6. CO competes with oxygen for binding sites on hemoglobin, thereby limiting the transport of oxygen. Low levels of oxygen are detected in the carotid artery and aortic arch. The stimulated chemoreceptors send nerve messages to the medulla which in turn sends nerve messages to the diaphragm and rib muscles to increase breathing movements.

8.4 Practice (page 296)

1. Bronchitis is an inflammation of the bronchioles, usually caused by a bacterial infection, viral infection, or a reaction to environmental agents. The irritation may initiate an inflammation response and bring about tissue swelling that creates a narrowing of the air passages. Mucus secretions increase, and air movement decreases.
2. Emphysema is characterized by increased resistance to airflow through the bronchioles. Although air flows into the alveoli fairly easily, the decreased diameter of the bronchioles creates resistance to the movement of air out of the lungs. Air pressure builds up in the lungs. The thin walls of the alveoli are unable to support the building pressure, and they stretch and eventually rupture. Fewer alveoli means less surface area for gas exchange, which, in turn, leads to decreased oxygen levels.
3. The solid mass of cancer cells in the lungs greatly decreases the surface area for diffusion.

Activity 8.4.1 (pages 296–297)

2. Normal tidal volume should be approximately 0.6 L to 0.9 L. Expect variation. Body mass is a significant factor.
3. Expect expiratory reserve volume to be approximately 3.8 L.
4. Expect vital capacity in males to be approximately 5 L; in females, approximately 4 L. The difference is largely due to body mass.

(a) sample: vital capacity = 5.0 L
expiratory reserve volume = 3.6 L
tidal volume = 0.8L

5.0 L = inspiratory reserve volume + 3.6 L + 0.8 L
inspiratory reserve volume = 0.6 L

(b) Generally, the tidal volumes of athletes and average people are very similar. However the vital capacity of a marathon runner would probably be greater.
(c) The swelling of the bronchioles will narrow the diameter and offer greater resistance to the movement of air during both inhalation and exhalation. However, forced exhalation will be affected more than inhalation. Expiratory reserve volume will decrease and residual volume increases as more air remains in the lungs.
(d) An emphysema patient would have difficulty exhaling, therefore less air would be expelled, especially during exercise. (Also, higher levels of CO_2 might be found in the air.) Tidal volume for an emphysema patient would be reduced, while expiratory reserve volume would be increased.

8.4 Practice (page 297)

1. ① residual volume: the amount of air always present in the lungs
   ② expiratory reserve volume: the amount of air that can be forcefully exhaled after a normal exhalation
   ③ tidal volume: the amount of air inhaled and exhaled in a normal breath
   ④ inspiratory reserve volume: the amount of air that can be forcefully inhaled after a normal inhalation
   ⑤ vital capacity: the maximum amount of air that can be exhaled after maximum inspiration
   ⑥ the volume of air consistently inflating the lungs at all times during normal (tidal) breathing
2. A person with a respiratory illness might show quick, shallow, tidal breathing and the possibility of reduced inspiratory and expiratory reserves. An athlete might show slow, deep tidal breaths and would have full use of inspiratory and expiratory reserves; these reserves might also be greater.
3. Most individuals receive adequate ventilation during rest; however, exercise places greater demands on the system. Many symptoms such as low oxygen delivery become more pronounced during exercise, making diagnosis easier. A comparison of normal breathing volumes with patient breathing volumes may provide an indication of respiratory disorders.
4. Answers will vary.

Investigation 8.4.1 (page 299)

Sample lab report to be provided.

(a) Exercise increases ventilation.

Case Study 8.4.1 (pages 299–302)

(a) The smoke increases the production of mucous.
(b) The tar causes the diameters of the bronchi and bronchioles to narrow.
(c) The tumour begins to develop in the basal layer of cells.
(d) Tumour cells have replaced many of the goblet cells which secrete mucous.
(e) Metastasis may occur once the cancer cell breaks through the basal membrane and enters a lymph vessel.
(f) The cancer is no longer confined to the lungs. It invades other tissues, disrupting their normal functioning.

