30.4 The Excretory System

Key Questions

- ***What is the principal role of the structures of the excretory system?***
- ***How do the kidneys clean the blood?***
- ***How do the kidneys help maintain homeostasis?***

Vocabulary

excretion
ureter
urinary bladder
urethra
nephron
filtration
glomerulus
Bowman's capsule
reabsorption
loop of Henle

Taking Notes

Preview Visuals Examine **Figure 30–19.** What does this Figure reveal about the important functions of the kidneys?

THINK ABOUT IT It's a hot day, and you've been getting thirsty for hours. Finally, you get the chance to go inside, and you gulp down more than a liter of water. The water tastes great, but as you drink, you begin to wonder. Where's all that water going? Will it just dilute your blood, or is something in your body making sure that everything stays in balance?

Structures of the Excretory System

What is the principal role of the structures of the excretory system?

The chemistry of the human body is a marvelous thing. An intricate system of checks and balances controls everything from your blood pressure to your body temperature. Nutrients are absorbed, stored, and carefully released when they are needed. However, every living system, including the human body, produces chemical waste products, some of which are so toxic that they will cause death if they are not eliminated.

For example, as a normal consequence of being alive, every cell in the body produces waste compounds, including excess salts and carbon dioxide. Ammonia, one of the most toxic of these waste compounds, is produced when the amino acids from proteins are used for energy. Ammonia is converted to a less toxic compound called urea, but it, too, must be eliminated from the body. The process by which these metabolic wastes are eliminated to maintain homeostasis is called **excretion.** Excretion is one part of the many processes that maintain homeostasis.

The excretory system, which includes the skin, lungs, liver, and kidneys, excretes metabolic wastes from the body. The ureters, urinary bladder, and urethra are also involved in excretion. **Figure 30–18** shows the major organs of excretion.

In Your Notebook *Make a two-column table that lists the organs of excretion in the first column and their function in the second column.*

The Skin The skin excretes excess water, salts, and a small amount of urea in sweat. By releasing sweat in very small amounts, this process eliminates wastes even when you may not think you're sweating.

The Lungs The blood transports carbon dioxide, a waste product of cellular respiration, from the body cells to the lungs. When you exhale, your lungs excrete carbon dioxide and small amounts of water vapor.

The Liver The liver plays many important roles in excretion. As we have seen, one of its principal activities is the conversion of potentially dangerous nitrogen wastes, a product of protein breakdown, into less toxic urea. Urea, which is highly soluble, is then transported through the blood to the kidneys for elimination from the body.

The Kidneys The major organs of excretion are the kidneys, a pair of fist-sized organs located on either side of the spinal column near the lower back. Through a complex filtering process, the kidneys remove excess water, urea, and metabolic wastes from the blood. The kidneys produce and excrete a waste product known as urine. **Ureters** transport urine from the kidneys to the **urinary bladder,** where the urine is stored until it is released through the **urethra.**

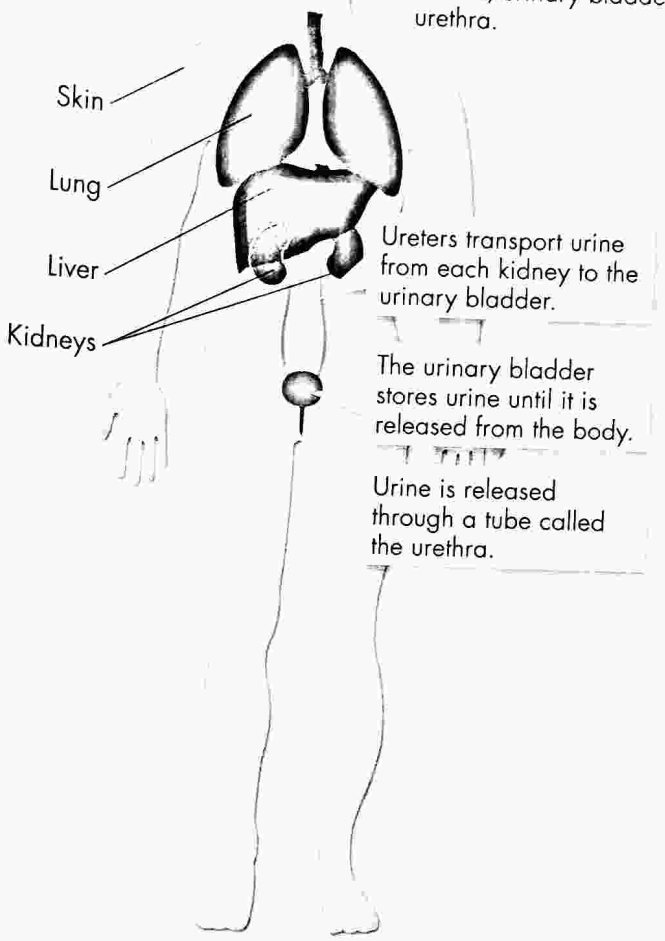


FIGURE 30–18 The Excretory System The organs of the excretory system include the skin, lungs, liver, kidneys, ureters, urinary bladder, and urethra.

Analyzing Data

The Composition of Urine

The kidneys are selective filters. As blood passes through them, urea, other impurities, and excess salts are removed from the blood. But important substances such as water, protein, and glucose remain in circulation. The collected waste products are excreted in urine. The concentrations of certain substances in the blood compared to their concentration in urine reveal the important work of the kidneys.

Concentrations of Selected Substances in Blood and Urine

Substance	Average Concentration in Blood (g/mL)	Average Concentration in Urine (g/mL)
Calcium	0.01	0.02
Glucose	0.10	0.00
Potassium	0.02	0.20
Sodium	0.32	0.60
Urea	0.03	2.00

1. Interpret Data Which substances listed have the highest and lowest concentrations in the blood? Which substances have the highest and lowest concentrations in the urine?

