The Respiratory System

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Lab zone **Discover Activity**

How Big Can You Blow Up a Balloon?

1. Take a normal breath, then blow as much air as possible into a balloon. Twist the end and hold it closed. Have your partner measure around the balloon at its widest point.
2. Let the air out of the balloon. Repeat Step 1 and calculate the average of the two measurements.
3. Compare your results with those of your classmates. The bigger the circumference, the greater the volume of air exhaled.

Think It Over

Inferring What factors might affect the volume of air a person can exhale?

Jerry, the main character in Doris Lessing's story "Through the Tunnel," is on vacation at the seaside. Day after day, he watches some older boys dive into deep water on one side of a huge rock. The boys mysteriously reappear on the other side. Jerry figures out that there must be an underwater tunnel in the rock. He finds the tunnel beneath the water and decides to swim through it. Once inside, though, he is terrified. The walls are slimy, and rocks scrape his body. He can barely see where he is going. But worst of all, Jerry has to hold his breath for far longer than ever before. The author describes Jerry this way: "His head was swelling, his lungs were cracking."

Respiratory System Functions

No one can go for very long without breathing. Your body cells need oxygen, and they get that oxygen from the air you breathe. **The respiratory system moves oxygen from the outside environment into the body. It also removes carbon dioxide and water from the body.**

Taking in Oxygen The oxygen your body needs comes from the atmosphere—the mixture of gases that blankets Earth. Your body doesn't use most of the other gases in the air you breathe in. When you exhale, most of the air goes back into the atmosphere.

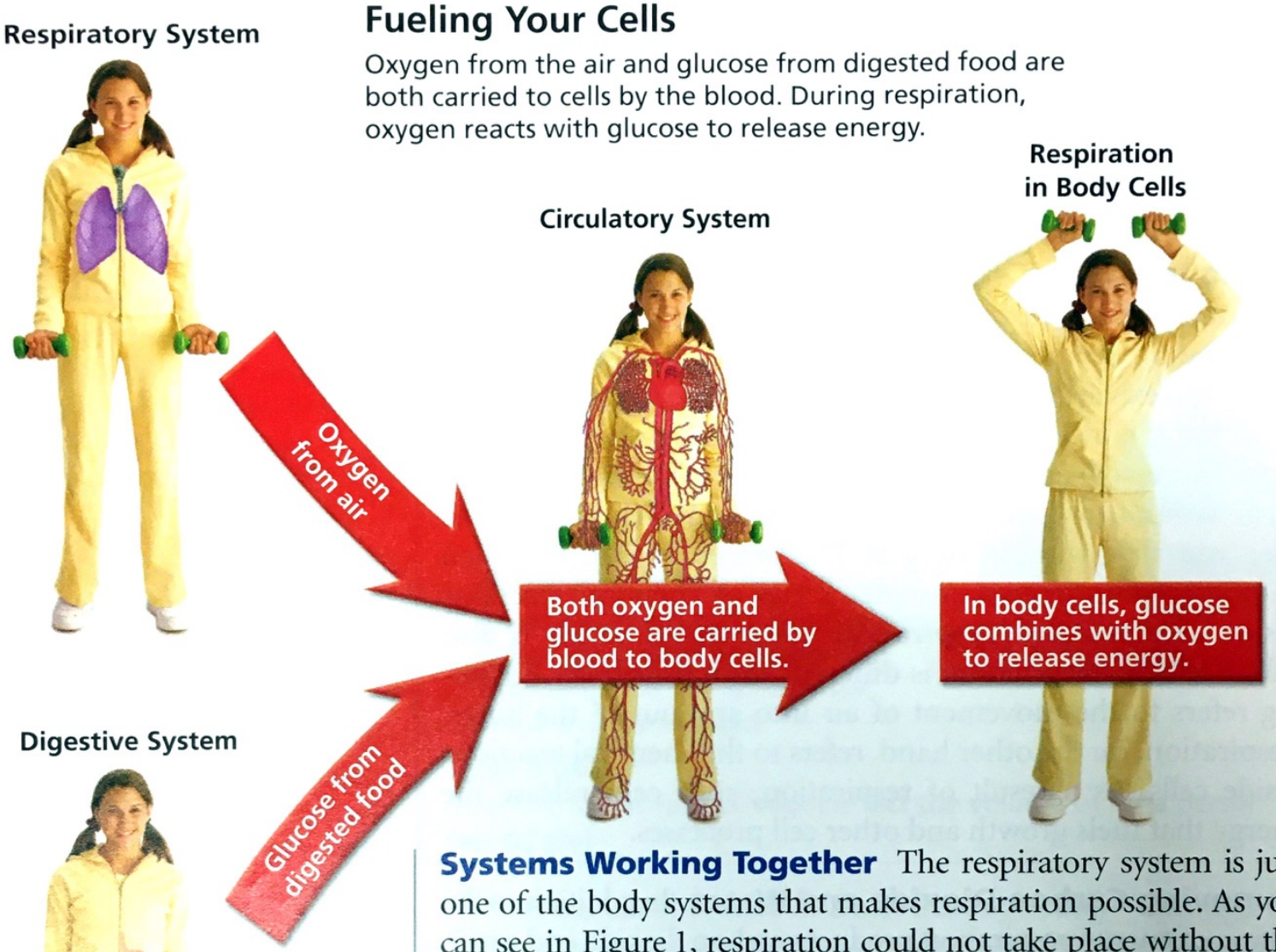
Oxygen is needed for the energy-releasing chemical reactions that take place inside your cells. Like a fire, which cannot burn without oxygen, your cells cannot "burn" enough fuel to keep you alive without oxygen. The process in which oxygen and glucose undergo a complex series of chemical reactions inside cells is called **respiration.** Respiration, which is also called cellular respiration, is different from breathing. Breathing refers to the movement of air into and out of the lungs. Respiration, on the other hand, refers to the chemical reactions inside cells. As a result of respiration, your cells release the energy that fuels growth and other cell processes.

