Chapter 14

Maintaining the Body

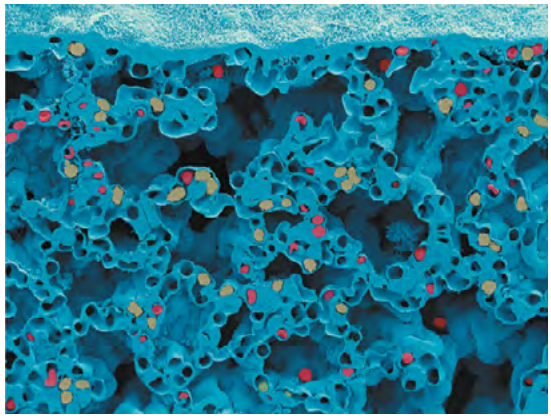
14.4 Respiration

Maybe it's only when you're huffing and puffing that you really think about breathing. Still, breathing in and out is something you do as many as 17,000 times a day! Breathing is your body's way of taking in oxygen, which is needed for cellular respiration, the process cells use to obtain energy in the form of ATP. Through breathing, your respiratory system moves oxygen from the air into your **lungs**, where gas exchange occurs. From the lungs, oxygen enters the circulatory system, which then delivers it to all your tissues. Breathing also allows your respiratory system to get rid of carbon dioxide, a waste product from an important cellular activity, the production of ATP.

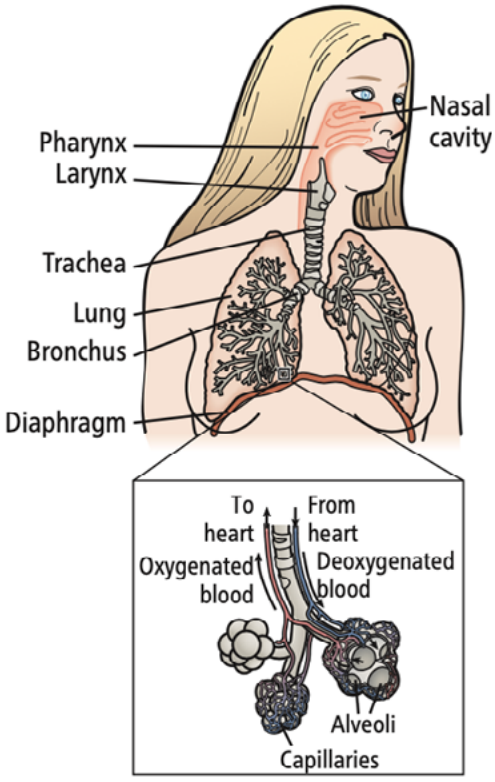
The Path of Air

FIGURE 14.8

(a) This photo (a scanning electron micrograph) shows a cross-section through the lung. Blood vessels surround alveoli, which appear as round empty spaces in the photo. Red blood cells (red) and white blood cells (yellow) are also visible. (b) The respiratory system brings oxygen into the body and gets rid of carbon dioxide. Gas exchange occurs in the lungs, in tiny sacs called alveoli.



(a)



(b)

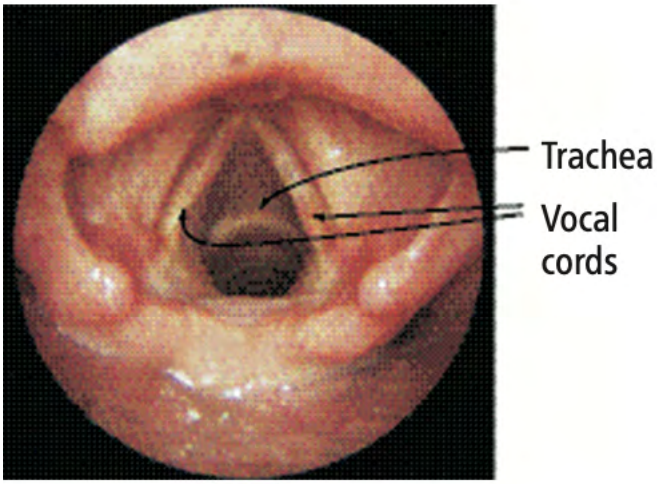
The respiratory system is shown in Figure 14.8. When you inhale, air enters through your nose. (You can also breathe in through your mouth—this is a useful backup because otherwise a stuffy nose could be fatal.) Hairs in your nostrils trap dust and other particles. Air continues up your nasal passages, where it is moistened by mucus and warmed by a dense network of capillaries. In the nasal passages, your sensory cells for smell also capture odor molecules present in the air. From the nasal passages, air moves through the *pharynx*, the part of the throat above the esophagus and windpipe. It then proceeds through the *larynx*, or voice box, and down the **trachea**, or windpipe. The trachea is a short tube stiffened by rings of cartilage. The rings keep the trachea open. The trachea branches into two tubes called *bronchi* that lead to the right and left lungs. Each bronchus branches into smaller and smaller tubules that finally end at tiny sacs called **alveoli**, where gas exchange occurs.

