37–3 The Respiratory System

Guide for Reading

Key Concepts
- What is the function of the respiratory system?
- How does smoking affect the respiratory system?

Vocabulary
pharynx
trachea
larynx
bronchus
alveolus
diaphragm
nicotine
emphysema

Reading Strategy: Monitoring Your Understanding Make a table with three columns labeled K, W, and L. Before you read, write what you know about respiration in column K and what you want to learn in column W. After you read, write what you have learned in column L.

When paramedics rush to the aid of an injured person, they check to see if the person is breathing. If the person's chest is not rising and falling and they cannot feel or hear air being exhaled from the mouth or nose, it is likely that the person is not breathing. Paramedics will ignore broken bones or burns to focus on breathing because there is no time to lose! If breathing stops for more than a few minutes, a life may be lost.

Paramedics can do mouth-to-mouth rescue breathing to force air into the lungs. They can do chest compressions to keep the blood circulating. Cardiopulmonary resuscitation, or CPR, is rescue breathing combined with chest compressions.

What Is Respiration?

In biology, the word *respiration* is used in two slightly different ways. Cellular respiration, which takes place in mitochondria, is the release of energy from the breakdown of food molecules in the presence of oxygen. Without oxygen, cells lose much of their ability to produce ATP. Without ATP, cells cannot synthesize new molecules, pump ions, or carry nerve impulses.

The blood carries oxygen from the lungs to the body's tissues, and carries carbon dioxide—a waste product of cellular respiration—in the opposite direction. At the level of the organism, respiration means the process of gas exchange—the release of carbon dioxide and the uptake of oxygen between the lungs and the environment.

The Human Respiratory System

The basic function performed by the human respiratory system is remarkably simple—to bring about the exchange of oxygen and carbon dioxide between the blood, the air, and tissues. With each breath, air enters the body through the air passageways and fills the lungs, where gas exchange takes place. The respiratory system consists of the nose, pharynx, larynx, trachea, bronchi, and lungs.

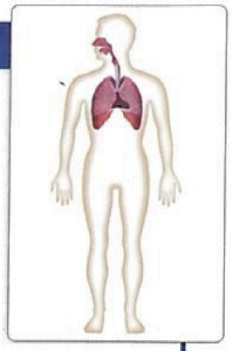
Figure 37–13 shows the structures of the respiratory system. Air moves through the nose to a tube at the back of the mouth called the pharynx, or throat. The **pharynx** serves as a passageway for both air and food. Air moves from the pharynx into the **trachea,** or windpipe. A flap of tissue called the epiglottis covers the entrance to the trachea when you swallow.

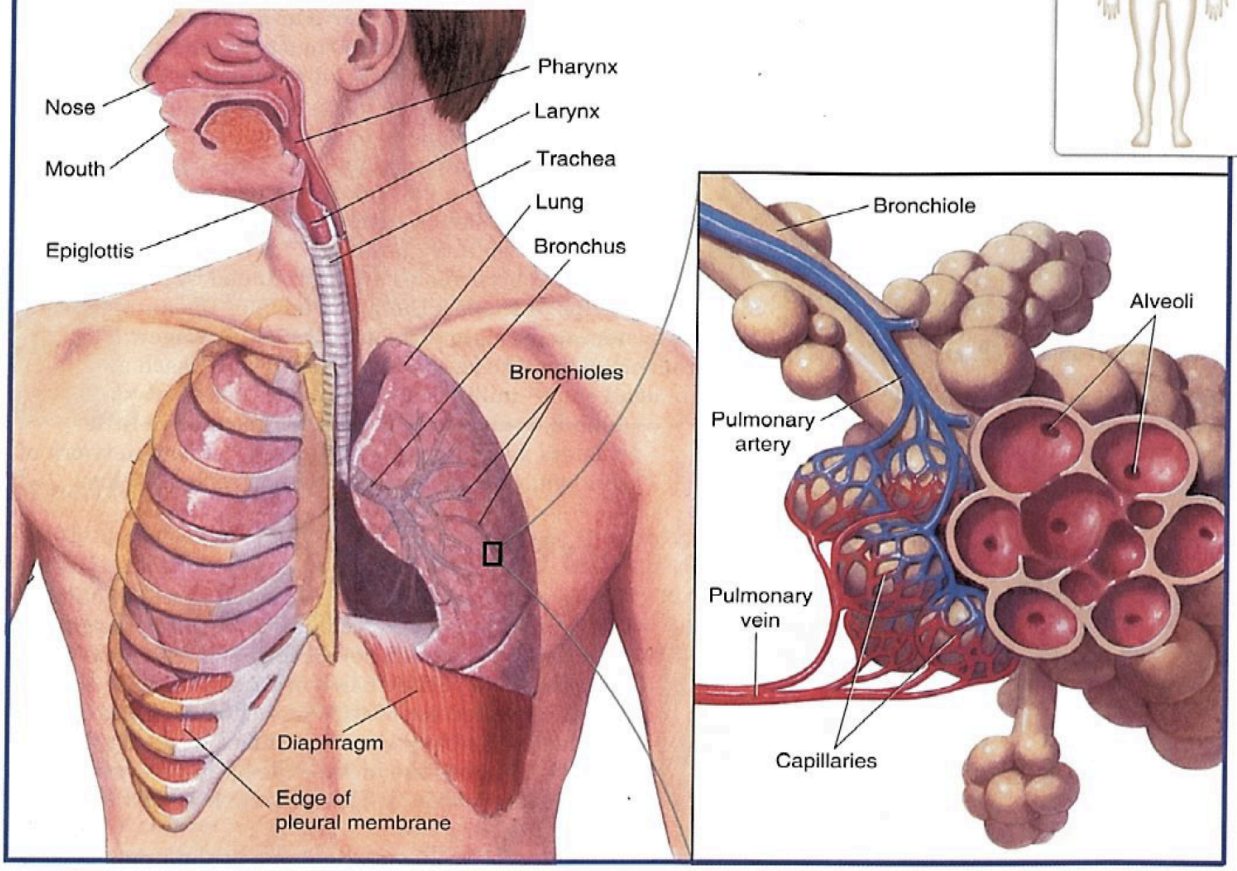
(magnification: 5600×)