Removing Carbon Dioxide and Water In addition to the release of energy, respiration produces carbon dioxide and water. Your respiratory system eliminates the carbon dioxide and some of the water through your lungs.

FIGURE 1

Fueling Your Cells

Oxygen from the air and glucose from digested food are both carried to cells by the blood. During respiration, oxygen reacts with glucose to release energy.



Systems Working Together The respiratory system is just one of the body systems that makes respiration possible. As you can see in Figure 1, respiration could not take place without the digestive and circulatory systems as well. Your respiratory system brings oxygen into your lungs. Meanwhile, your digestive system absorbs glucose from the food you eat. Then, your circulatory system carries both the oxygen and the glucose to your cells, where respiration occurs.

The Path of Air

If you look toward a window on a bright day, you may see tiny particles dancing in the air. These particles include such things as floating grains of dust, plant pollen, and ash from fires. Though you can't see them, air also contains microorganisms. Some of these microorganisms can cause diseases in humans. When you breathe in, all these materials enter your body along with the air.

However, most of these materials never reach your lungs. On its way to the lungs, air passes through a series of structures that filter and trap particles. These organs also warm and moisten the air. **As air travels from the outside environment to the lungs, it passes through the following structures: nose, pharynx, trachea, and bronchi.** It takes air only a few seconds to complete the route from the nose to the lungs.

The Nose Air enters the body through the nose and then moves into spaces called the nasal cavities. Some of the cells lining the nasal cavities produce mucus. This sticky material moistens the air and keeps the lining from drying out. Mucus also traps particles such as dust.

