Unit A Maintaining Health

Chapter 1: Circulation and Immunity

Practice, page 9

1.

HEART THEORIES

Person	Theory About the Heart	Limitations of the Theory
Galen	The heart is divided in two halves, blood is produced in the liver, and blood moves like ocean tides.	Evidence was gathered only from animal dissections, and there was no experimental testing to support the theory.
Leonardo da Vinci	He drew anatomically correct sketches of the heart. The heart is like a chambered furnace for the body.	There were lots of observations on dead bodies, but human cadaver dissections were not officially permitted, so he did not share his findings.
William Harvey	He had a modern view of the heart. Blood is re-pumped in a closed system of vessels.	Without the technology of the microscope, Harvey could not see capillaries to prove that blood moved from arteries to veins.

2. Solution:

$$\text{stroke volume} = 60 \text{ mL/beat (for females)}$$

$$= 60 \text{ mL/beat} \times \frac{1 \text{ L}}{1000 \text{ mL}}$$

$$= 0.060 \text{ L/beat}$$

$$\text{heart rate} = 68 \text{ beats/minute}$$

$$\text{cardiac output} = ?$$

$$\text{cardiac output} = (\text{stroke volume}) \times (\text{heart rate})$$

$$= \left(\frac{0.060 \text{ L}}{\text{beat}}\right) \times \frac{(68 \text{ beats})}{\text{min}}$$

$$= 4.08 \text{ L/min}$$

$$= 4.1 \text{ L/min}$$

The cardiac output is 4.1 L/min.

3. Solution:

$$\text{cardiac output} = 4.08 \text{ L/min}$$

$$\text{volume pumped in one year} = ?$$

$$\text{volume pumped in one year} = \frac{4.08 \text{ L}}{\text{min}} \times \frac{60 \text{ min}}{\text{h}} \times \frac{24 \text{ h}}{\text{d}} \times \frac{365.25 \text{ d}}{\text{a}} = 2.1 \times 10^6 \text{ L/a}$$

The volume pumped in one year is 2.1×10^6 L/a.

4. Since the average cardiac output is just under 5 L/min and the average human has 5 L of blood, this means that it takes about one minute to circulate all the blood in the body.

5. $\text{stroke volume} = 70 \text{ mL/beat (for males)}$

$$= 70 \text{ mL/beat} \times \frac{1 \text{ L}}{1000 \text{ mL}}$$

$\text{heart rate} = 180 \text{ beats/minute}$

$\text{cardiac output} = ?$

$\text{cardiac output} = (\text{stroke volume}) \times (\text{heart rate})$

$$= \frac{(0.070 \text{ L})}{\text{beat}} \times \frac{180 \text{ beats}}{\text{min}}$$

$= 12.6 \text{ L/min}$

$= 13 \text{ L/min}$

The cardiac output is 13 L/min.

6. **a.** Values for cardiac output will vary for each student. The following sample calculation shows the results for a female student with a resting heart rate of 71 beats per minute.

Solution: $\text{stroke volume} = 60 \text{ mL/beat (for females)}$

$$= 60 \text{ mL/beat} \times \frac{1 \text{ L}}{1000 \text{ mL}}$$

$= 0.060 \text{ L/beat}$

$\text{heart rate} = 71 \text{ beats/minute}$

$\text{cardiac output} = ?$

$\text{cardiac output} = (\text{stroke volume}) \times (\text{heart rate})$

$$= \frac{(0.060 \text{ L})}{\text{beats}} \times \frac{(71 \text{ beats})}{\text{min}}$$

$= 4.26 \text{ L/min}$

$= 4.3 \text{ L/min}$

The cardiac output is 4.3 L/min.

b. Answers will vary. The following sample calculation follows from question 6.a. and shows the results for a female student with a resting heart rate of 71 beats per minute.