2. Calculate Approximately how many times more concentrated is urea in urine than in the blood? MATH

3. Infer Recall that urea is a byproduct of amino acid breakdown. How might the urea concentration vary in the blood and urine as the result of high protein diets? Explain.

Excretion and the Kidneys

How do the kidneys clean the blood?

What does a kidney do? **As waste-laden blood enters the kidney through the renal artery, the kidney removes urea, excess water and minerals, and other waste products.** The clean, filtered blood leaves the kidney through the renal vein and returns to circulation.

Each kidney contains nearly a million individual processing units called **nephrons.** These nephrons are where most of the work of the kidney takes place—impurities are filtered out, wastes are collected, and purified blood is returned to circulation. Blood purification in the kidneys is complex and involves two distinct processes: filtration and reabsorption.

BUILD Vocabulary

WORD ORIGINS The word **glomerulus** derives from the Latin words *glomus,* which means "ball of yarn," and *glomerare,* which means "to form into a ball." The twisted capillaries of a glomerulus resemble a ball of yarn.

Filtration Passing a liquid or gas through a filter to remove wastes is called **filtration.** The filtration of blood mainly takes place in the **glomerulus** (gloh MUR yoo lus). A glomerulus is a small but dense network of capillaries (very small blood vessels) encased in the upper end of each nephron by a hollow, cup-shaped structure called **Bowman's capsule.** A glomerulus is shown in **Figure 30–19.**

Because the blood is under pressure and the walls of the capillaries and Bowman's capsule are permeable, much of the fluid from the capillaries flows into Bowman's capsule. The material that is filtered from the blood is called the filtrate. The filtrate contains water, urea, glucose, salts, amino acids, and some vitamins. Large substances in the blood, such as proteins and blood cells, are too large to pass through the capillary walls.

Reabsorption Nearly 180 liters of filtrate pass from the blood into nephron tubules every day. That's the equivalent of 90 2-liter bottles of soft drink. Thank goodness, not all of those 180 liters are excreted. In fact, nearly all of the material that moves into Bowman's capsule makes its way back into the blood. The process by which water and dissolved substances are taken back into the blood is called **reabsorption.**

A number of materials, including salts, vitamins, amino acids, fats, and glucose, are removed from the filtrate by active transport and reabsorbed by the capillaries. Because water follows these materials by osmosis, almost 99 percent of the water that enters Bowman's capsule is actually reabsorbed into the blood. In effect, the kidney first throws away nearly everything and then takes back only what the body needs. This is how the kidney is able to remove drugs and toxic compounds from the blood—even chemicals the body has never seen before.

A section of the nephron tubule called the **loop of Henle** is responsible for conserving water and minimizing the volume of the filtrate. The waste material—now called urine—that remains in the tubule is emptied into a collecting duct.

Urine Excretion From the collecting ducts, urine flows to the ureter of each kidney. The ureters carry urine to the urinary bladder for storage until the urine leaves the body through the urethra.

