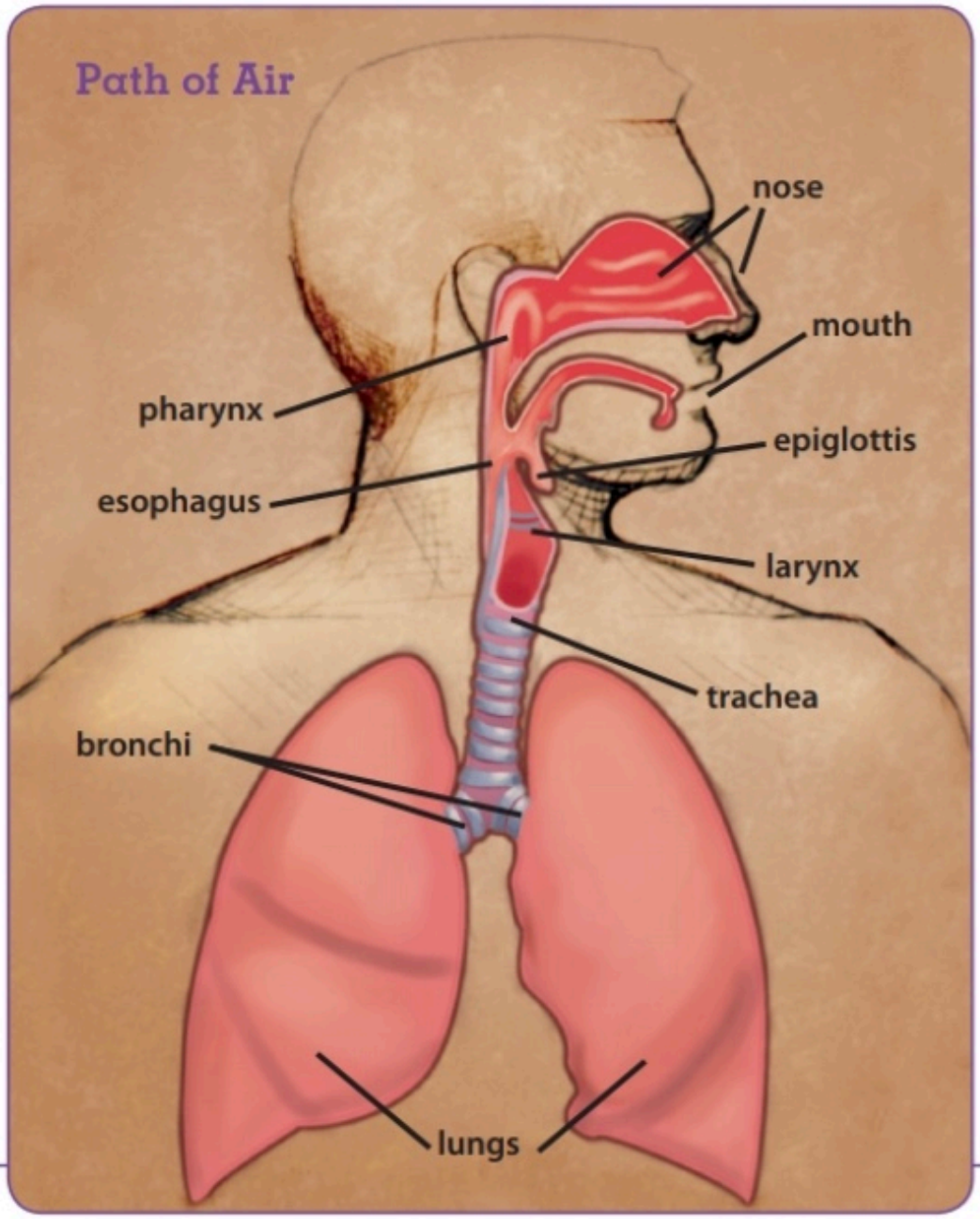
The Path of Air

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



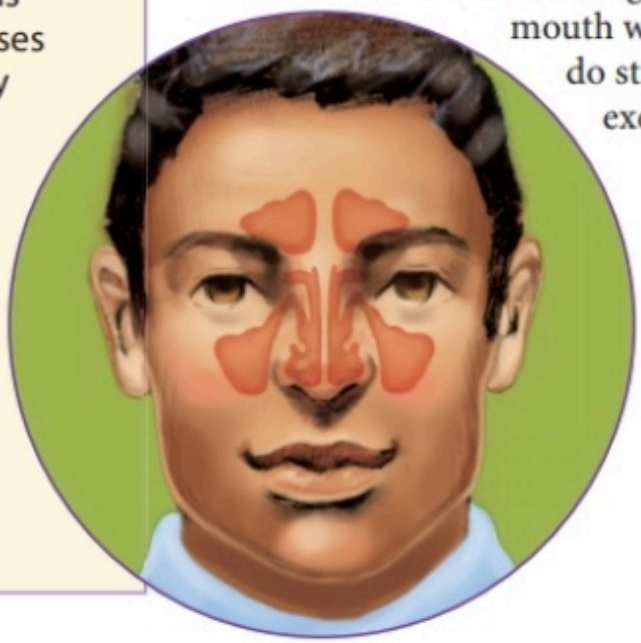
your lungs produce *mucus*, a sticky substance that captures bacteria, dust, and other particles in the air. Tiny hairlike structures called **cilia** line your