$\text{rate} = \text{cardiac output}$

$= 4.26 \text{ L/min}$

$\text{time to fill a barrel} = ?$

$$\text{time to fill a barrel} = \frac{(\text{volume of barrel})}{\text{rate}}$$

$$= \frac{(213 \text{ L})}{4.26 \text{ L/min}}$$

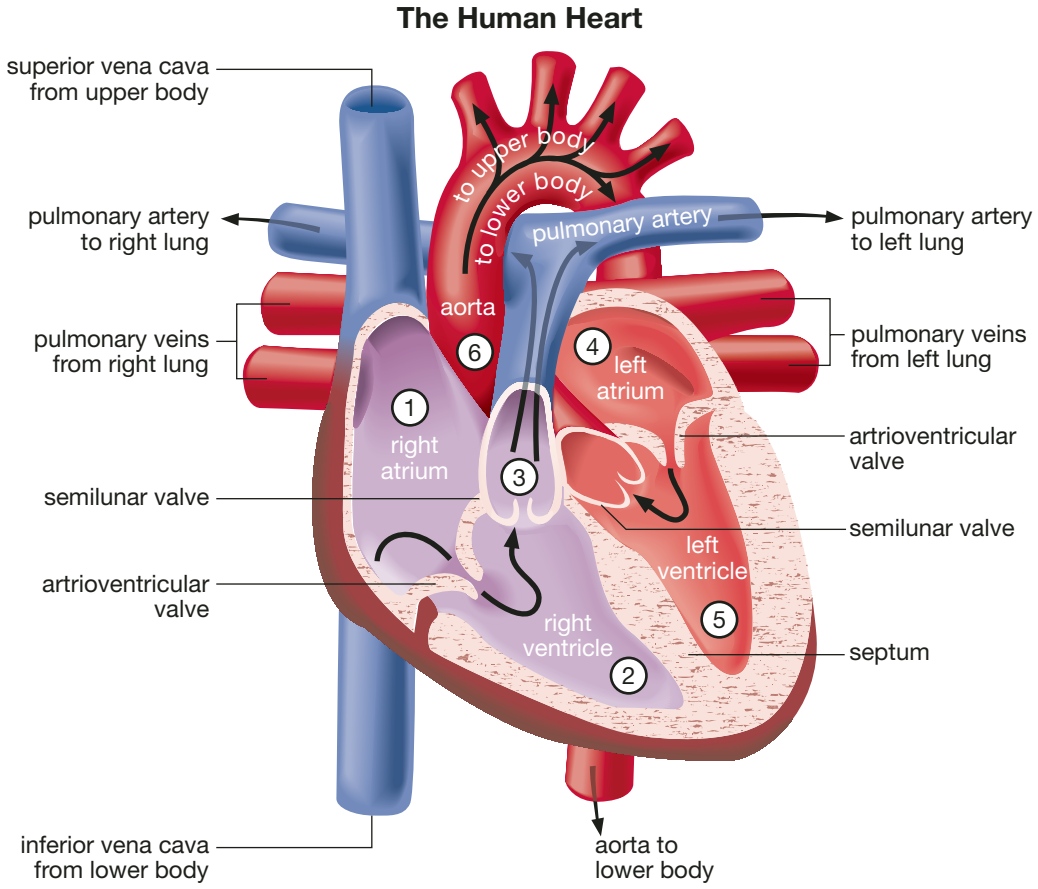
$= 50 \text{ min}$

It would take a pump 50 min to fill the barrel if it was operating at the same rate as the cardiac output.

c. If the heart rate doubles, then the cardiac output doubles if the stroke volume remains constant. This means that the rate of pumping into the same barrel should also double. The overall effect is that the barrel would fill in only half the time calculated in question 6.b. By using the sample data provided in 6.a. and 6.b., the barrel would fill in 25 minutes.

Practice, page 13

7. Your diagram should be similar to the following.



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Results for questions 8 and 9 will vary depending on student age. Sample data for a 17-year-old student follows.

8. Find your maximum heart rate by subtracting your age from 220.

220 – 17 = 203 beats per minute

9. Students will use their answers from question 8 to finish this table.

Your Target Heart Rate	
Personal Health Goal	**Heart Rate**
	50% of 203 bpm = 102 bpm
maintain fitness level	
	60% of 203 bpm = 122 bpm
increase fat burning or weight loss	
	70% of 203 bpm = 142 bpm
increase cardiovascular endurance	
	80% of 203 bpm = 162 bpm

