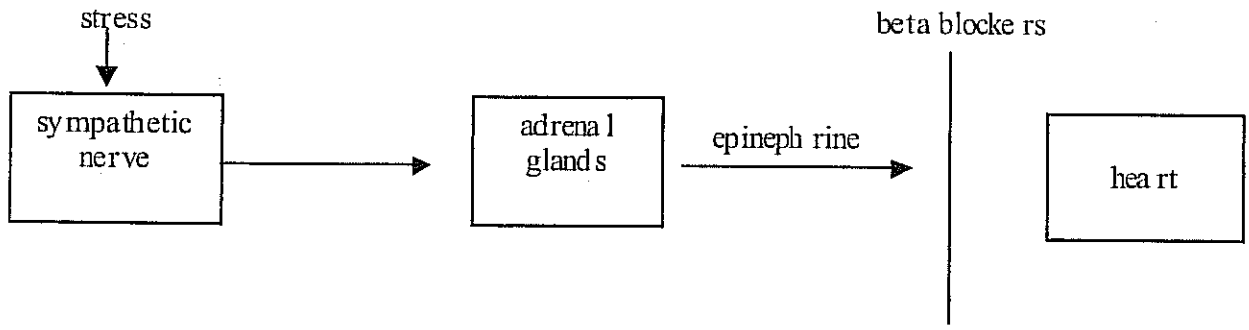
7. The heart's beat rate is set by the sinoatrial (SA) node, located where the venae cavae enter the right atrium. Nerve impulses are carried from the SA node to other muscle cells by modified muscle tissue. Originating in the atria, the contractions travel to a second node, the atrioventricular (AV) node. The AV node serves as a conductor, passing nerve impulses via two large nerve fibres, called Purkinje fibres, through the septum toward the ventricles. The Purkinje fibres run along the septum that separates the right and left ventricles, carrying impulses from the AV node to the bottom tip of the heart. From here, these branching fibres carry impulses up along the outer walls of the ventricles back toward the atria. A wave of cardiac contraction follows the nerve pathway. Both right and left atria contract prior to the contraction of the right and left ventricles.
8. The heart muscle beats faster, contracts with more force, and increases in mass.
9. Electrocardiographs map electrical fields within the heart. Electrodes placed on the body surface are connected to a recording device. The electrical impulses are displayed on a graph called an electrocardiogram (ECG). Changes in electrical current reveal normal or abnormal events of the cardiac cycle. The first wave, referred to as the P wave, monitors atrial contraction. The larger spike, referred to as the QRS wave, records ventricular contraction. A final T wave signals that the ventricles have recovered. ECGs can be analyzed to diagnose heart conditions. ECGs are especially useful for monitoring the body's response to exercise. Stress tests are performed by monitoring a subject who is riding a stationary bike or running on a treadmill. Some heart malfunctions remain hidden during rest, but can be detected during vigorous exercise.
10. Many possible answers. Some commonly patented medical technologies include drugs, materials used to construct artificial organs, electronic devices, medical imaging technology and related computer software.
11. The consumption of drugs such as caffeine or nicotine increases heart rate. Similarly, during exercise the body attempts to maintain homeostasis by increasing the heart rate to increase oxygen levels. However, the effects of drugs are not a homeostatic mechanism. The drugs often interfere with sympathetic or parasympathetic nerves.
12. Artificial hearts do not carry the antigens found in donor hearts and thus rejection by the recipient's immune system becomes less likely. Artificial hearts do not harbor viruses and other infectious diseases. However, artificial hearts, to date, do not work nearly as well as real hearts—they are less able to make homeostatic adjustments.
13. Answers will vary.

7.8 Practice (page 266)

1. Cardiac output is the amount of blood pumped from the heart each minute. Stroke volume is the quantity of blood pumped after each ventricular contraction. Heart rate is the number of times the heart beats per minute.
2. Systolic blood pressure is the blood pressure during ventricular contraction. Diastolic blood pressure is the blood pressure on an artery during ventricular relaxation.
3. Increased arteriolar resistance will increase blood pressure.
4. Blood pressure receptors are located in the walls of the aorta and the carotid arteries. When blood pressure exceeds acceptable levels, the receptors initiate nerve messages that stimulate the autonomic system to maintain homeostasis.

5.



The diagram shows the beta-blockers tie up receptor sites designed to accept epinephrine. The effects of epinephrine are therefore eliminated.

6. Beta 1 blockers work best because they have a limited number of actions and effects. This produces fewer side effects.