nasal passages as well as most of the respiratory system. The cilia within your nose move in waves to transport the mucus into the body. Scientists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

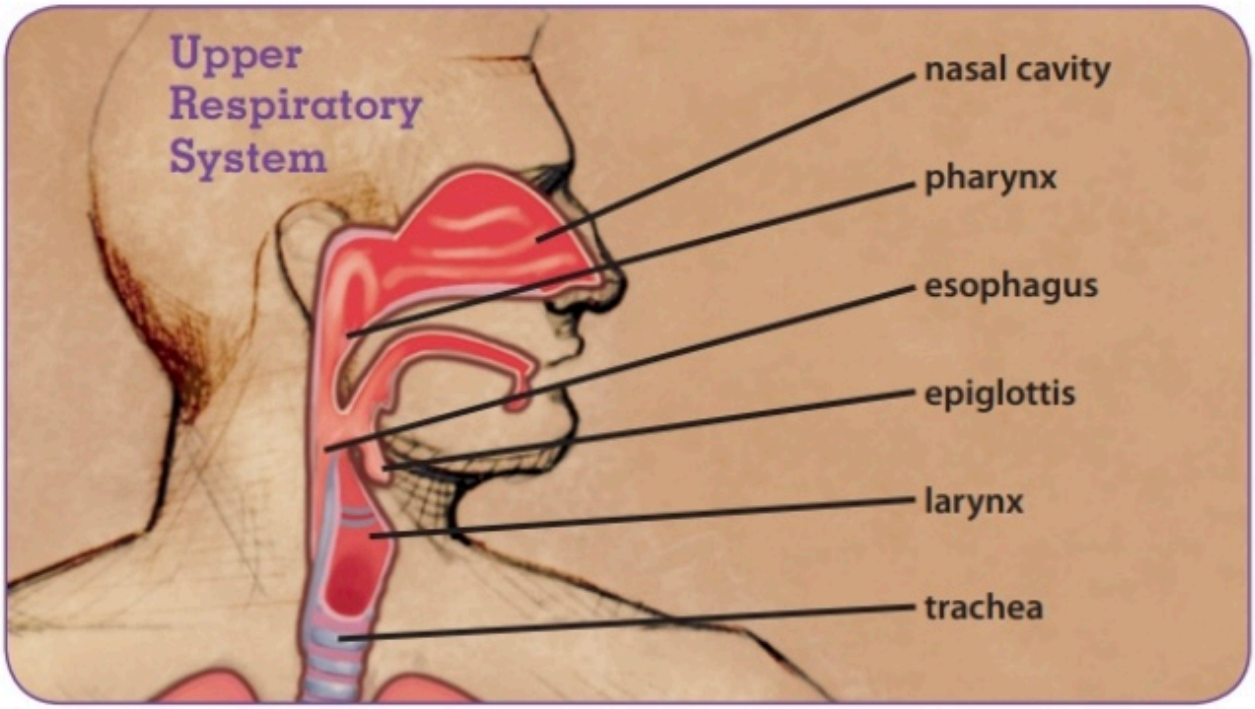
FANTASTIC FACTS

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.