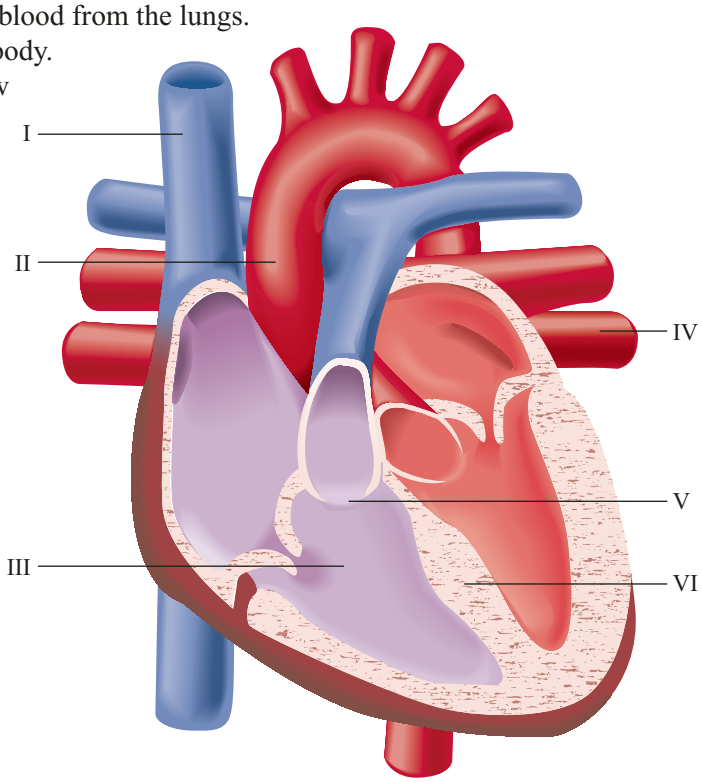
10. As people get older, their target heart rates will decrease for each category.

1.1 Questions, page 19

Knowledge

1. Beginning with the vena cavae, the order of the structures of the cardiovascular system through which blood flows is as follows: vena cavae, right atrium, right ventricle, lungs, left atrium, left ventricle, aorta, and body.

2.
a. IV The pulmonary veins receive oxygenated blood from the lungs.
b. II The aorta sends oxygenated blood to the body.
c. V The semilunar valve prevents the backflow of blood into the heart.
d. VI The septum separates the right and left halves of the heart.
e. I The vena cavae collects deoxygenated blood from the body.



Applying Concepts

3. a. $\text{stroke volume} = 100 \text{ mL/beat}$

$$= 100 \text{ mL/beat} \times \frac{1 \text{ L}}{1000 \text{ mL}}$$

$$= 0.100 \text{ L/beat}$$

$\text{heart rate} = 50 \text{ beats/minute} (\text{rest})$

$\text{heart rate} = 115 \text{ beats/minute} (\text{light exercise})$

$\text{heart rate} = 180 \text{ beats/minute} (\text{high-intensity exercise})$

$\text{cardiac output} = ?$

at rest: $\text{cardiac output} = (\text{stroke volume}) \times (\text{heart rate})$

$$= \frac{0.100 \text{ L}}{\text{beat}} \times \frac{(50 \text{ beats})}{\text{min}}$$

$$= 5.0 \text{ L/min}$$

The cardiac output is 5.0 L/min for the athlete at rest.

light exercise: $\text{cardiac output} = (\text{stroke volume}) \times (\text{heart rate})$

$$= \frac{(0.100 \text{ L})}{\text{beat}} \times \frac{(115 \text{ beats})}{\text{min}}$$

$$= 11.5 \text{ L/min}$$

The cardiac output is 11.5 L/min for the athlete doing light exercise.

high-intensity exercise: $\text{cardiac output} = (\text{stroke volume}) \times (\text{heart rate})$

$$= \frac{(0.100 \text{ L})}{\text{beats}} \times \frac{(180 \text{ beats})}{\text{min}}$$

$$= 18.0 \text{ L/min}$$

The cardiac output is 18.0 L/min for the athlete doing high-intensity exercise.

b. Regular cardiovascular exercise increases the elasticity of the heart tissue—this gives the heart a greater capacity to expand and, therefore, a larger stroke volume. Since the stroke volume is larger, an increased volume of blood is pumped to the body during each of the heart's cycles, so the athlete's body can get the necessary amount of blood with fewer heartbeats.

An inactive person tends to have a heart with less elastic tissue, so this heart has a decreased ability to expand and, therefore, a reduced stroke volume. This reduction in blood volume pumped to the body during each of the heart's cycles means that it takes more heartbeats every minute to supply the body with the required amount of blood.

Practice, page 23

11. **a.** Parts of the circulatory system that correspond to a community's water pipes, sewage pipes, pump, and water are, in order, the arteries, veins, heart, and blood.

b. One limitation is that the circulation of blood in the human body is a closed system because large amounts of blood do not normally enter and leave the system. A community's water system is not a closed system. Clean drinking water comes from the environment and then returns to the environment. In other words, many communities may use the same river system as a water source, but under normal circumstances many people do not get their blood from the same common source.

Another limitation of the analogy is that the body does not have the equivalent of a water system's reservoir. There is no place in the body that contains a vast pool of blood that can be stored over many months.