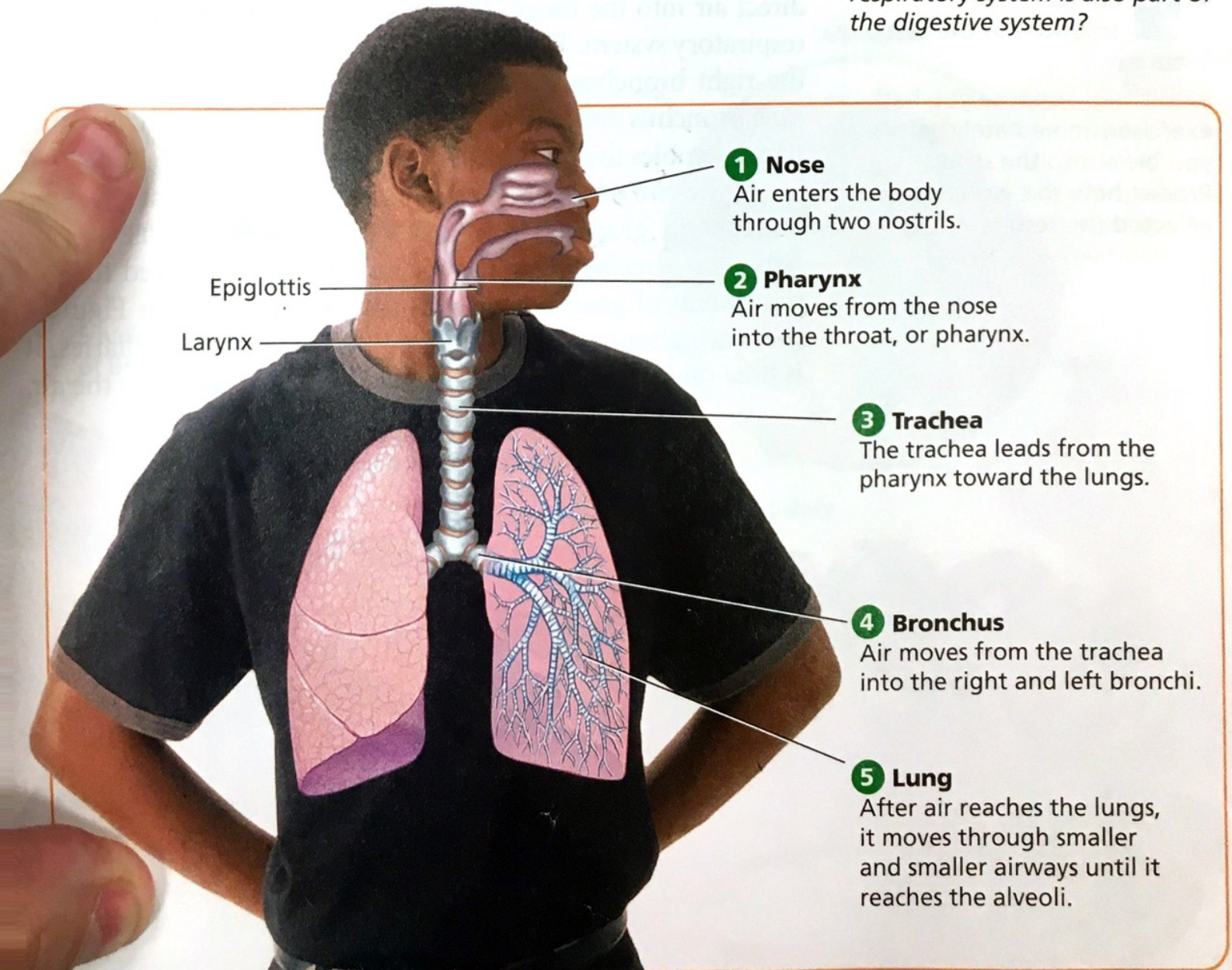
The cells that line the nasal cavities have **cilia** (SIL ee uh), tiny hairlike extensions that can move together in a sweeping motion. The cilia sweep the mucus into the throat, where you swallow it. Stomach acid destroys the mucus, along with everything trapped in it.

Some particles and bacteria can irritate the lining of your nose or throat, causing you to sneeze. The powerful force of a sneeze shoots the particles out of your nose and into the air.

The Pharynx Next, air enters the **pharynx** (FAR ingks), or throat. The pharynx is the only part of the respiratory system that is shared with another system—the digestive system. Both the nose and the mouth connect to the pharynx.

Reading Checkpoint **What is the role of cilia?**

FIGURE 2
The Respiratory System
On its path from outside the body into the lungs, air passes through several structures that clean, warm, and moisten it. Once in the lungs, the oxygen in the air can enter your bloodstream.
Classifying *Which part of the respiratory system is also part of the digestive system?*



The Trachea From the pharynx, air moves into the **trachea** (TRAY kee uh), or windpipe. You can feel your trachea if you gently run your fingers down the center of your neck. The trachea feels like a tube with a series of ridges. The firm ridges are rings of cartilage that strengthen the trachea and keep it open.