Your lungs contain about 300 million alveoli. Each alveolus is surrounded by a net of capillaries. Both the alveolus and the surrounding capillaries have extremely thin walls, consisting of only a single flattened cell. This allows gas exchange to happen through diffusion. Gas molecules diffuse down their concentration gradients—oxygen diffuses from the alveolus into the blood, and carbon dioxide diffuses from the blood into the alveolus.

When you exhale, air reverses its path. Air moves from the alveoli up through tubules to the bronchi, trachea, and nasal passages, and out through the nose. As air passes the larynx, it may vibrate your vocal cords (Figure 14.9). This makes the sound waves that allow you to talk, yell, and sing. In order to make different sounds, you control muscles that stretch your vocal cords, as well as other muscles in your lips, tongue, and cheeks.

FIGURE 14.9

Vibrations in your vocal cords produce the sounds that make up speech. You control the sounds you make by loosening or tightening your vocal cords and by moving the muscles of your lips, tongue, and cheeks.



Inhaling and Exhaling

How do you inhale and exhale? Your lungs sit inside your rib cage in an air-filled pocket called the *thoracic cavity*. The bottom of the thoracic cavity is covered by a sheet of muscle called the **diaphragm**. The contraction and relaxation of the diaphragm cause inhalation and exhalation. When the diaphragm is relaxed, it is dome shaped (Figure 14.10). When you inhale, you contract your diaphragm. The muscle fibers shorten, and the diaphragm flattens, increasing the volume of the thoracic cavity. The muscles between your ribs also contract, pulling the rib cage up and out from the body. This further increases the volume of the thoracic cavity. When the volume of the thoracic cavity increases, the air pressure inside it decreases and becomes lower than the pressure of the air outside the body. Since air will move from an area of high pressure to an area of lower pressure, air enters the lungs, filling the alveoli. This process is similar to the way a bicycle pump sucks in air when you pull back its plunger.

When you exhale, the diaphragm and rib muscles relax, decreasing the volume of the thoracic cavity. This increases the air pressure in the thoracic cavity and pushes air out of the lungs. You breathe about 12 times each minute. During a typical breath, only about 10% of the air in the lungs is exchanged with outside air—this is enough to keep your body tissues supplied with oxygen. Of course, you have some control over how often and how deeply you breathe. You don't have to worry about "forgetting" to breathe, though; respiration is controlled automatically by the brainstem, along with many other involuntary activities.

By the way, if you have ever wondered what a hiccup really is, a hiccup is caused by a sudden spasm of the diaphragm. Each spasm sucks air in, snapping the vocal cords shut and creating a "Whic" noise. Hiccups may be caused by any irritation to the diaphragm, including eating too much or too quickly.

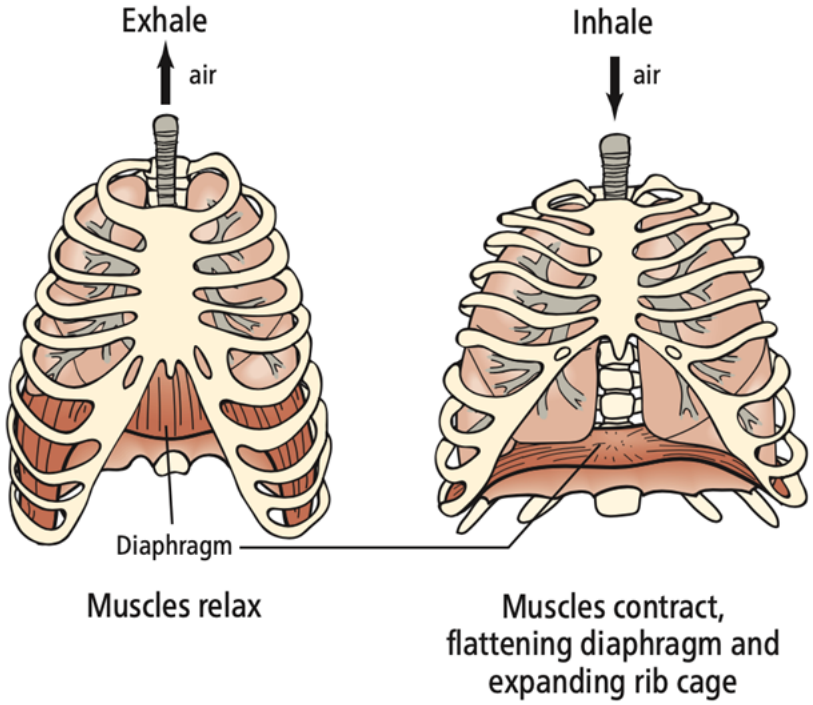


FIGURE 14.10

When you inhale, your diaphragm contracts and flattens and your rib cage expands. This increases the volume of the thoracic cavity, causing air to flow into your lungs. When you exhale, the diaphragm and rib muscles relax, pushing air out of the lungs.

READING CHECK

Does it take energy to inhale, to exhale, or both?

CHECK YOUR ANSWER

It takes energy to inhale. Energy is needed to contract the muscles of the diaphragm and the rib cage. It does not take energy to exhale. Exhalation requires only that these muscles relax, a process that requires no energy.

You can read more about the respiratory system here:

https://www.livescience.com/22616-respiratory-system.html