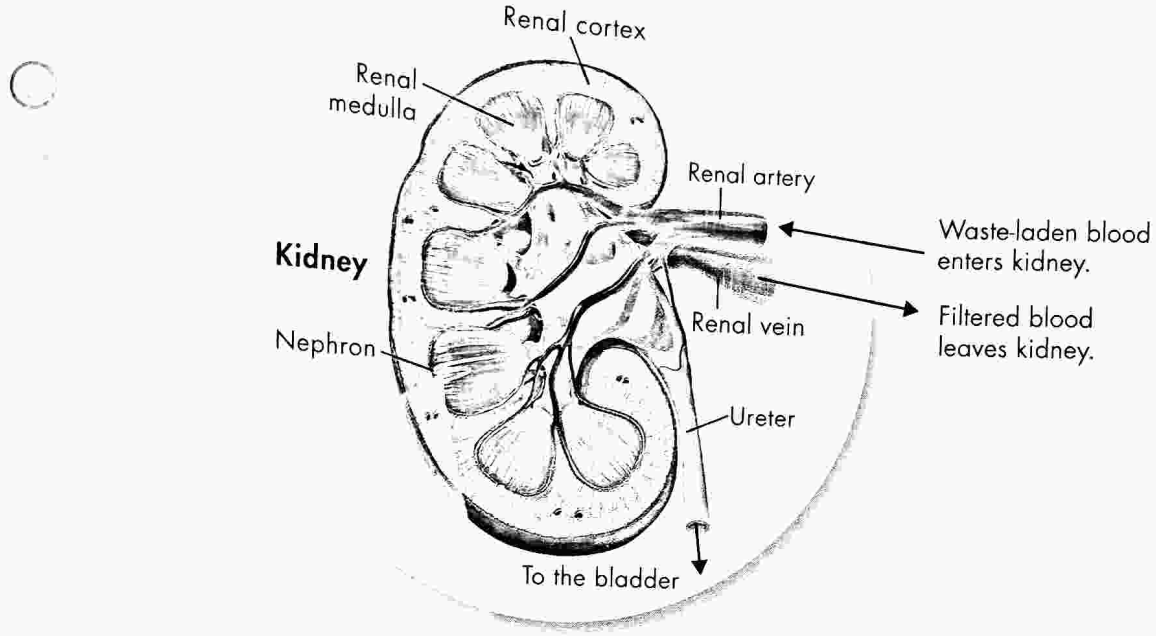
MYSTERY CLUE

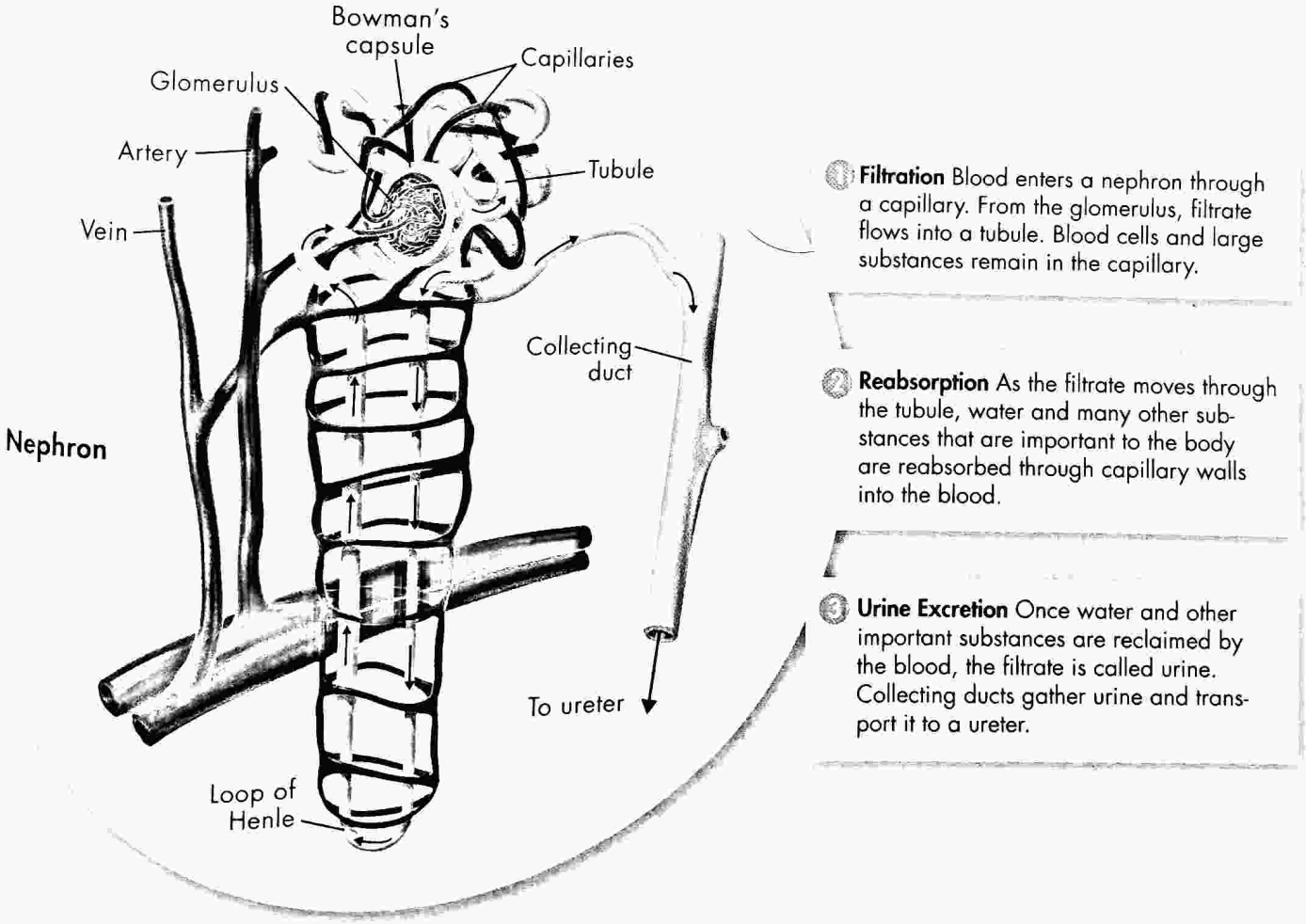
The illegal drug taken by one of the athletes contained a synthetic compound never found in nature. How did his body remove the compound from his blood and eliminate it in urine?

ZOOMING IN

STRUCTURE AND FUNCTION OF THE KIDNEYS

FIGURE 30–19 Kidneys are made up of nephrons. Blood enters the nephron, where impurities are filtered out and emptied into the collecting duct. Purified blood leaves a nephron through a vein. **Interpret Visuals** *List in order the structures that blood flows through in a kidney.*





1. **Filtration** Blood enters a nephron through a capillary. From the glomerulus, filtrate flows into a tubule. Blood cells and large substances remain in the capillary.

2. **Reabsorption** As the filtrate moves through the tubule, water and many other substances that are important to the body are reabsorbed through capillary walls into the blood.

3. **Urine Excretion** Once water and other important substances are reclaimed by the blood, the filtrate is called urine. Collecting ducts gather urine and transport it to a ureter.

The Kidneys and Homeostasis

How do the kidneys help maintain homeostasis?

The kidneys play an important role in maintaining homeostasis. Besides removing wastes, the kidneys also maintain blood pH and regulate the water content of the blood. **The kidneys respond directly to the composition of the blood. They are also influenced by the endocrine system. Disruption of proper kidney function can lead to serious health problems.**

Control of Kidney Function To a large extent, the activity of the kidneys is controlled by the composition of the blood itself. For example, if you eat salty food, the kidneys will respond to the excess salt in your blood by returning less salt to your blood during reabsorption. If the blood is too acidic, then the kidneys excrete more hydrogen ions in the urine. If your blood glucose levels rise past a certain point, the kidneys will even excrete glucose into the urine. This is one of the danger signals of diabetes, a disease caused by the body's inability to control the concentration of glucose in the blood.

Glands release hormones that also influence kidney function. For example, if you have not consumed enough fluids or if you have sweat excessively, your pituitary gland releases antidiuretic hormone (ADH) into your blood. This hormone causes the kidneys to reabsorb more water and to excrete less water in the urine. If the blood contains excess water, ADH secretion stops and more water is excreted.

