit together. There are many reasons why a person snores. The person may have an allergy or a cold. If the wall of cartilage that separates a person's nostrils is crooked, he may snore. A person may also snore if he is overweight, sleeps on his back, or has swollen tonsils.



QUICK CHECK

1. What is the name of the two air tubes that branch off the trachea?
2. What are alveoli?
3. What causes the hiccup noise?



How Much Air Is in Your Lungs?

Lung capacity is different for each person. Your age, gender, size, and level of physical fitness can all affect how much air your lungs hold.

Doctors may measure your lung volume under different conditions. Sometimes they measure your lung volume during normal, quiet breathing. Other times they may measure the maximum amount of air that you can exhale after a deep breath. This is called your *vital lung capacity*.

In this activity you will use a balloon to measure your vital lung capacity.

Problem

How much air can you exhale in one breath?

Procedure

1. Complete the hypothesis in your Activity Manual.
2. Stretch a large round balloon, and then blow into it several times, letting the air out of the balloon after each time.
3. Take a deep breath. Exhale as much air as possible into the balloon. Be sure that you are exhaling only once.
4. Twist the end of the balloon, and pinch it closed with your fingers. Do not let air escape from the balloon.
5. Have your partner hold the meter stick in a vertical position. The end of the meter stick should rest on a desk or table. Place the balloon on its side against the meter stick. Rest the centimeter ruler across the top of the balloon. Do not push down on the balloon.
6. Use the ruler to measure the width of the balloon that you blew into. The place on the meter stick that the centimeter ruler points to is the diameter of the balloon. Record the diameter of the balloon that you blew into.

Process Skills

- Hypothesizing
- Measuring and using numbers
- Collecting, recording, and interpreting data

Materials

round balloon, 12 in.
meter stick
centimeter ruler
calculator
Activity Manual

7. Repeat steps 3–6 two more times. Record the diameter each time.
8. Calculate and record the average diameter of the balloon.
9. Exchange places with your partner. Repeat steps 1–8 for your partner. Make sure that your partner uses a different balloon.
10. Look at the graph on your Activity Manual page. Use the average diameter to find out how many liters of air you exhaled and record the amount.

Conclusions

- Do the results support your hypothesis?
- Did the diameter of the balloon change the second and third times that you blew into the balloon? If so, why do you think it changed?

Follow-up

- Compare the lung volumes of boys and girls.
- Compare the vital lung capacity of students who play a wind or brass instrument with those who do not.



Respiratory Problems

The respiratory system involves many parts. God's design connects the different parts of our bodies to work together. When all the parts are working properly, you hardly notice any of them. However, if one part stops working well, you usually notice it very quickly. The problem may be merely an annoyance, such as a stuffy head or a runny nose. Or it could be a life-threatening problem, such as when the body is not able to get the air that it needs.

Respiratory problems vary a lot. Some affect only one part of the respiratory system. Others, however, cause trouble for many parts. Some are sicknesses that come and go, whereas others may last a person's whole life.

Diseases

Many diseases can affect the body's ability to breathe properly. The most common respiratory disease is a cold. Cold viruses usually affect the nose and throat, causing their cells to swell. The cells start producing more mucus than normal, and the person may have trouble breathing through his nose. Colds can also affect the sinuses, ears, and bronchi.

Influenza, or the flu, is also caused by a virus. Flu viruses are similar to cold viruses. They often have some of the same symptoms. Flu viruses, though, usually also cause fevers, headaches, and muscle aches. The viruses may lead to a more serious illness or infection.

Both colds and the flu are very *contagious*, or easy to spread to other

Healthy habits help keep viruses from spreading.



people. Colds and the flu are usually spread through the air when a sick person coughs or sneezes. When another person inhales, he breathes in the virus. That particular virus may or may not make him sick. Sometimes a person may get sick by touching his mouth or nose after he has touched something that a sick person has coughed or sneezed on. Frequent hand washing can help keep viruses from spreading.

Some problems affect the throat, another part of the respiratory system. Many different things cause sore throats. Sometimes dust or smoke in the air can irritate the throat and cause it to be sore. The extra mucus produced because of a cold or flu may also irritate the lining in the throat. The throat usually has a coating that helps keep it moist. Sometimes extreme coughing will dry out the throat and cause it to hurt.

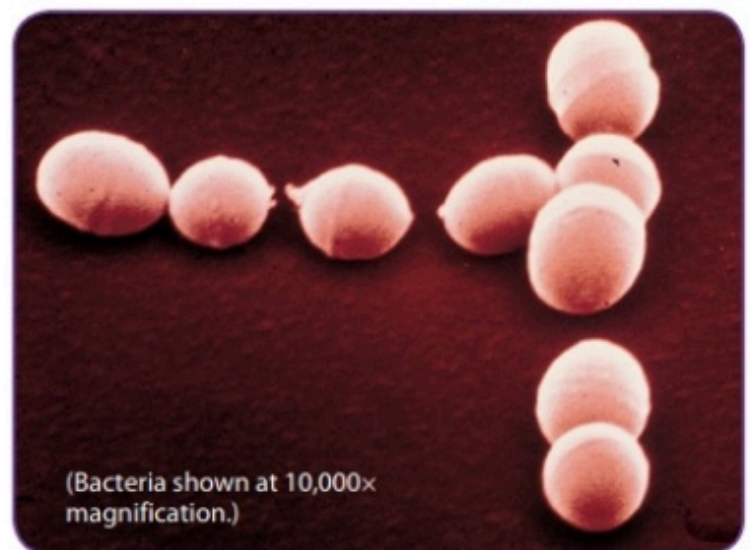
Occasionally a virus or bacteria may infect the throat or larynx. Strep throat is a type of infection that is caused by bacteria. A person with strep throat will usually have a high fever for several days. A doctor can test to see if a sore throat is strep throat. If it is, the doctor can prescribe medicine to help the body get rid of the bacteria.