The trachea, like the nose, is lined with cilia and mucus. The cilia in the trachea sweep upward, moving mucus toward the pharynx, where it is swallowed. The trachea's cilia and mucus continue the cleaning and moistening of air that began in the nose. If particles irritate the lining of the trachea, you cough. A cough, like a sneeze, sends the particles into the air.

Normally, only air—not food—enters the trachea. If food does enter the trachea, the food can block the opening and prevent air from getting to the lungs. When that happens, a person chokes. Fortunately, food rarely gets into the trachea. The epiglottis, a small flap of tissue that folds over the trachea, seals off the trachea while you swallow.

The Bronchi and Lungs Air moves from the trachea to the **bronchi** (BRAHNG ky) (singular *bronchus*), the passages that direct air into the lungs. The **lungs** are the main organs of the respiratory system. The left bronchus leads into the left lung, and the right bronchus leads into the right lung. Inside the lungs, each bronchus divides into smaller and smaller tubes in a pattern that resembles the branches of a tree.

At the end of the smallest tubes are structures that look like bunches of grapes. The "grapes" are **alveoli** (al VEE uh ly) (singular *alveolus*), tiny sacs of lung tissue specialized for the movement of gases between air and blood. Notice in Figure 3 that each alveolus is surrounded by a network of capillaries. It is here that the blood picks up its cargo of oxygen from the air.

Gas Exchange

Because the walls of both the alveoli and the capillaries are very thin, certain materials can pass through them easily. **After air enters an alveolus, oxygen passes through the wall of the alveolus and then through the capillary wall into the blood. Carbon dioxide and water pass from the blood into the alveoli. This whole process is known as gas exchange.**

How Gas Exchange Occurs Imagine that you are a drop of blood beginning your journey through a capillary that wraps around an alveolus. When you begin that journey, you are carrying a lot of carbon dioxide and little oxygen. As you move through the capillary, oxygen gradually attaches to the hemoglobin in your red blood cells. At the same time, you are getting rid of carbon dioxide. At the end of your journey around the alveolus, you are rich in oxygen and poor in carbon dioxide.

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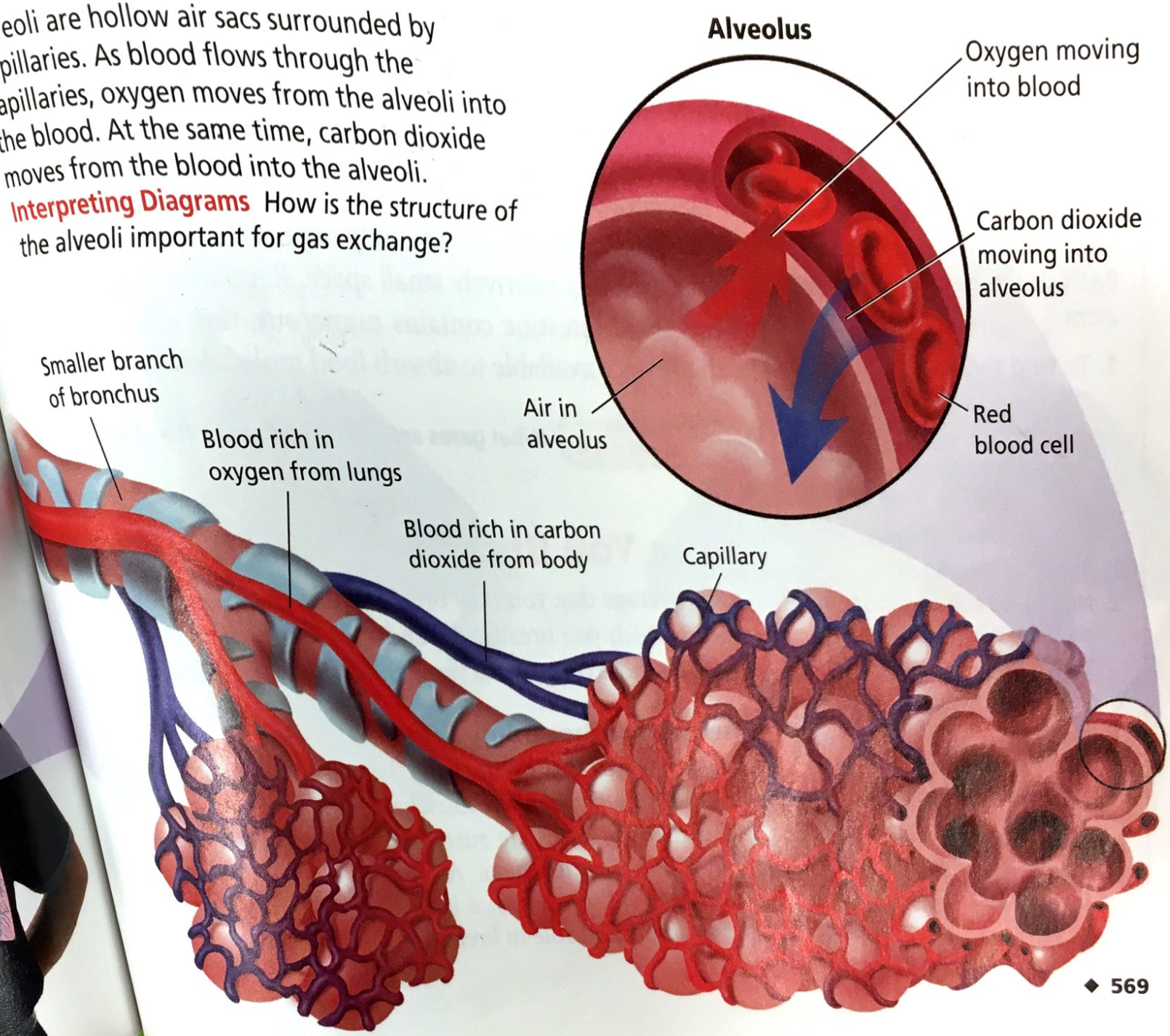
FIGURE 3