Did you know that the color of your urine is an indicator of how hydrated you are? A pale yellow color indicates that you are well hydrated because your kidneys are releasing a good amount of water. A darker color indicates that the water level in your blood is low, causing your kidneys to conserve water.

MYSTERY CLUE

Would Seth's and Philip's blood contain a high level or low level of ADH?

Urine Testing Medical professionals can learn a lot about a person's health from a simple urine sample. The presence of protein or glucose in urine can be indicators of diseases such as dangerously high blood pressure or diabetes. Although many filtered substances are reabsorbed into the blood, drugs generally remain in the filtrate and are eliminated in urine. This is why the effects of many drugs wear off over time and why urine tests are often used to detect the use of illegal drugs.

In Your Notebook *Explain in your own words why urine can reveal a lot about a person's health.*

Kidney Disorders The kidneys are the master chemists of the blood supply. If anything goes wrong with the kidneys, serious medical problems will likely follow. Three of these problems are kidney stones, kidney damage, and kidney failure.

▶ ***Kidney Stones*** Sometimes substances such as calcium, magnesium, or uric acid salts in the urine crystallize and form kidney stones. When kidney stones block a ureter, they cause great pain. Kidney stones are often treated using ultrasound waves. The sound waves pulverize the stones into smaller fragments, which are eliminated with the urine.

▸ ***Kidney Damage*** Many diseases, injuries, and exposure to hazardous substances can lead to impaired kidney function. But most cases of kidney damage in the United States are related to high blood pressure and diabetes. Excessive blood pressure damages the delicate filtering mechanism, and high blood sugar levels cause the kidneys to filter more blood than normal. Over time, the tubules weaken, and the kidneys may fail to keep up with the demands placed upon them.

▸ ***Kidney Failure*** When kidneys can no longer cleanse the blood and maintain a state of homeostasis in the body, a person is said to be in kidney failure. A patient with kidney failure must receive dialysis or undergo a kidney transplant as shown in **Figure 30–20.**

During dialysis, a machine performs the role of the kidneys. The patient's blood is pumped through the machine, cleansed, and pumped back into the body. Although the procedure is painless, it is very time-consuming. Most patients receive dialysis treatments three times a week for about four hours each time. To prevent the buildup of fluid and harmful materials between treatments, patients must restrict their fluid intake and eat foods low in potassium, phosphorus, and salt.

In transplantation, a patient receives a kidney and ureter from a compatible donor. Fortunately for the donor, a person can survive with just one healthy kidney.

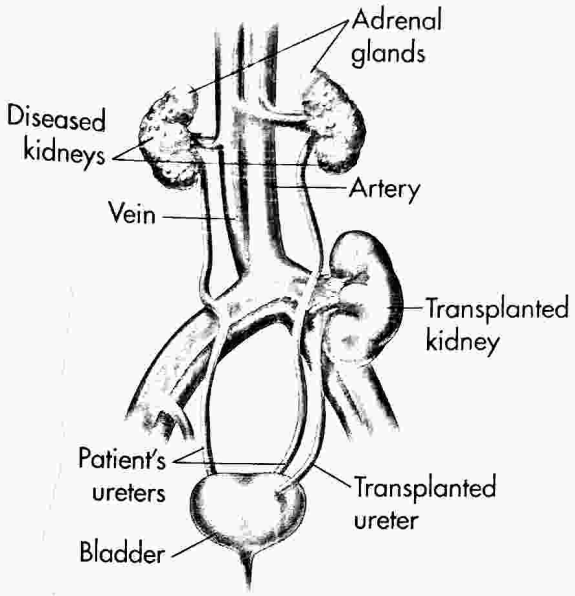


FIGURE 30–20 Kidney Transplantation Unless the patient's diseased kidneys are causing infection or high blood pressure, they are left in place when a healthy kidney and ureter are transplanted from a donor.

30.4 Assessment

Review Key Concepts

1. a. Review List the organs that are involved in excretion.

b. Classify Why is excretion important for homeostasis?

2. a. Review What substances do the kidneys remove from blood?

b. Sequence Explain what happens during filtration, reabsorption, and urine excretion.

3. a. Review Describe how the kidneys help maintain water balance.

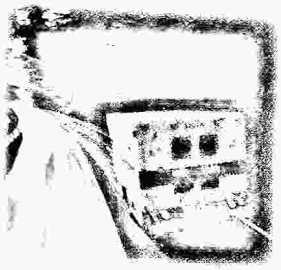
b. Apply Concepts Why do you think protein and glucose in the urine are signs of kidney damage?

BUILD VOCABULARY

4. Two words that are often used interchangeably are *excretion* and *secretion*. They have two distinct meanings, however. An excretion is usually a waste product of metabolism that is expelled from an organism. A secretion is a useful substance that is released inside or outside an organism. Name one example each of an excretion and a secretion from this lesson.

33.3 The Respiratory System

THINK ABOUT IT When medics examine an unconscious accident victim, one of the first things they do is check whether the person is breathing. This is one way to determine whether there is still a life to save. Why do we make such a close connection between breathing and life? For that matter, why do we need to breathe? All cells in our body, especially brain cells, require a constant supply of oxygen for cellular respiration. Without oxygen, many cells begin to die within minutes. The respiratory system works together with the circulatory system to provide our cells with oxygen. Any interruption in that vital function can be fatal.



Key Questions

- ***What is the function of the respiratory system?***
- ***How are oxygen and carbon dioxide exchanged and transported throughout the body?***
- ***What mechanisms are involved in breathing?***
- ***How does smoking affect the respiratory system?***

Vocabulary

pharynx
trachea
larynx
bronchus
alveolus
diaphragm

Taking Notes

Flowchart Make a flowchart that shows the path of air through the respiratory system.