7.9 Practice (page 268)

1. Factors that can lead to cardiovascular disorders include high levels of cholesterol in the blood, smoking, diabetes mellitus, high blood pressure, lack of regular exercise, rapid weight gain or loss, and genetic factors (congenital problems).
2. Hypertension is high blood pressure. It is caused by increased resistance to blood flow, resulting in a sustained increase in blood pressure.
3. Arrhythmia is an irregular heartbeat, sometimes caused by a blocked coronary artery.
4. The circulatory, nervous and hormonal systems all play important roles in monitoring the needs of the body and adjusting to meet them. During times of stress, the sympathetic nerve stimulates the adrenal glands, which releases epinephrine. Epinephrine and direct stimulation from the sympathetic nerve increase heart rate and breathing rate. The increased heart rate provides for faster oxygen transport, while the increased breathing rate ensures that the blood contains higher levels of oxygen. Both systems work together to improve oxygen delivery to active tissues. A secondary but important function is the increased efficiency of waste removal from the active tissues.
5. Epinephrine causes vasodilation of the arterioles leading to the heart, brain, and muscles, preparing the organism for the fight-or-flight reaction. At the same time, the blood vessels leading to the kidney, stomach, and intestines constrict, depriving these areas of the body with nutrients until the stress situation has been overcome. This causes blood pressure in the body to increase, allowing for greater delivery of oxygen to the muscles.
6. The two individuals could have a different body mass. The greater the body mass the greater is the oxygen requirement. One person could have a less effective respiratory system. The circulatory system can compensate for a less efficient respiratory system by increasing cardiac output. The two people could have different stroke volumes. The individual with the stronger heart would have the greater stroke volume.

Investigation 7.9.1 (pages 269–270)
(a) Sample values are provided.

Position	Systolic BP (mm Hg)	Diastolic BP (mm Hg)	Pulse rate (beats/min)
standing	120	80	70
sitting	110	85	65
lying	107	88	62

(b) Systolic pressure varied more with the change in posture. It is a measure of changes in the strength of the stroke volume. As you stand, the hear must pump harder to maintain blood pressure. Blood is being pumped against the force of gravity.
(c) Psychological factors (nervousness, etc.) will also affect blood pressure. Other physical factors, such as sitting with legs crossed, will affect diastolic pressure; this position causes less blood flow back to the heart.

Investigation 7.9.2 (pages 270–271)
Sample report to be provided
(a) Exercise increases heart rate and blood pressure.

Sections 7.8–7.9 Questions (page 271)
1. Increased stroke volume increases cardiac output.
2. Accumulation of metabolic products causes arteriolar dilation. Activities such as exercise cause an increase in metabolic products. Because these products accumulate in the most active tissues, the increased blood flow helps provide greater nutrient supply and carries the potentially toxic materials away.
3. Special blood pressure receptors are located in the walls of the aorta and the carotid artery, which are major arteries found on either side of the neck. When blood pressure exceeds acceptable levels, the receptors respond to the increased pressure on the wall of the artery. A nerve message travels to the medulla oblongata, the blood pressure regulator located at the stem of the brain. Sympathetic (stress) nerve impulses are decreased, which causes arterioles to dilate, increasing outflow of blood from the artery. Parasympathetic (slow-down) nerve impulses are increased, causing heart rate and stroke volume to decrease. The decreased cardiac output slows the movement of blood into the arteries, lowering blood pressure.
4. No, arteries further from the heart generally have lower blood pressure. Distance from the heart and diameter of the artery are two important factors.
5. When lying down, the heart is at the same level as the blood pressure receptors and less pressure is needed to get blood to the head.
6. Increased heart rate means less filling time between heart contractions and hence less filling.
7. Many possible examples: renal hypertension—reduce salt intake; stroke—reduce stress and fats in diet; coronary artery disease—increase physical activity, change diet.

7.10 Practice (page 274)

1. Fluid pressure is greater in the arterioles. Blood vessels create resistance to blood flow. The further blood flow is from the heart, the more it has slowed. The force that blood exerts on the wall of a capillary is about 35 mm Hg at the arteriole end of the capillary and approximately 15 mm Hg at the venous end.
2. The reservoir of blood in the arteries creates pressure on the inner wall of the capillary. Much lower pressure is found in the ECF. Although fluids bathe cells, no force drives the extracellular fluids. Water moves from an area of high pressure, the capillary, into an area of low pressure, the ECF. The outward flow of water and small mineral ions is known as filtration.
3. The process that allows water to flow out of the capillary but keeps large materials inside the capillary is known as filtration.
4. Histamine is released by cells when they detect a foreign invading material that is potentially harmful. Histamine increases the permeability of the capillary membranes, enlarging the capillary and causing the area to redden. Proteins and white blood cells leave the capillary in search of the foreign invader while also altering the osmotic pressure. The proteins in the ECF create another osmotic force that opposes the osmotic force in the capillaries. Less water is absorbed into the capillary, and tissues swell.