12. **a.** The pulmonary arteries carry oxygen-poor blood from the heart to the lungs.
b. The aorta is the body's largest artery.
c. The coronary arteries carry oxygen-rich blood from the aorta to nourish the heart tissues.
d. The pulmonary veins carry oxygen-rich blood from the lungs to the heart.
e. The venae cavae carry oxygen-poor blood from the body's tissues to the heart.

13. Arteries always carry blood away from the heart and veins always carry blood to the heart. This is always true. However, it is not always true that arteries carry oxygen-rich blood and veins carry oxygen-poor blood. The pulmonary arteries carry oxygen-poor blood from the right ventricle to the lungs. The pulmonary veins carry oxygen-rich blood from the lungs back to the heart.

14. It is important for the walls of capillaries to be thin so that oxygen and other substances needed by cells can diffuse from the blood to the tissue cells. The thin walls also allow carbon dioxide and waste materials to diffuse from the tissue cells into the blood.

Practice, page 24

15. **a.** vein
b. capillary
c. venule
d. arteriole
e. artery

16. The correct order is artery, arteriole, capillary, venule, and vein.

17. If inactivity means that the muscles are not regularly contracting, then the veins will have a harder time moving blood back to the heart, which may result in impaired circulation.

18. The lower-leg veins are the farthest away from the heart and the blood in them has the longest way to travel back to the heart. Gravity also plays a role here since when you are standing, the path from the feet to the heart is straight up—this is opposite to the direction that gravity naturally tends to pull matter.

It follows that blood is more likely to be slowed down or pool in the lower legs. The valves in the legs' veins are therefore under the greatest amount of stress and most often become less effective. This can lead to varicose veins.

19. For a standing person, the valves in the leg veins are working against gravity. If people spend much of their days on their feet, it means that blood is pooling in the legs for a longer amount of time. This can put extra stress on these valves. Elevating the feet at the end of a long period of standing reduces some of the force from pooled blood drawn downward by gravity. Raising the feet also takes pressure off the valves, which reduces the risk of developing varicose veins or suffering damage from that condition.

Conclusion

4. Blood flows from the hand toward the heart. If blood is pushed against this flow, it pools in the veins at certain places. These places correspond with the valves.

Practice, page 29

20. a. The value of 138 is systolic pressure. This is pressure created by blood pushing against the walls of the brachial artery when the heart's ventricles are contracting. The elastic fibres in the artery walls stretch and expand slightly in response to this pressure.

When the heart's ventricles are relaxed, a residual pressure is maintained as arteries attempt to return to their previous shape between contractions of the ventricles. This diastolic pressure is represented by 96.

b. The unit for each of these pressures is millimetres of mercury.

c. Blood pressure values higher than 140/90 are categorized as high blood pressure because these values are abnormally high. This often indicates health problems that need to be treated by a physician. Since the values from the automated machine are close to high blood pressure levels, it would be wise to make an appointment with a family doctor and have these values confirmed. It may not necessarily be cause for concern because the high values could be due to other factors that may have temporarily raised blood pressure values, such as tight clothing around the arm when the test was taken; anxiety or nervousness; or eating or drinking something.

21. The source of residual pressure is the slight contraction of the arteries' elastic walls as they attempt to rebound from the slight stretching caused by the previous heartbeat.

22. Several factors cause the blood's speed to drop as it passes through the capillaries. The total cross-sectional area of vessels carrying blood dramatically increases as the blood passes from arteries, into arterioles, and then into capillary beds. Since there is a much larger opening for the incoming blood to pass through, the blood does not have to flow as fast for the output to match the input. A similar effect can be observed if a student places his or her thumb over the end of a garden hose and then releases the thumb to create a larger opening. In this case, water comes out of the hose at a reduced speed. The top two photos from Figure A1.xx can be checked for further details.

Another effect has to do with resistance to the blood flow. Capillaries are so tiny that blood cells have to pass single file through the smallest of these vessels. This causes a drop in pressure that results in a slowing down of the blood flow.

1.2 Questions, page 33

Knowledge

1. The following table compares arteries, veins, and capillaries.

	Arteries	Veins	Capillaries
description of vessel walls	thick-walled and elastic fibre	thinner walls with no elastic fibres	thinnest walls possible—only one cell thick
direction of vessel blood flow in relation to heart	away from heart	toward heart	from arteries and arterioles, through capillaries, to venules and veins, and back to heart
blood oxygen level in vessel	relatively high level	relatively low level	higher level at end close to arteries and a lower level at end close to veins
colour in a circulatory system diagram	red	blue	red at end close to arteries and blue at end close to veins
blood pressure in vessel	high pressure	very low pressure	pressure decreases as blood moves from the end closest to arteries to end closest to vein
valves present	no	yes	no
pulse present	yes	no	no

Applying Concepts

2. a. People with diabetes would no longer have to inject themselves with insulin. Using an inhaler would be a much less painful and invasive delivery system, and there would be less chance of infection from poor sanitation at the injection site or scarring from repeated injections. In terms of disposal and safety, it is much more convenient to carry around an inhaler than it is to carry syringes.

b. The path from fat under the skin is as follows: a fat capillary under the skin; a venule; a vein; the vena cava; the right atrium; the right ventricle; the pulmonary arteries; the lungs; the pulmonary veins; the left atrium; the left ventricle; the aorta; several arteries; an arteriole; and end at a capillary next to a target cell in the liver.