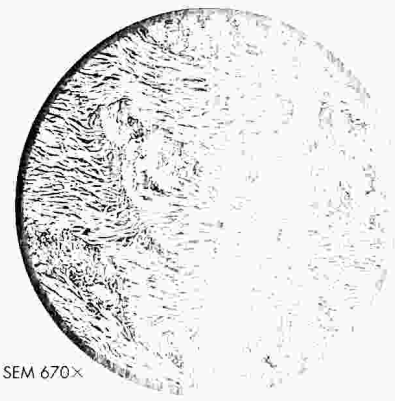
Structures of the Respiratory System

What is the function of the respiratory system?

For organisms, rather than single cells, *respiration* means the process of gas exchange between a body and the environment. **The human respiratory system picks up oxygen from the air we inhale and releases carbon dioxide into the air we exhale.** With each breath, air enters the body through the air passageways and fills the lungs, where gas exchange takes place. The circulatory system links this exchange of gases in the lungs with our body tissues. The respiratory system consists of the nose, pharynx, larynx, trachea, bronchi, and lungs.

Nose The respiratory passageways transport air into some of the most delicate tissues in the body. To keep lung tissue healthy, air entering the respiratory system must be filtered, moistened, and warmed. Hairs lining the entrance to the nasal cavity start the filtering process by trapping large particles. Incoming air is warmed in the inner nasal cavity and sinuses. These areas produce mucus that moistens the air and catches even more dust particles. If you've ever blown your nose after spending time in a dusty environment, you've seen evidence of the way nasal hairs and mucus protect the lungs.

In Your Notebook *In your own words, compare and contrast cellular respiration and respiration at the organism level.*



SEM 670×

FIGURE 33–14 Cilia Cilia in the trachea sweep mucus and debris away from the lungs. **Infer** *What would likely happen to a person's respiratory system if the cilia were damaged by pollutants?*

Pharynx, Larynx, and Trachea Air moves through the nose to a cavity 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. When you swallow food or liquid, a flap of tissue called the epiglottis covers the entrance to the trachea, ensuring that the food or liquid goes into the esophagus.

Between the pharynx and 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.

Mucus produced in the trachea continues to trap inhaled particles. Cilia lining the trachea sweep both mucus and trapped particles away from the lungs toward the pharynx. From there, the mucus and particles can be swallowed or spit out. This process helps keep the lungs clean and open for the important work of gas exchange.

Lungs From the trachea, air moves into two large tubes in the chest cavity called **bronchi** (singular: bronchus). Each bronchus leads to one lung. Within each lung, the large bronchus divides into smaller bronchi, which lead to even smaller passageways called bronchioles. Bronchi and bronchioles are surrounded by smooth muscles controlled by the autonomic nervous system. As the muscles contract and relax, they regulate the size of air passageways.

The bronchioles continue to divide until they reach a series of dead ends—millions of tiny air sacs called **alveoli** (singular: alveolus). Air moving through these tubes 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 then proceeds onto a narrow country lane—which dead-ends. Alveoli are grouped in clusters, like bunches of grapes. A delicate network of capillaries surrounds each alveolus.

BUILD Vocabulary

MULTIPLE MEANINGS **Alveolus** is also the term for a honeycomb cell in a beehive or a tooth socket in the jaw.

Quick Lab
GUIDED INQUIRY

What's in the Air?

❶ Trace the outline of a microscope slide on graph paper. Repeat four times.

❷ Cut out the outlines and tape them to the bottom of five slides.

❸ Pick indoor and outdoor spots to place your slides. On the back of each slide, write your initials, the date, and where you will put the slide.

❹ Cover the front of each slide with a thin coat of petroleum jelly.

❺ Leave the slides in the locations you chose for at least 24 hours.

❻ Collect the slides, place them under a microscope, and count the number of particles in ten of the squares on each slide. Record your results.