Gas Exchange in the Alveoli

Alveoli are hollow air sacs surrounded by capillaries. As blood flows through the capillaries, oxygen moves from the alveoli into the blood. At the same time, carbon dioxide moves from the blood into the alveoli.

Interpreting Diagrams How is the structure of the alveoli important for gas exchange?



Surface Area for Gas Exchange Your lungs can absorb a large amount of oxygen because of the large surface area of the alveoli. An adult's lungs contain about 300 million alveoli. If you opened the alveoli and spread them out on a flat surface, you would have a surface area of about 70 square meters.

The huge surface area of the alveoli enables the lungs to absorb a large amount of oxygen. The lungs can, therefore, supply the oxygen that people need—even when they are performing strenuous activities. When you play a wind instrument or a fast-paced game of basketball, you have your alveoli to thank.

Your lungs are not the only organs that provide a large surface area in a relatively small space. Recall from Chapter 2 that the small intestine contains numerous, tiny villi that increase the surface available to absorb food molecules.

Reading Checkpoint **What gases are exchanged across the alveoli?**

How You Breathe

In an average day, you may breathe more than 20,000 times. The rate at which you breathe depends on your body's need for oxygen. The more oxygen you need, the faster you breathe.

Muscles for Breathing Breathing, like other body movements, is controlled by muscles. Figure 5 shows the structure of the chest, including the muscles that enable you to breathe. Notice that the lungs are surrounded by the ribs, which have muscles attached to them. At the base of the lungs is the **diaphragm** (DY uh fram), a large, dome-shaped muscle that plays an important role in breathing.

The Process of Breathing **When you breathe, the actions of your rib muscles and diaphragm expand or contract your chest. As a result, air flows in or out.**

Here's what happens when you inhale, or breathe in. The rib muscles contract, lifting the chest wall upward and outward. At the same time, the diaphragm contracts and moves downward. The combined action of these muscles makes the chest cavity larger. The same amount of air now occupies a larger space, causing the pressure of the air inside your lungs to decrease. This change means that the pressure of air inside the chest cavity is lower than the pressure of the atmosphere pushing on the body. Because of this difference in air pressure, air rushes into your chest, in the same way that air is sucked into a vacuum cleaner.

When you exhale, or breathe out, the rib muscles and diaphragm relax. This reduces the size of the chest cavity. This decrease in size squeezes air out of the lungs, the way squeezing a container of ketchup pushes ketchup out of the opening.