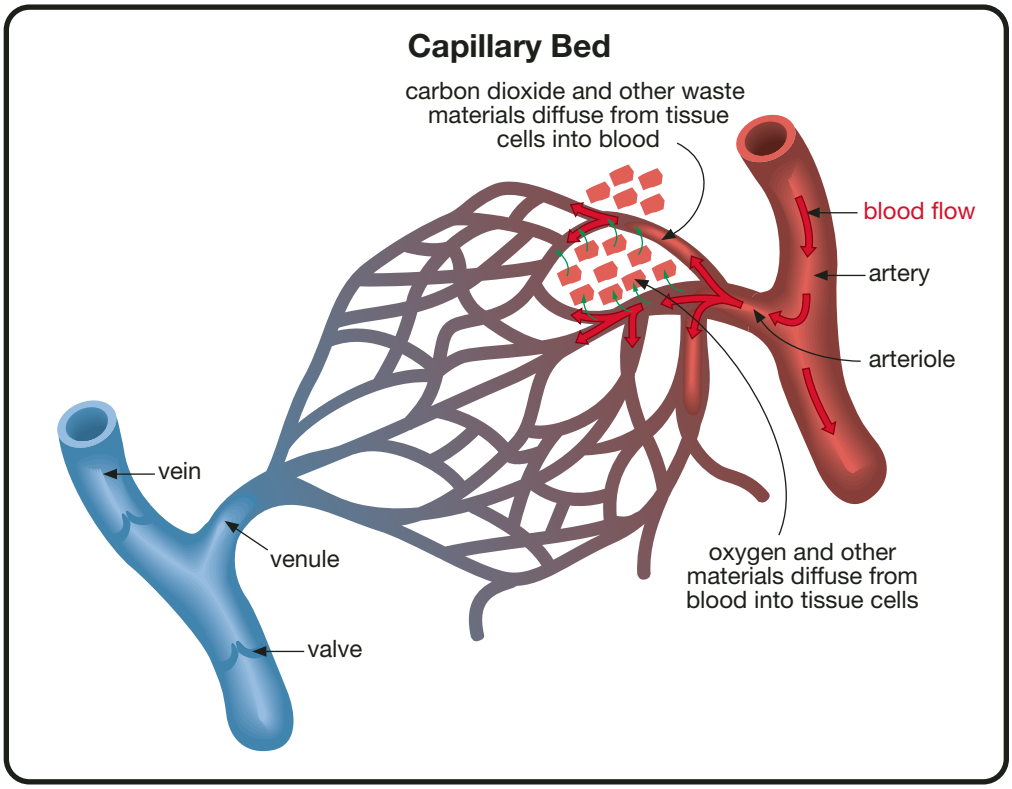
c. Inhaled insulin would take the following path from the lungs to a target cell in the liver: the lungs; the capillaries and venules of lung tissue; the pulmonary veins; the left atrium; the left ventricle; the aorta; several arteries; an arteriole; and then to a capillary next to the target liver cell.

d. The inhaled delivery system would be faster because the needed chemical would not have to first travel through the de-oxygenated parts of the circulatory system. This quicker delivery would be an advantage over the hypodermic delivery system.

3. Factors that can cause a person's blood pressure to increase include a stronger contraction of the heart, a higher heart rate, and a loss in the elasticity of the arteries. Higher blood pressure readings can also be attributed to anxiety level, exercise, a greater than normal amount of blood in vessels, viscosity (thickness) of the blood, chemicals such as caffeine or epinephrine, kidney disease, or a narrowing of the blood vessels due to a poor diet.

4. If an artery is cut, the greater pressure in an artery means that the blood flows out more quickly and forcefully than it would in a vein. It follows that there is a greater risk of blood loss with a cut artery than there is with a cut vein.