Analyze and Conclude

1. Observe On which slide did you count the most particles? The fewest?

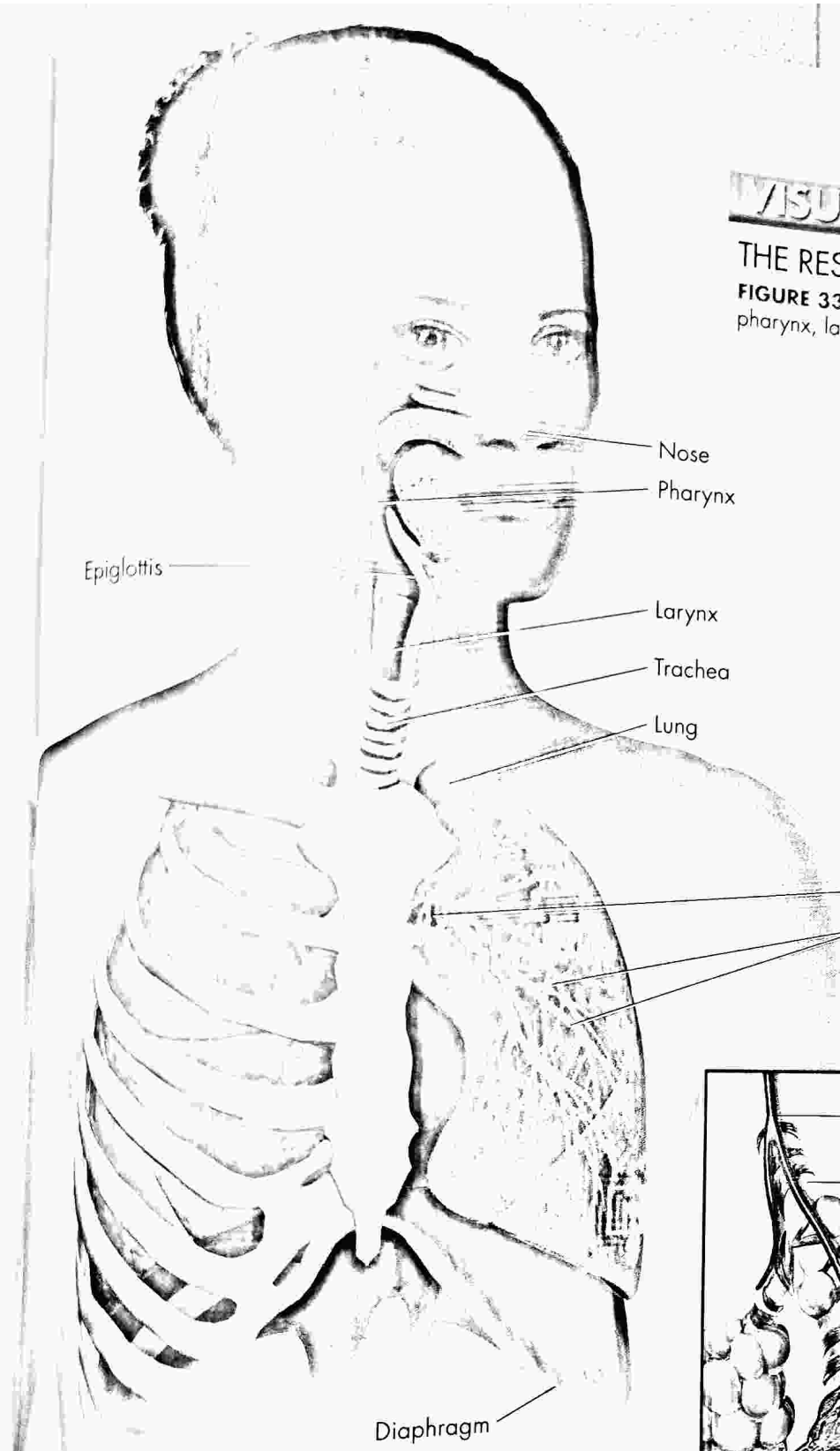
2. Draw Conclusions Were you surprised by the results? Why or why not?

3. Apply Concepts What structures in your body prevent most of these particles from entering your lungs?

VISUAL SUMMARY

THE RESPIRATORY SYSTEM

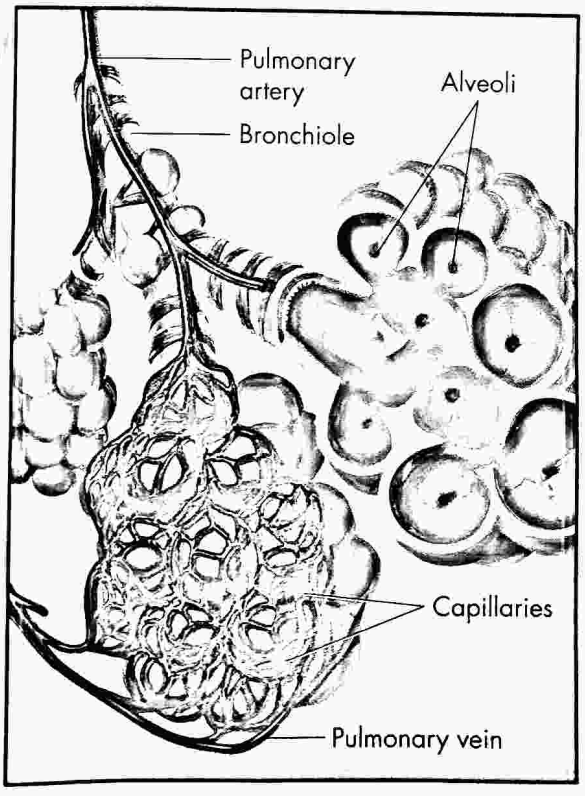
FIGURE 33–15 Air moves through the nose, pharynx, larynx, trachea, and bronchi into the lungs.



1 Nose Air enters the body through the nose, where it is filtered, moistened, and warmed.

2 Pharynx, Larynx, and Trachea From the nose, air moves into the pharynx. Then, it passes through the larynx, which contains the vocal cords, and through the trachea.

3 Lungs From the trachea, air moves into the bronchi. Each bronchus leads to one lung. The bronchi divide into bronchioles, which eventually end at alveoli.



Gas Exchange and Transport

How are oxygen and carbon dioxide exchanged and transported throughout the body?

Each healthy lung contains about 150 million alveoli, which provide an enormous surface area for gas exchange. **Oxygen and carbon dioxide are exchanged across the walls of alveoli and capillaries. Chemical properties of blood and red blood cells allow for efficient transport of gases throughout the body.**