Section 8.4 Questions (page 303)

1. The buildup of mucous caused by irritants in the smoke initiate a cough reflex.
2. A greater number of foreign particles enter the lungs. This increases the possibility of infections and toxic agents entering the respiratory tract.
3. The lung is a spongy tissue that allows the X-ray to pass through the tissue. A tumor is a mass of cells that blocks the X-rays. The concentrated mass of cells appears as a white spot on the film.
4. Sample: 10 cigarettes × 15 mg × 75% = 112.5 mg of tar
5. Answers will vary. This question allows students to construct many different answers. Students may indicate how smoking makes individuals susceptible to other infections. The slowing of cilia may allow foreign particles to enter the lung. The lower oxygen levels associated with carbon monoxide may also be addressed. Some students may even consider how smoking leads to elevated blood pressure, or they may use a

capillary fluid exchange model to describe how smoking can lead to pulmonary edema.

6. The respiratory system provides oxygen to the circulatory system, which transports it and other nutrients to cells and tissues. Cellular respiration is the key link.

8.6 Practice (page 306)

1. Stimulants are drugs that speed the action of the central nervous system, often causing an increase in heart and breathing rate. Depressants are drugs that slow down the action of the central nervous system, often causing a decrease in heart and breathing rate
2. Stimulants increase heart and breathing rate, depressants decrease heart and breathing rate.

Sections 8.5–8.6 Questions (page 307)

1. Stimulants increase the activity of cells. To meet the energy demands of increased activity, more oxygen and nutrients need to be delivered to cells. An increased heart rate and breathing rate will help deliver more oxygen and maintain homeostasis.
2. Under normal circumstances, impulses are relayed between nerve cells in the brain by transmitter chemicals. A transmitter chemical released from one nerve cell attaches to receptor sites on another nerve cell. When enough receptor sites have been filled by the transmitter chemicals, the nerve cell membrane is disrupted and an impulse is initiated—the nerve cell fires. Stimulants and depressants interfere with either the movement of these transmitter molecules or their attachment to the receptor sites. Depressants slow down the action of the central nervous system. Some depressants delay the effect of transmitter chemicals by slowing the reaction of connecting nerves. Stimulants speed up the action of the central nervous system. Some stimulants prevent the transmitting chemicals from breaking down or recycling. The transmitting chemical remains longer than it normally would and keeps the receptor sites on the nerve cell full, resulting in more frequent firing of the nerve cell.
3. In the short term, by interfering with the nervous system, alcohol affects other systems within the body. Nerves that conduct breathing movements from the brainstem are depressed. Alcohol consumption slows the heart, which in turn lowers oxygen delivery to the tissues of the body. Alcohol also affects nerve cells in the brain that control the release of a hormone that regulates water reabsorption by the kidneys. Under the influence of alcohol, the kidneys' ability to reabsorb and store water is impaired, and urine output increases. In turn, the loss of fluids from the body affects blood pressure.

   One of the most pronounced long-term effects of alcohol on homeostatic mechanisms occurs in the liver. Alcohol is readily broken down and used for energy, preventing the body from using other nutrients such as sugars, amino acids, and fatty acids. These nutrients are converted to fat and stored in the liver. The accumulation of fats in the liver is known as cirrhosis. With cirrhosis, normal liver cells are replaced by the fats and the liver can no longer eliminate chemical wastes from the body, produce needed proteins, or carry out many of its other vital functions. A buildup of toxic wastes or a lack of needed proteins affects every organ system.
4. Addiction is the body's attempt to cope with the chemical disruption caused by a drug. Nerve cells in the brain adjust to prolonged exposure to a drug such as nicotine by producing fewer receptor proteins. As a result, the neurons become less sensitive

to the drug. As time passes, more of the drug is needed to maintain the same pleasurable feeling.

5. Many possible answers. Reasons in favor of donation include the potential to save another life and the use of tissues to generate beneficial products. Reasons against donation include religious beliefs regarding the removal of bodily tissues, possible use of organs for profit, and misuse of tissues for purposes other than for transplants.
6. Stimulants increases heart and breathing rate beyond the normal range. Exercise increases the energy demands on tissues, which leads to increases in heart rate and the breathing rate. Because the drug re-establishes a maximum limit for homeostasis, the heart rate may increase to such an extent that blood pressure may extend beyond the safe limit—an artery may burst. Another problem is that an extremely rapid heart rate may cause an irregular rhythm.
7. Interfering with the nervous system, which is designed to monitor body systems, is potentially dangerous. By interfering with homeostatic readjustments, blood pressure, blood pH, and the level of oxygen delivered to cells might go unchecked.