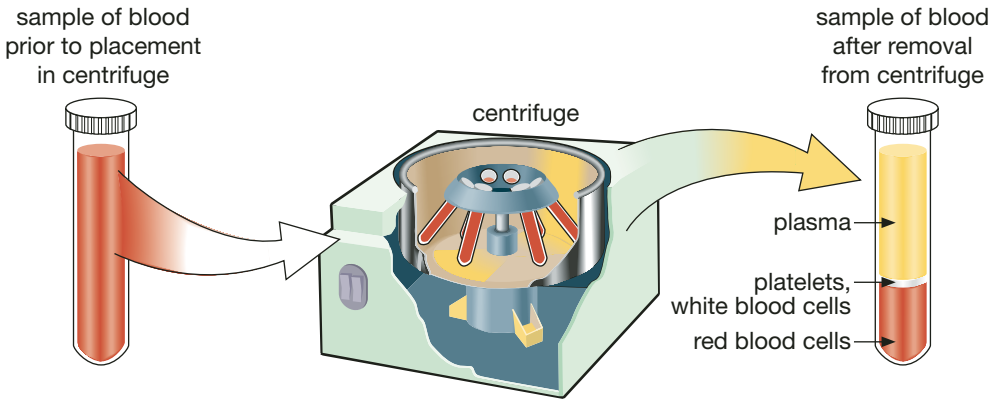
5. The following illustration is a sketch of a capillary bed.



6. Contracting muscles in the lower legs help to massage the blood in the lower legs back toward the heart. Once the leg muscles push the blood in the veins, the valves are able to direct this blood.

Practice, page 36

23.



24. **a.** Plasma comprises about 55% of blood volume.
b. Red blood cells make up almost 45% of the total volume of blood.
c. Platelets and white blood cells comprise less than 1% of the total volume of blood.

Practice, page 38

25. **a.** In conditions of extreme fatigue, cancer patients benefit from a transfusion of red blood cells.

b. Spinning a sample of whole blood in a centrifuge could separate the whole blood into red blood cells and other components.

26. **a.** White blood cells only live from 13 to 20 days, while red blood cells live about 120 days. Therefore, more white cells need to be made because they don't live nearly as long as red cells.

b. White blood cells act to defend the body against diseases and other foreign invaders. Most disease-causing agents tend to be found in the fluid spaces between tissue cells, so this is also where white blood cells tend to be. Since a blood test only counts the number of white blood cells in the bloodstream, the white cells outside of the bloodstream are not included.

Practice, pages 40 and 41

27. The blood components that best correspond to bags I, II, and III are, respectively, red blood cells, plasma, and platelets.

28. If burn victims are highly susceptible to dehydration, the blood component that best addresses this problem is plasma, due to its high water content.

29. To prevent uncontrollable internal bleeding, platelets are often given to cancer patients after they receive radiation therapy.

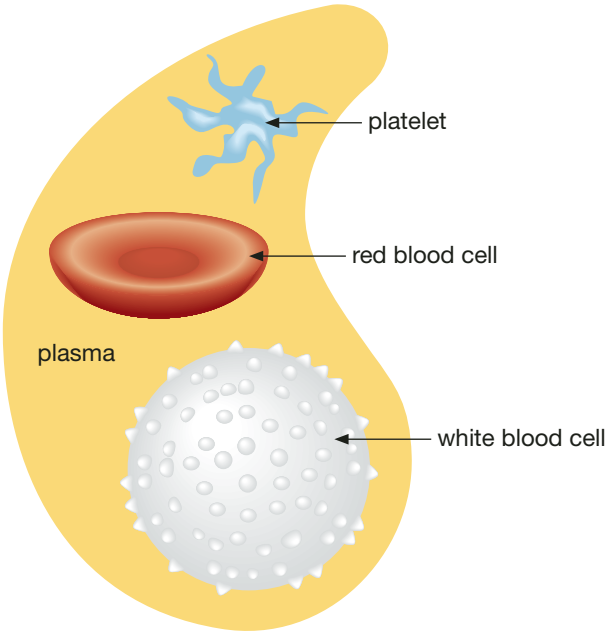
30. Every time you donate whole blood, this product can be put in a centrifuge and separated into red blood cells, plasma, and platelets. Each one of these three components can then be used to help another person and possibly save a life.

1.3 Questions, page 41

Knowledge

1. **a.** The four components of blood from most abundant to least abundant are plasma, red blood cells, white blood cells, and platelets.

b. The following diagram illustrates each component of question 1.a.



2. a. Slide number 6 from the patient with neutrophilia has more white blood cells than the patient with healthy blood.

b. The patient with neutrophilia is likely suffering from an infection.