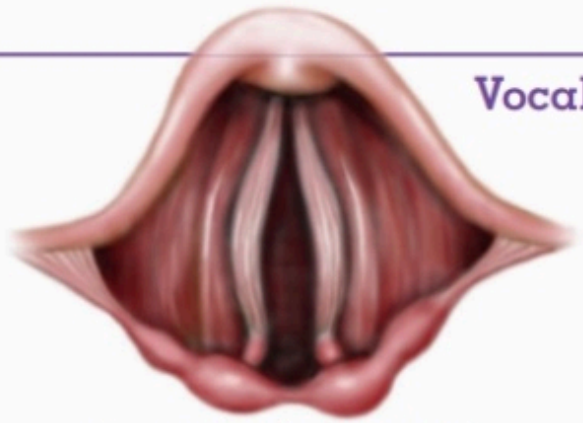
Talking or laughing with food in your mouth may cause your epiglottis to work improperly. It may stay open because you are talking though it needs to close so you can swallow your food. Instead of the food going down your esophagus, the food may accidentally go down your trachea and cause you to choke. Choking occurs when an object, such as a piece of food, goes down the wrong "pipe."

Your Larynx

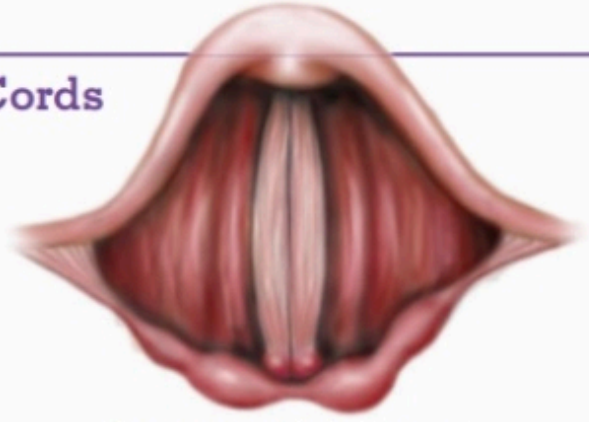
At the top of your trachea is your **larynx**, or voice box. It is made up of nine pieces of cartilage and many small muscles. Two small bands of elastic tissue stretch across the inside of the larynx. These soft bands are called your **vocal cords**.

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

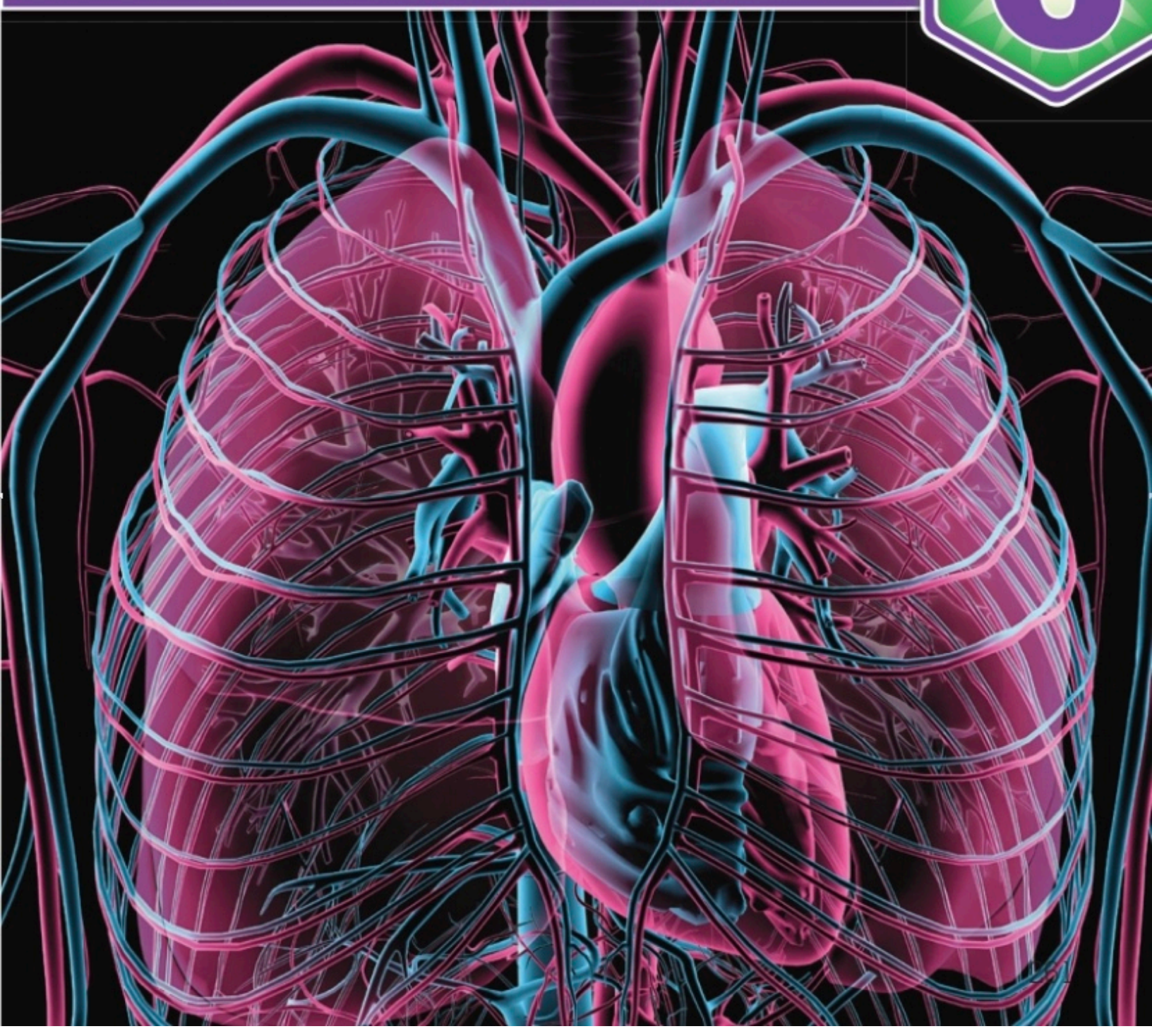
Your larynx changes the pitch of your voice by changing the thickness and the length of the vocal cords. You can model this with a balloon. Inflate a balloon and let the air escape. While the air is escaping, stretch open the mouth of the balloon. This will change the length and thickness of the opening. 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?