Reading Checkpoint **What muscles cause the chest to expand during breathing?**

FIGURE 5

The Breathing Process

When you inhale, the diaphragm moves downward and pressure in the lungs decreases, causing air to flow in. When you exhale, the diaphragm moves upward and the pressure in the lungs increases, pushing the air out.

Interpreting Diagrams *How does the movement of the diaphragm affect the size of the chest cavity?*

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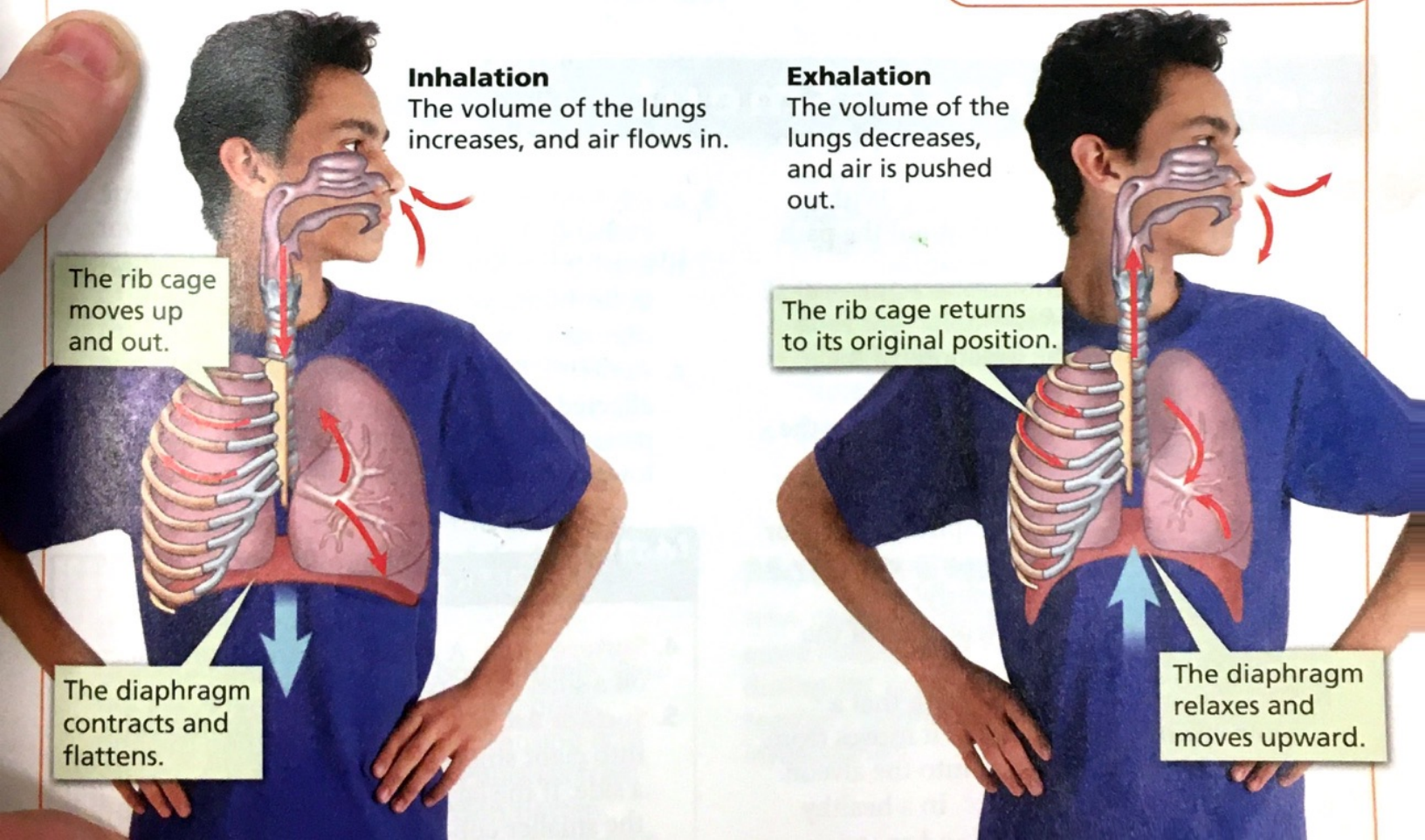