Applying Concepts

3. Carbon monoxide has a much greater affinity for hemoglobin than does oxygen, so carbon monoxide will preferentially bind to hemoglobin and form a stable bond. As a result, if you inhale even low concentrations of carbon monoxide, more hemoglobin combines with carbon monoxide than does oxygen. If carbon monoxide is taking the place of oxygen on the red blood cells, that means that the blood cannot transport needed oxygen to the body's cells. A person could suffocate even though he or she is able to breathe normally.

4. Anticoagulants that thin blood make it easier for blood to flow through damaged or constricted blood vessels.

5. a. Having improperly functioning white blood cells means that the person is not able to fight off disease-causing organisms.

b. A transplant of healthy bone marrow means that healthy and normally functioning white blood cells will be produced.

6. At the time this textbook was published, the Canadian Blood Services uses these criteria to determine eligibility for donating blood:

- You must have identification containing your full name and signature or full name and photograph.
- You must be at least 17 years old.
- You must weigh at least 50 kg (110 pounds).
- If you have previously donated blood, at least 56 days must have passed since your last donation.
- You must be in good health and feeling well. You should have had something to eat and be well rested. A hemoglobin test on your blood will be done at the clinic, and a sample of your blood must pass this test.
- At the time of the donation, you will be asked a number of questions related to your suitability to give blood. These questions will include whether you currently have a cold, if you have been to the dentist recently, or if you have any body part pierced.

Practice, page 43

31. It is now known that scurvy is due to insufficient amounts of vitamin C in people's diet. The main source of vitamin C for the early Europeans was fresh fruit and vegetables. At that time it was rare to find these items aboard the wooden sailing ships that ventured into northern waters.

32. Inuit people never suffered from scurvy because their diets included maktaaq, a snack consisting of whale skin with an attached thin layer of blubber. Whale blubber is a rich source of vitamin C, so this food would help prevent scurvy.

33. Inuit people knew that maktaaq and many other foods in their traditional diet promoted good health. Although the term *vitamin C* was not introduced until the twentieth century, the collective experiences from thousands of years of interaction with the Arctic environment allowed Inuit people to develop an understanding of what food combinations kept people healthy. This information would have been very helpful to the early European Arctic explorers. The solution for avoiding scurvy was at hand, especially since many of these early Europeans were whalers and vitamin C-rich whale blubber was likely already aboard their ships.

Practice, page 45

34. The sandwich filling containing peanut butter would be the only one to be free of cholesterol because all the other fillings come from animal sources.

35. **a.** The unit mmol/L means millimoles per litre, which is a unit of concentration.

b. Person B has the healthier cholesterol levels. One reason for this is that this person has lower levels of LDL cholesterol. Low-density lipoprotein carries cholesterol from the liver to the body's tissue cells and in the process can add to the unhealthy accumulation of cholesterol on the inside of arteries.

Another reason is that person B has higher levels of HDL cholesterol. High-density lipoprotein scours the bloodstream for cholesterol and then transports the cholesterol to the liver to eliminate it from the body. Higher levels of HDL means that more cholesterol is being eliminated from the body.

Practice, page 46

36. Cardiovascular disease refers to a wide range of disorders that affect the heart and/or blood vessels. Examples include coronary heart disease, strokes, and varicose veins. Atherosclerosis is another example. This disease involves deposits of cholesterol and other fatty substances building up on the inside lining of an artery. If the artery is a coronary artery, this disorder can lead to coronary heart disease and a heart attack. If the artery is one that supplies the brain with blood, the disorder can lead to a stroke.

37. a. Plaque can develop a harder outer surface that is rigid and inflexible. Since plaque is attached to the inside of an artery, the artery loses its elasticity.

b. As the left ventricle contracts, blood is pushed through the aorta to the rest of the body. The systolic blood pressure that results pushes on the walls of healthy arteries, causing them to slightly expand. When the ventricles relax, the healthy arteries contract slightly as they return to their initial shape. The residual pressure that results is responsible for the diastolic pressure.

Arteries lined with cholesterol and plaque are unable to slightly expand and contract. This would have the effect of raising the values of the systolic pressure and, therefore, the residual diastolic pressure.

38. As plaque builds up on the inside of arteries, the outer plaque surface can become hard and rigid with a rough surface. Cracks can develop in the plaque. Since platelets rupture when they pass over a rough surface, the presence of plaque makes the clotting process more likely.

Practice, page 49

39. Only about 25% of cholesterol in the bloodstream is made up of cholesterol absorbed from food. Reducing the cholesterol content of food eaten can only influence one-quarter of the total cholesterol in a person's bloodstream.