◀ **Figure 37–12** In this cross section of the trachea, the cilia have been colored green. **Inferring** *What is the role of cilia in the respiratory system?*

FIGURE 37–13 THE RESPIRATORY SYSTEM

The respiratory system is responsible for the exchange of oxygen and carbon dioxide. Air moves through the nose, pharynx, larynx, trachea, and lungs. After reaching the lungs, the trachea branches into smaller and smaller tubes called bronchioles, which end in alveoli, or air sacs.





Cilia and Mucus The respiratory passageways allow air to pass directly into some of the most delicate tissues in the body. To keep the lung tissue healthy, air entering the respiratory system must be warmed, moistened, and filtered. Large dust particles get trapped by the hairs lining the entrance to the nasal cavity. Some of the cells that line the respiratory system produce a thin layer of mucus. The mucus moistens the air and traps inhaled particles of dust or smoke. Cilia sweep the trapped particles and mucus away from the lungs toward the pharynx. The mucus and trapped particles are either swallowed or spit out. These protective measures help keep the lungs clean and open for the important work of gas exchange.

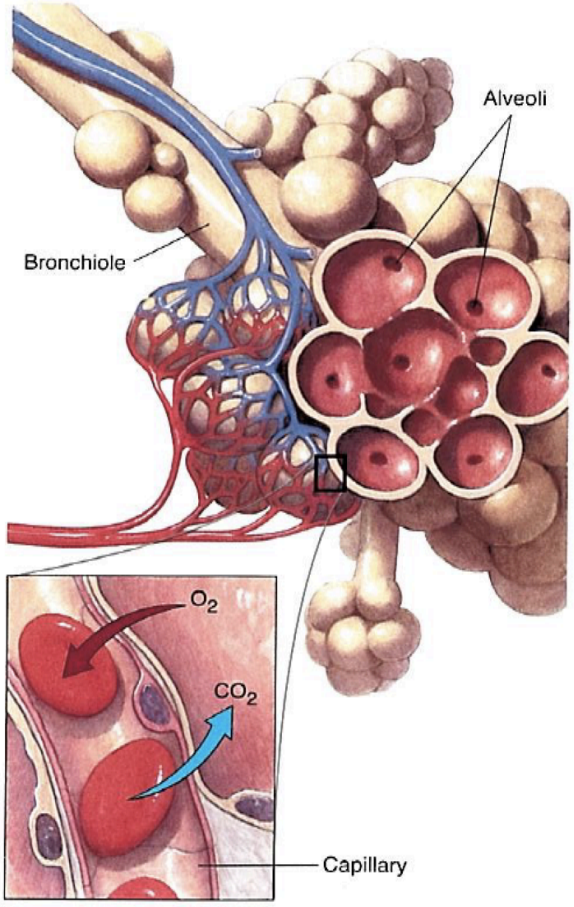
CHECKPOINT *What is the pharynx?*

The Larynx At the top of the trachea is the larynx. The **larynx** contains two highly elastic folds of tissue known as the vocal cords. When muscles pull the vocal cords together, the air moving between them causes the cords to vibrate and produce sounds. Your ability to speak, shout, and sing comes from these tissues.

The Bronchi From the larynx, air passes through the trachea into two large passageways in the chest cavity called **bronchi** (singular: bronchus). Each bronchus leads into one of the lungs. Within each lung, the large bronchus subdivides into smaller bronchi, which lead to even smaller passageways called bronchioles. Air moving along this path can be compared to a motorist who takes an exit off an eight-lane highway onto a four-lane highway, makes a turn onto a two-lane road, and ends up on a narrow country lane.

The bronchi and bronchioles are surrounded by smooth muscle that helps to support them and enables the autonomic nervous system to regulate the size of the air passageways. The bronchioles continue to subdivide until they reach a series of dead ends—millions of tiny air sacs called **alveoli** (singular: alveolus). Alveoli are grouped in little clusters, like bunches of grapes. A delicate network of thin-walled capillaries surrounds each alveolus.

▼ **Figure 37–14** Gas exchange occurs by diffusion across the membrane of an alveolus and a capillary. **Drawing Conclusions** *Where is oxygen more concentrated, in an alveolus or in a capillary?*



Gas Exchange

There are about 150 million alveoli in each healthy lung, providing an enormous surface area for gas exchange. Oxygen dissolves in the moisture on the inner surface of the alveoli and then diffuses across the thin-walled capillaries into the blood. Carbon dioxide in the bloodstream diffuses in the opposite direction, across the membrane of an alveolus and into the air within it. This process is illustrated in **Figure 37–14.**

The process of gas exchange in the lungs is very efficient. The air that you inhale usually contains 21 percent oxygen and 0.04 percent carbon dioxide. Exhaled air usually contains less than 15 percent oxygen and 4 percent carbon dioxide. The lungs remove about one fourth of the oxygen in the air that you inhale and increase the carbon dioxide content of that air by a factor of 100.

Because oxygen dissolves easily, you may wonder why hemoglobin, the oxygen-carrying protein in blood, is needed at all. The reason is efficiency. Hemoglobin binds with so much oxygen that it increases the oxygen-carrying capacity of the blood more than 60 times. Without hemoglobin to carry the oxygen that it uses, your body might need as much as 300 liters of blood to get the same result!