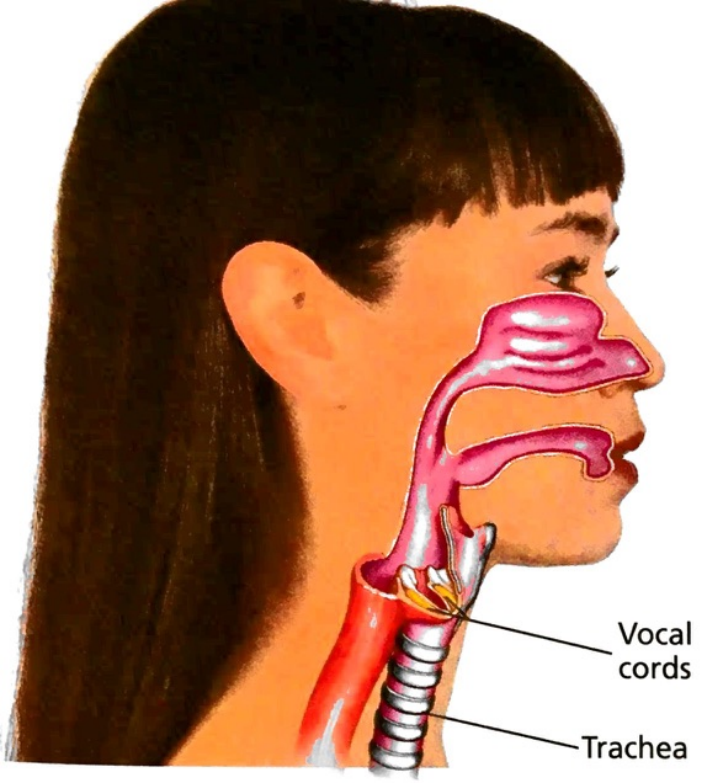

FIGURE 6
The Vocal Cords
Air moving over the vocal cords causes them to vibrate and produce sound.
Interpreting Diagrams *Where are the vocal cords located?*

Relating Breathing and Speaking The air that moves out of your lungs as you breathe also helps you speak. The **larynx** (LAR ingks), or voice box, is located in the top part of the trachea, underneath the epiglottis. Place your fingers on your Adam's apple, which sticks out from the front of your neck. You can feel some of the cartilage that makes up the larynx. Two **vocal cords**, folds of connective tissue that produce your voice, stretch across the opening of the larynx.

If you've ever let air out of a balloon while stretching its neck, you've heard the squeaking sound that the air makes. The neck of the balloon is something like your vocal cords. If you look at Figure 6 you can see that the vocal cords have a slitlike opening between them. When you speak, muscles make the vocal cords contract, narrowing the opening. Air from the lungs rushes through this opening. The movement of the vocal cords makes the air molecules vibrate, or move rapidly back and forth. This vibration creates a sound—your voice.

Section 1 Assessment

Target Reading Skill Sequencing With a partner, review your flowchart about the path of air. Add any necessary information.

Reviewing Key Concepts

1. **a.** Listing What are the functions of the respiratory system?
   b. Comparing and Contrasting Explain the difference between respiration and breathing.
   c. Predicting How might respiration in your body cells be affected if your respiratory system did not work properly?
2. **a.** Identifying Name the structures of the respiratory system.
   b. Sequencing Describe the path that a molecule of oxygen takes as it moves from the air outside your body into the alveoli.
   c. Relating Cause and Effect In a healthy person, how do coughing and sneezing protect the respiratory system?
3. **a.** Reviewing What three substances are exchanged in the alveoli?
   b. Explaining What happens to the carbon dioxide in the blood when it flows through the capillaries in the alveoli?
   c. Applying Concepts How would gas exchange be affected at the top of a tall mountain, where air pressure is lower and there is less oxygen than at lower elevations? Explain.

Math Practice

4. Surface Area A cube measures 4 cm × 4 cm on a side. Find its surface area.
5. Surface Area Suppose you cut up the cube into eight smaller cubes, each 2 cm × 2 cm on a side. If the larger cube represents a lung, and the smaller cubes represent alveoli, which would provide a larger surface area for oxygen exchange?