Inside the Body

UNIT 6



Respiratory System 11

WORLDVIEW THINKING

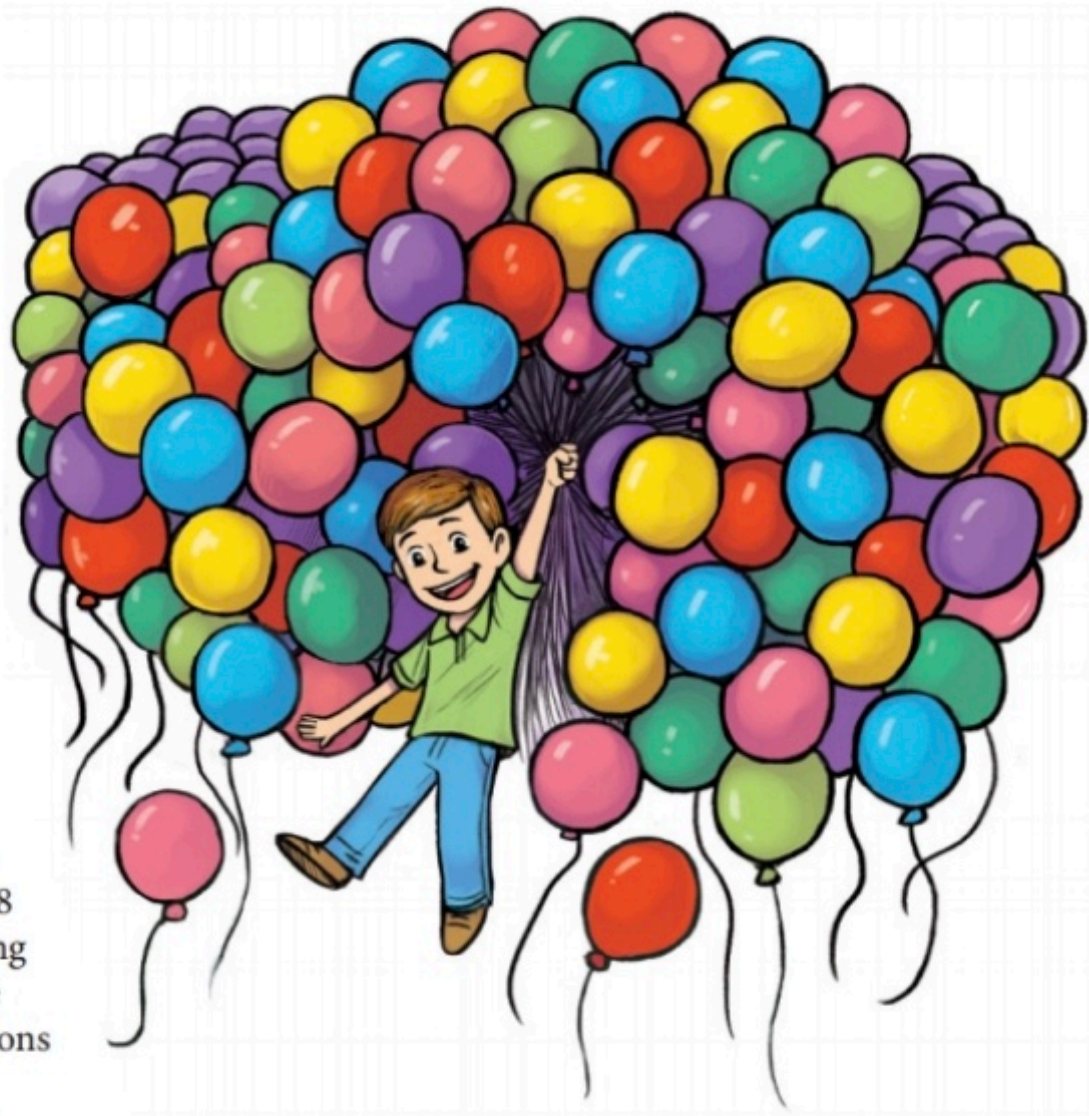
Let's take a trip inside your lungs. The tiny passageways there are lined with hairlike structures called cilia. The lining of your lungs makes a sticky mucus, which traps dust, bacteria, and other particles you breathe in. The cilia beat waves to sweep this mucus—and all it captures—out of your lungs to keep them clear and healthy.