7.11 Practice (page 276)

1. Lymph is a fluid found outside capillaries and contains some small proteins that have leaked through capillary walls. Lymph is transported in open-ended lymph vessels that are similar to veins. The low-pressure return system operates by slow muscle contractions against the vessels, which are supplied with flaplike valves that prevent the backflow of fluids. Eventually, lymph is returned to the venous system.
2. They are white blood cells that produce antibodies.
3. The spleen is a lymphoid organ that acts as a reservoir for blood and a filtering site for lymph.

Sections 7.10–7.11 Questions (page 276)

1. The movement of water between blood and the ECF is regulated by fluid pressure and by osmotic pressure. Water moves from an area of high fluid pressure, the capillary, to an area of low fluid pressure, the ECF. Proteins and dissolved minerals in the blood cause fluid from the capillaries to move into the blood by osmosis.
2. The balance between osmotic pressure and fluid pressure is upset during hemorrhage. The decreased blood volume affects blood pressure. The force that drives fluid from the capillaries diminishes, but the osmotic pressure, which draws water into the capillaries, is not altered. Although proteins are lost with the hemorrhage, so are fluids. Fewer proteins are present, but the concentration has not been changed. The force drawing water from the tissues and ECF is greater than the force pushing water from the capillary. The net movement of water into the capillaries provides a homeostatic adjustment. As water moves into the capillaries, fluid volumes are restored.
3. Individuals who are suffering from starvation often display tissue swelling, or edema. Plasma proteins are often mobilized as one of the last sources of energy. The decrease in concentration of plasma proteins has a dramatic effect on osmotic pressure, which draws fluids from the tissues and ECF into the capillaries. The decreased number of

proteins lowers osmotic pressure, thereby decreasing absorption. More water enters the tissue spaces than is pulled back into the capillaries, causing swelling.

4. When you eat a food to which you are allergic, cells react as though they are endangered and release a chemical messenger, which stimulates the release of another chemical stimulator, histamine. Histamine increases the permeability of the capillary membranes, enlarging the capillary and causing the area to redden. Proteins and white blood cells leave the capillary in search of the foreign invader while also altering the osmotic pressure. The proteins in the ECF create another osmotic force that opposes the osmotic force in the capillaries. Less water is absorbed into the capillary, and tissues swell.
5. Lymph vessels are a system of open ended vessels which collect proteins and debris from the ECF. Lymph vessels are similar to veins, and lymph is a fluid similar to blood plasma. Eventually, lymph is returned to the venous system.
6. Answers will vary. Students should recognize the danger of anaphylactic shock.
7. Antihistamines work by inhibiting the immune response. This would slow the natural response to a potentially harmful invader such as a virus.

Chapter 7 Review (pages 278–279)

1. (a) Veins that return blood to the heart from the body are labelled 1 and 2.
   (b) The ventricle that contains deoxygenated blood is labelled 5.
   (c) The AV valves, 4 and 7, produce the *lubb* sound.
2. Arteries are thick-walled to withstand the high pressure of blood as it leaves the heart. Veins are thin-walled with valves to conduct the blood under low pressure back to the heart. Capillaries are very small and have walls that are only one-cell in thickness to allow an efficient exchange of materials between the blood and ECF.
3. False. The pulmonary artery has deoxygenated blood.
4. The right ventricle pumps blood to the lungs, organs close to the heart. The left ventricle pumps oxygenated blood to all parts of the body. The left ventricle pumps blood a greater distance and thus it must have more muscle.
5. Blood pressure fluctuates depending on whether the heart is contracting or relaxing. Blood pressure is greatest during ventricular contraction and lowest during heart relaxation.
6. A reduction in the elasticity of the arteries might cause high blood pressure; there is an icreased risk of stroke, caused by restricted blood flow to the brain or by the rupture of arteries in the brain. There is also an increased risk of heart attack caused by restricted flow of blood to the heart muscles.
7. Severe bleeding causes a drop in blood pressure, reducing oxygen delivery to tissues. Physiological responses that will help the victim survive include blood clotting, and the seepage of ECF into the capillaries to raise blood volume. Also, pressure receptors would signal a drop in blood pressure; the brain would respond by initiating increased cardiac output and arteriolar resistance to raise blood pressure.
8. Athletes have more heart muscle which provides a greater stroke volume.
9. When people stand up too rapidly, they feel dizzy because the resting heart rate is low, the blood pressure is low, and the blood is pulled down from the brain by gravity. To counteract the effects of gravity when a person stands up, the heart rate and blood pressure rise to get blood to the upper parts of the body.
10. High blood pressure can lead to a stroke because the increased pressure can cause a rupture of the walls of the arteries or arterioles in the brain. High blood pressure can