Activity 8.7.1 (pages 308–312)

1. The age of fetal pigs used for dissection is usually 112 to 115 days.
4. Students will likely see 4 toes. A vestigial is barely visible.
9. The liver consists of 3 lobes.
10. The gall bladder is located underneath the right lobe of the liver.
13. The pancreas is white or creamy in colour. The pancreas is narrow and held in place by mesentery. Encourage descriptive language rather than providing a specific answer.
15. The inner lining is glistening. Some students may see folds.
16. The thoracic cavity houses the heart and lungs.
20. The walls of a ventricle are much thicker than the walls of an atrium.
22. The lungs should expand.

Analysis

(a) The umbilical cord serves as a connection between the embryo and the placenta. Nutrients and wastes are exchanged between mother and fetus in the placenta.

(b)

Organ	Function
stomach	initial protein digestion
liver	multiple functions (e.g., glycogen storage)
small intestine	major area of digestion and nutrient absorption
gall bladder	stores bile
pancreas	digestive enzymes and insulin
large intestine	water reabsorption and waste storage
spleen	houses white blood cells

(c) The mesentery holds the organs in place.
(d) The left ventricle pumps blood much further than the right ventricle.
(e) The lungs are an area of gas exchange. The tissue contains many air sacs.
(f) They keep the trachea open.
(g) Refer to the chapter diagrams.
(h) Answers will vary.

Chapter 8 Review (pages 314–315)

1. **Figure 1** shows the components of the human respiratory system.
   (a) W is an alveolus. Alveoli are sacs of the lung in which the exchange of gases between the atmosphere and the blood occurs.
   X is the trachea. The trachea is the windpipe, a tube that conducts air from the larynx to the left and right bronchi.
   Y is a bronchiole. Bronchioles are the smallest passageways of the respiratory tract. They terminate in alveoli.
   (b) The trachea, X, has cartilaginous rings.
   (c) The inflammation or restriction of the bronchioles, Y, is associated with asthma.
2. Because the blood and water move in opposite directions, deoxygenated blood is in contact with oxygenated water, while oxygenated blood is in contact with deoxygenated water. This ensures that oxygen always diffuses from the water into blood that has a low concentration of oxygen. If the blood and water flowed in the same direction, the amount of oxygen diffusion would be reduced because there would be only a small difference between the oxygen concentrations in the water and in the blood
3. Gills are, essentially, extensions of the outer surface of the body. The extensive folding and branching of the gills provide increased surface area for the diffusion of gases. This system is efficient in the water, but on land too much evaporation could dry them out, making the membrane impermeable to the diffusion of gases.
   Frog lungs are balloon-like structures with internal folds that allow a much greater surface area for gas exchange. The internal location solves the problem of evaporation.
4. During inhalation, the diaphragm contracts, rib cage moves outwards, chest volume increases, lung pressure drops below that of atmospheric pressure, and air rushes in. During exhalation, the diaphragm relaxes, rib cage falls, chest volume decreases, lung pressure increases over atmospheric pressure, and air rushes out.
5. During exhalation, air travels through the alveolus, bronchioles, bronchi, trachea, pharynx, and nasal cavities.
6. Breathing actions that would be involved in expiration following strenuous exercice are (b), (c), (e), and (h).
7. As people exhale, the concentration of carbon dioxide in the room gradually increases. Chemoreceptors in the medulla are stimulated by elevated levels of carbon dioxide. A nerve message is sent from the medulla to the intercostal muscles and diaphragm to increase breathing movements.
8. (a) The lung collapses and ventilation is severely hampered. To compensate, respiratory rate increases. The gasp is a forced inhalation in an attempt to get more oxygen.
   (b) Plug the hole in the chest cavity or remove fluids in an attempt to restore lower pleural pressure for inhalation.
9. (a) There is comparatively little water in the atmosphere. Cells of the respiratory tract have a great deal of water, which diffuses into the air held in the respiratory tract. The forcible expulsion of air during exhalation releases the water vapor.
   (b) Oxygen is used by the cells of the body. Blood returning to the lung has less oxygen, and thus exhaled air has less oxygen.
   (c) The increase in water vapor and carbon dioxide in exhaled air will lower the percentage of nitrogen.