Scientists today have learned to make artificial cilia they can control. But these cilia are not as complex as those God designed for your body. That's because no one knows how cilia are so coordinated since they have no nerves. Imagine a rowing team trying to coordinate without talking to each other! Artificial cilia have only four different parts and contain tiny magnetic particles. Scientists move them by changing magnetic fields. The actions of artificial cells are not nearly as precise or productive as the cilia in your body. As scientists and inventors look to the human body for design ideas, it draws our attention to God—the greatest designer of all.

Consider

- What is the purpose of cilia in the lungs?
- Why do you think scientists often look at the natural world to get ideas for designing things?

Breathing



You need to breathe in order to stay alive. Most of the time, you do not think about breathing, though. If you did, you would not be able to do anything else. Imagine how hard it would be to talk, work, or play if you had to stop every few seconds and remind yourself to take a breath. Even when at rest, most fifth graders breathe between 15 and 25 times each minute.

In fact, you breathe in more than 14,000 L (3,698 gal) of air each day. During your life, you will breathe enough air to fill up millions of balloons.

Genesis 2:7 tells us that God created man and breathed into him the breath of life. With this breath, man became a living person. Breathing is a gift of God. The human **respiratory system**, or breathing system, is one of His amazing designs.

Why You Breathe

Every cell in your body needs oxygen in order to live and function. Without oxygen, you would not have any energy. You would not be able to think, digest food, pump blood, or move.

When you **inhale**, or breathe in, you take in air. Your blood takes the oxygen from the air to every cell in your body. The cells use the oxygen and produce carbon dioxide. Too much carbon dioxide in your body, though, can be harmful. So the carbon dioxide is sent out of your body when you **exhale**, or breathe out.

A person needs more oxygen when he exercises or participates in activities such as baseball.

How You Breathe

The brain controls how you breathe. Most of the time, you do not have to think about it. Your brain does it automatically. This automatic breathing is called **involuntary breathing**. You breathe involuntarily when you are unconscious, asleep, or simply not thinking about breathing.

God made us able to control our breaths at times, though. **Voluntary breathing** takes place when you think about breathing and control it. Your brain can tell your body to stop breathing for a short amount of time. Without this control, you would not be able to hold your breath when swimming. You also could not do things like play wind or brass instruments.

The brain also controls how fast and how deeply you breathe. When your brain registers that there is too much carbon dioxide, it sends a signal for you to breathe more deeply. For example, when you exercise, a signal is sent to the brain that more oxygen is needed by the cells. This causes you to breathe faster.