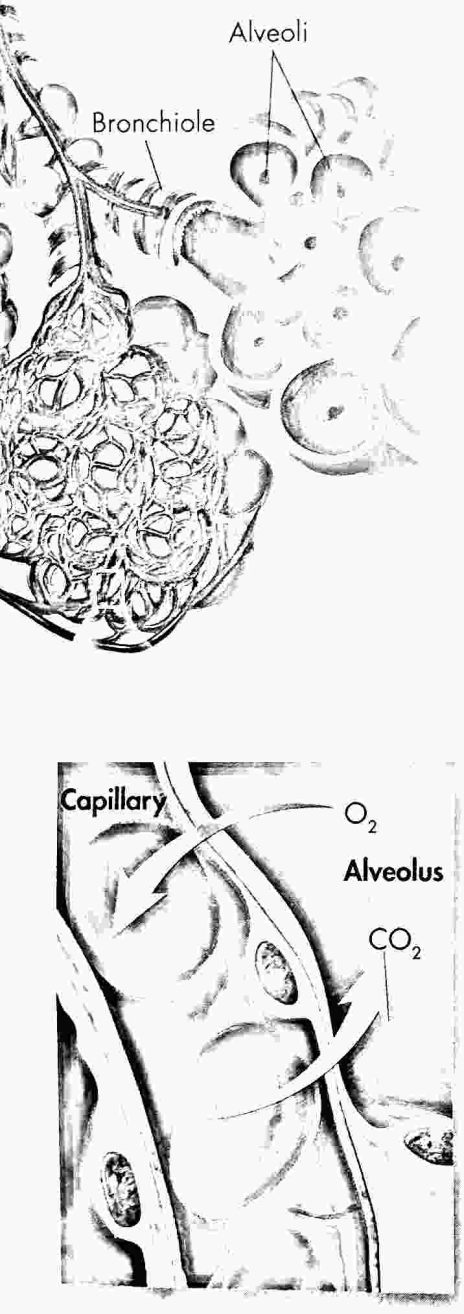
Gas Exchange When air enters alveoli, oxygen dissolves in the moisture on their inner surface and then diffuses across thin capillary walls into the blood. Oxygen diffuses in this direction because the oxygen concentration is greater in the air within the alveoli than it is in the blood within the capillaries. Meanwhile, carbon dioxide diffuses from blood into the alveoli because its concentration is greater in the blood than it is in the air in the alveoli. The process of gas exchange is illustrated in **Figure 33–16.**

The air 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. This means your lungs remove about a fourth of the oxygen in the air you inhale and increase the carbon dioxide content of that air by a factor of 100.

Transport Hemoglobin binds with and transports oxygen that diffuses from alveoli to capillaries. It also increases the efficiency of gas exchange. Diffusion of oxygen from alveoli into capillaries is a passive process. That process stops when oxygen concentration in the blood and alveoli is the same. But hemoglobin actively binds to dissolved oxygen, removing it from plasma and enabling diffusion from the alveoli to continue. Hemoglobin binds with so much oxygen that it increases blood's oxygen-carrying capacity more than 60 times.

When carbon dioxide diffuses from body tissues to capillaries, it is transported in the blood in three different ways. Most carbon dioxide enters red blood cells and combines with water, forming carbonic acid. The rest of it dissolves in plasma or binds to hemoglobin and proteins in plasma. These processes are reversed in the lungs, where carbon dioxide is released into alveoli and exhaled.

FIGURE 33–16 Gas Exchange Carbon dioxide and oxygen diffuse across capillary and alveolus walls. Draw Conclusions *Where is oxygen more concentrated, in an alveolus or in a capillary?*



In Your Notebook *What would happen to the surface area for gas exchange if a disease caused the walls between alveoli to break down?*

Breathing

What mechanisms are involved in breathing?

Surprisingly, there are no muscles in our lungs or connected directly to them that participate in breathing. The force that drives air into the lungs comes from ordinary air pressure, the diaphragm, and muscles associated with the ribs. **Movements of the diaphragm and rib cage change air pressure in the chest cavity during inhalation and exhalation.**

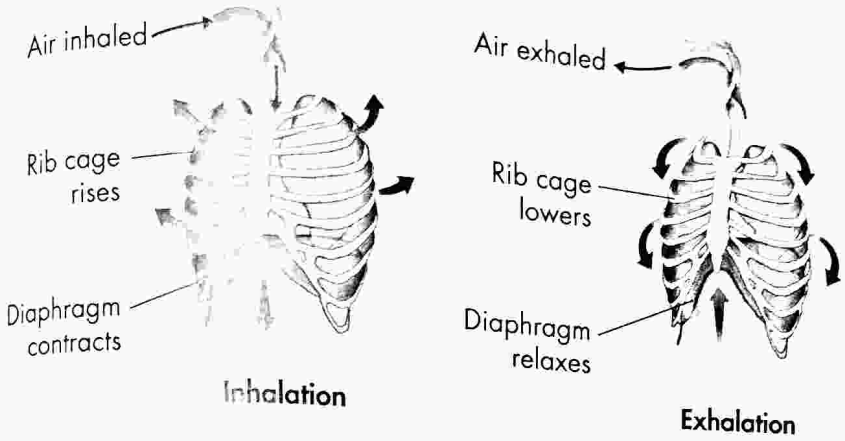


FIGURE 33–17 Breathing
During inhalation, the rib cage rises and the diaphragm contracts, increasing the size of the chest cavity. During exhalation, the rib cage lowers and the diaphragm relaxes, decreasing the size of the chest cavity. Humans have some conscious control over breathing—when they swim or play an instrument, for example.

Inhalation The lungs are sealed in two sacs, called pleural membranes, inside the chest cavity. At the bottom of the chest cavity is a large dome-shaped muscle known as the **diaphragm.**

As **Figure 33–17** shows, when you inhale, the diaphragm contracts and flattens. Muscles between the ribs also contract, raising the rib cage. These actions increase the volume of the chest cavity. Because the chest cavity is tightly sealed, this creates a partial vacuum inside the cavity. Atmospheric pressure does the rest, filling the lungs as air rushes into the breathing passages.

Exhalation During ordinary breathing, exhalation is usually passive. Both the rib cage and the diaphragm relax. This relaxation decreases the volume of the chest cavity and makes air pressure in the chest cavity greater than atmospheric pressure. Air rushes back out of the lungs. To blow out a candle, speak, sing, or yell, however, you need more force than passive exhalation provides. The extra force is provided by muscles between the ribs and abdominal muscles, which contract vigorously as the diaphragm relaxes.

The system works only because the chest cavity is sealed. If a wound punctures the chest—even if it does not affect the lungs directly—air may leak into the chest cavity and make breathing impossible. This is one reason chest wounds are always serious.