Sometimes a cold or the flu can turn into bronchitis. This disease

causes the bronchi to become infected and swollen. A germ, such as a virus, irritates the lining of the bronchi. This often causes the cilia to stop moving. They cannot trap or remove particles. The air passages become blocked, and more mucus is produced. The extra mucus in the bronchi makes it harder for the air to pass in and out of the lungs. This is why a person with bronchitis often sounds raspy. He may also cough a lot. Coughing is the body's way to try to remove the extra mucus.

Pneumonia is a lung infection. It is caused by viruses or bacteria and may develop from another illness. The infection causes the lungs to fill with fluid. The fluid keeps the lungs from being able to properly fill with air. Oxygen cannot reach all areas of the lungs. This makes it hard for oxygen to get from the alveoli to the bloodstream.

Streptococcus bacteria can cause strep throat.



(Bacteria shown at 10,000x magnification.)

Allergies

Sneezing does not always mean that you have a cold. It may mean that you are having an allergic reaction to something in the air. The air that we inhale usually contains particles such as dust and pollen. For some people, this dust or pollen may cause breathing problems. Their bodies react to things in the air that other people never even notice.

People with respiratory allergies often sneeze. They may also have runny noses, itchy eyes, or breathing problems. Allergies often come and go with the seasons. For example, pollen is in the air the most in the spring and the fall. A person may be fine in the winter but react as soon as the spring pollen arrives. An allergy is not contagious. It cannot be spread like a cold or the flu can.

Asthma

Asthma is a disorder that causes the small bronchial tubes to become narrow from time to time. This can make it hard for a person to breathe. Asthma can vary a lot from person to person. Some people with asthma have very few problems, whereas others have severe difficulties.



Some people need regular treatments for asthma.

Allergies and air pollution are two things that may cause someone to have an asthma attack. During an attack, the muscles around the bronchial tubes tighten more than normal. This makes the bronchial tubes smaller. The airways are often swollen and irritated. This makes it difficult for the person to breathe. The person may cough and wheeze as he breathes.

Someone with asthma may use an inhaler. The inhaler contains medicine that can be breathed in. It can help prevent an asthma attack from starting or getting worse. Asthma is not contagious. Most people with asthma are able to keep it under control. This way they can still participate in sports and other activities.

Smoking

Smoking is harmful to your health. Cigarette smoke contains poisonous chemicals that harm the lungs and other parts of the body. Most of the smoke particles are very small. They cannot be trapped by the cilia and mucus in the airways. These poisonous chemicals then get into the lungs. As the smoke particles cool, they form a sticky tar that stays in the lungs. The tar makes the cilia clump together so that they cannot work properly. When this happens, dust, dirt, and smoke stay in the lungs. This sticky tar may cause diseases such as *lung cancer*.

Another deadly disease caused by cigarette smoking is *emphysema*. Sometimes cigarette smoke causes the alveoli to stop working properly. This keeps the lungs from being able to transfer oxygen and carbon dioxide between the air and the blood. Once the alveoli are damaged, they cannot be repaired. People with emphysema have difficulty breathing. They also get tired a lot. This is because they do not get enough oxygen into their bloodstream. Even blowing out a match can be difficult for them to do.

The human body is one of God's marvelous designs. He created all the parts of our body to work together.



Healthy lung



Smoker's lung

The respiratory system works with other systems in our body to keep us alive. We should say with the psalmist in Psalm 139, "I will praise thee; for I am fearfully and wonderfully made: marvellous are thy works." Our bodies were made by God and belong to Him. Taking care of our bodies brings glory to Him.



QUICK CHECK

1. What is the most common respiratory disease?
2. If a person has pneumonia, which part of the respiratory system is infected?
3. What is a respiratory disorder that causes the bronchial tubes to narrow?
4. What are two lung diseases that are often caused by smoking?

Words to Know

respiratory system	epiglottis
inhale	larynx
exhale	vocal cords
diaphragm	bronchi
cilia	lungs
pharynx	alveoli
trachea	

Key Ideas

Compare and contrast involuntary breathing and voluntary breathing

Identify reasons the body needs oxygen

Describe how the muscles work together to breathe

Locate the parts of the respiratory system on a diagram

Describe the function of the parts of the respiratory system and how air moves through the body

Summarize how speech happens

Identify some respiratory sounds

Describe some respiratory diseases and problems

Explain the importance of practicing good stewardship in caring for your lungs