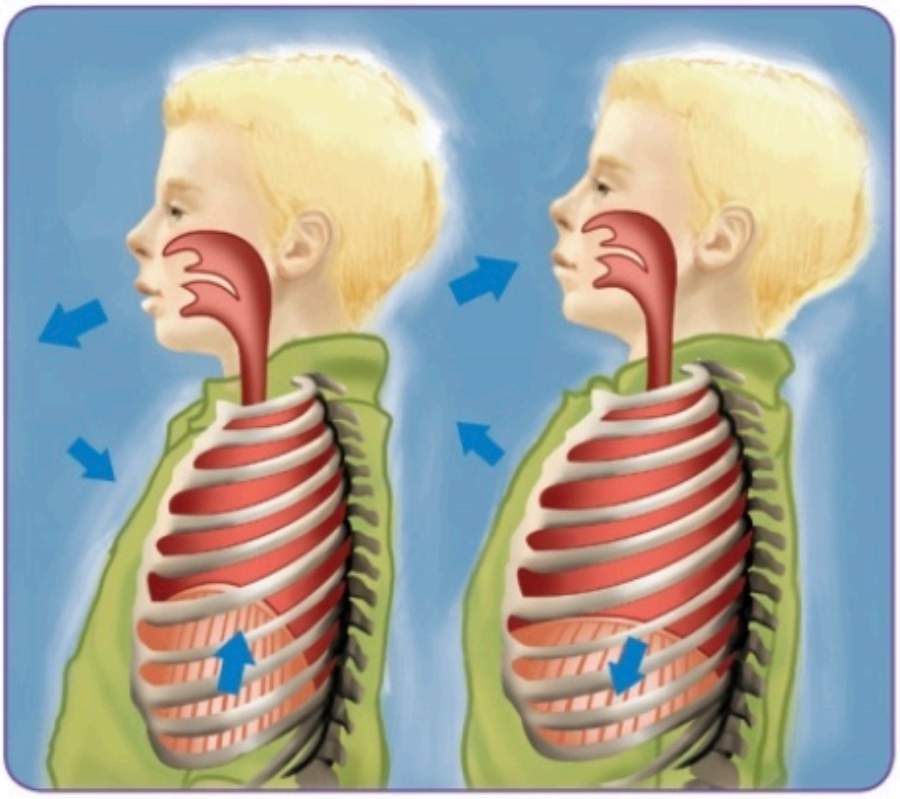
SCIENCE & HISTORY

History records examples of people free-diving, or diving while holding one's breath. In some cultures free-divers search for sponges or pearls. This is not always the case, though. One free-diver searched for something very interesting—an anchor!

In 1911 an Italian ship lost its anchor in a storm. So the ship's captain hired a Greek sponge diver, Yorgos Haggi Statti, to get the anchor back. Statti claimed that he could hold his breath for up to seven minutes. He tied a stone to himself and dove 77 m (252 ft) into the deep Aegean Sea to try to recover the anchor. On his third try, he ran a rope through the anchor's eye. The ship's crew was then able to pull up the anchor.

Breathing Muscles

Two special sets of muscles work with your brain to help you breathe. These muscles, your diaphragm and your chest muscles, change the space and pressure inside your body to allow you to breathe. The **diaphragm** is a strong, curved muscle attached below the lungs to the lower ribs and backbone. It separates the chest from the abdomen.



When a person inhales, the diaphragm moves downward and the rib cage moves upward. When a person exhales, the diaphragm pushes upward and the rib cage moves inward.

When you inhale, your diaphragm tightens and moves downward. At the same time, your chest muscles, which are located behind and between your ribs, lift your rib cage up and out of the way. This provides more space for your lungs. More space means the volume of your lungs expands. This, in turn, causes the air pressure inside them to decrease. The air pressure inside your lungs becomes less than the pressure outside your body. To equalize the pressure, air is sucked into your lungs.

When you exhale, the process is reversed. Your diaphragm and chest muscles relax. As your diaphragm relaxes, it pushes up. As your chest muscles relax, they push in. These actions decrease the amount of space in your chest and increase the air pressure. This forces the air in your lungs out of your body, releasing the carbon dioxide and other gases back into the air.

QUICK CHECK

1. What is your breathing system called?
2. Which gas does every cell in your body need?
3. Which muscles work together to help you breathe?

Find out in Chapter 11 about what funny noise can occur when air cannot flow freely though the back of the mouth and the nose.

The Bible speaks often of blood. Chapter 12 tells why the Old Testament sacrifices for sin required the shedding of blood.

Inside your body is a very important "cage." In Chapter 11 you will learn what this cage is made of and what it does.