Breathing and Homeostasis You can control your breathing almost any time you want, to blow up a balloon or to play a trumpet. But this doesn't mean that breathing is purely voluntary. Your nervous system has final control of your breathing muscles whether you are conscious or not. This is why people who drown have water in their lungs. When they lose consciousness, they "breathe" water into their lungs.

Breathing is initiated by the breathing center in the part of the brain stem called the medulla oblongata. Sensory neurons in or near the medulla and in some large blood vessels gather information about carbon dioxide levels in the body and send the information to the breathing center. When stimulated, the breathing center sends nerve impulses that cause the diaphragm and chest muscles to contract, bringing air into the lungs. The higher the blood carbon dioxide level, the stronger the impulses. If the blood carbon dioxide level reaches a critical point, the impulses become so powerful that you cannot keep from breathing.

Smoking and the Respiratory System

How does smoking affect the respiratory system?

The upper respiratory tract filters out many particles that could damage the lungs. But some particles and certain kinds of chemicals can bypass those defenses, enter the lungs, and cause serious problems. **Chemicals in tobacco smoke damage structures throughout the respiratory system and have other negative health effects, too.**

Effects on the Respiratory System Three of the most dangerous substances in tobacco smoke are nicotine, carbon monoxide, and tar. Nicotine is an addictive stimulant that increases heart rate and blood pressure. Carbon monoxide is a poisonous gas that blocks hemoglobin from binding with oxygen, thus interfering with oxygen transport in blood. Tar contains at least 60 compounds known to cause cancer.

Tobacco smoke also paralyzes cilia in the trachea. With the cilia out of action, inhaled particles stick to the walls of the respiratory tract or enter the lungs, and smoke-laden mucus is trapped along the airways. Irritation from accumulated particles and mucus triggers a cough—called a smoker's cough—to clear the airways. Smoking also causes the lining of the respiratory tract to swell, which reduces airflow to the alveoli.

Diseases Caused by Smoking Damage to the respiratory system from smoking can become permanent and lead to diseases such as chronic bronchitis, emphysema, and lung cancer. Only 30 percent of male smokers live to age 80, but 55 percent of male nonsmokers live to that age. Clearly, smoking reduces life expectancy. The effect of smoking on the lungs can be seen in **Figure 33–18.**

▶ ***Chronic Bronchitis*** In chronic bronchitis, the bronchi become inflamed and clogged with mucus. Smoking even a moderate number of cigarettes on a regular basis can produce chronic bronchitis. Affected people often find simple activities, like climbing stairs, difficult. Treatments can control symptoms, but there is no cure.

▶ ***Emphysema*** Long-term smoking can lead to emphysema (em fuh SEE muh). Emphysema is the loss of elasticity and eventual breakdown of lung tissue. This condition makes breathing difficult. People with emphysema cannot get enough oxygen to the body tissues or rid the body of excess carbon dioxide. There is no cure for emphysema, but it can be treated with medication.

▶ ***Lung Cancer*** Lung cancer is particularly deadly because, by the time it is detected, it usually has spread to other areas of the body. Few people diagnosed with lung cancer live more than five years. About 87 percent of lung cancer deaths are due to smoking.

FIGURE 33–18 Effect of Smoking on Lungs Chemicals in cigarette smoke damage cilia in the lungs. Over time, particles build up and lead to respiratory diseases such as chronic bronchitis, emphysema, and lung cancer. The damage that smoking can cause to lungs is visible in the bottom photograph.

Healthy Lung

Smoker's Lung

What Secondhand Smoke Does
Exposes people to cancer-causing chemicals such as formaldehyde, arsenic, and ammonia
Aggravates asthma
Increases incidence of ear infections
Causes sticky platelets and damaged blood vessels
Causes up to 70,000 deaths from heart disease each year

FIGURE 33–19 Secondhand Smoke Effects Smokers not only put their own health at risk, but also the health of their family and friends exposed to their smoke.

Other Effects of Smoking Smoking also has very negative effects on the circulatory system. For example, it raises blood pressure by constricting blood vessels, which forces the heart to work harder to deliver enough oxygen.

Nonsmokers exposed to high levels of secondhand smoke are also at greater risk for respiratory and circulatory system disease. Inhaling the smoke of others is particularly dangerous for young children because their lungs are still developing. Studies now indicate that children of smokers are twice as likely as children of nonsmokers to develop asthma or other respiratory problems. Pregnant women who smoke place their babies at risk for many complications, some of which can lead to lifelong problems.

Whatever the age of a smoker, and no matter how long that person has smoked, his or her health can be improved by quitting. Nicotine is a powerful drug with strong addictive qualities that make it very difficult to quit smoking. Considering the medical dangers and the powerful addiction, the best solution is not to start smoking.

MYSTERY CLUE

John's doctor told him that if he hadn't stopped smoking, he probably would never have lived past age 50. Explain the doctor's reasoning.

33.3 Assessment

Review Key Concepts

1. a. Review Explain the function of the respiratory system.

b. Use Analogies Explain how a molecule of oxygen flowing through the respiratory system is like a commuter driving home from work.

2. a. Review Describe the process of gas exchange in the lungs.

b. Relate Cause and Effect Carbon monoxide, a poisonous gas, binds to hemoglobin more easily than oxygen does. Based on this information, why do you think that carbon monoxide alarms in homes have saved many lives?

3. a. Review Explain the process of breathing.

b. Infer The brain's breathing center responds to the level of carbon dioxide in the blood, not the level of oxygen. What consequences could this have for people at high altitudes, where oxygen levels are low?

4. a. Review Describe the effects of smoking on the respiratory system.

b. Apply Concepts People with emphysema cannot exhale as much carbon dioxide as people with healthy lungs can. Why do you think this leaves them short of breath?

Apply the Big idea

Structure and Function

5. Compare and contrast human respiration with what you learned about respiration in birds and fish in Chapter 27.