40. a. The breakfast described includes bacon and butter, which are both high in saturated fat. The egg has some saturated fat, but it is a significant source of dietary cholesterol. Overall, this meal has a negative effect on blood cholesterol levels. The saturated fat in the bacon and the butter tends to elevate the levels of LDL cholesterol.

b. The deep-fried onion rings and the donut are likely both sources of trans fats. Trans fats tend to raise the levels of LDL cholesterol and lower HDL cholesterol levels. The overall effect is a significant rise in blood cholesterol levels.

Although the large soft drink does not contribute to blood cholesterol levels, it is a significant source of sugar. The excessive consumption of foods rich in sugar has been linked to obesity and also to type II diabetes. Both obesity and type II diabetes have been shown to increase the risk of heart attack.

c. Tuna is a source of polyunsaturated omega-3 fatty acids, while olive oil is a source of monounsaturated omega-9 fatty acids. Both of these substances tend to lower LDL cholesterol levels and raise HDL cholesterol levels, resulting in an overall positive effect on blood cholesterol levels. This meal is the healthiest choice of the three meals presented.

41. Fat is an important nutrient needed to make healthy cell membranes, to properly develop the brain and nervous system, and to produce hormone-like substances that regulate body functions (e.g., blood pressure). A diet that eliminates all foods containing fat is very unhealthy because an essential nutrient is denied.

If the only source of fat is an occasional binge of fries and gravy, then the body is still denied essential fatty acids because this snack is rich in saturated fats and trans fats, but not omega-3 and omega-6 essential fatty acids. In addition, the fries and gravy will also cause an unhealthy spike in blood cholesterol levels.

Practice, page 52

42. a. The problem addressed by having people increase the marine sources of omega-3 fatty acids in their diets is the high incidence of cardiovascular disease in the general population. Cardiovascular disease is the number one cause of death in Canada.

b. Several unintended problems might arise from this technological solution. If large numbers of people in the developed world began to eat fish as a staple part of their diet, there could be a negative effect on both the marine environment and ocean ecosystems. The world's oceans are already stressed, and a widespread change in eating habits could have a negative effect on fish stocks.

Another problem is that people could get the message that all they have to do is change their eating habits, at the exclusion of the other risk factors for cardiovascular disease. Even if eating habits change, there will be little change in the incidence of cardiovascular disease if people continue to live inactive lifestyles.

c. The depletion of fish stocks could be solved by finding other ways of adding marine omega-3 fatty acids to people's diets. Perhaps animal feed could be supplemented with fish oil to augment the omega-3 fatty acid content in eggs, milk, and meat. However, making dramatic changes to what is fed to animals is a risky business that can have unpredictable effects—outbreaks of Bovine Spongiform Encephalopathy (BSE) in cattle are a case in point.

Another solution might be to find a marine plant that can produce the marine omega-3 fatty acids rather than always relying upon fish. The marine plants could be harvested and then incorporated into other food products. Again, if this were to be done on a large scale, sustainability and environmental effects on the oceans would have to be considered. Another possibility would be to genetically engineer land plants to produce the marine omega-3 fatty acids. Again, this technological fix has its own risks.

43. a. The definition for traditional ecological knowledge is as follows.

Traditional ecological knowledge is knowledge acquired over thousands of years through a people's direct contact with the environment. It's a dynamic approach to developing new understandings of human interactions with the environment that focuses on the inseparable relationship between land, resources, and culture.

The last part of this definition implies a holistic approach that goes beyond the minutiae of the details to include connections between land, resources, and culture.

b. A benefit of integrating scientific research with traditional ecological knowledge is that two different points of view can be used to solve problems. The scientific point of view brings methods, tools, and technologies of Western science, while traditional ecological knowledge brings thousands of years of human experience with the environment, as well as a viewpoint that stresses connections to the wider context of culture and other human dimensions.

44. The following is a sample of how you may have completed the questionnaire.

Cardiovascular Disease Risk Questionnaire

Read the following lifestyle and family history statements that relate to circulatory diseases. Place a check mark next to the ones that apply to you.

☑ 1. I have a father or brother who had a heart attack, a stroke, or a heart procedure (e.g., angioplasty, coronary bypass, or another example) before age 55.

❑ 2. I have a mother or sister who had a heart attack, a stroke, or a heart procedure (e.g., angioplasty, coronary bypass, or another example) before age 65.

☑ 3. I smoke or I am exposed to second-hand smoke.

❑ 4. My blood pressure is greater than 140/90 mmHg.

❑ 5. I have diabetes.

☑ 6. I am physically inactive and rarely engage in aerobic exercise activities, such as cycling, jogging, swimming, and soccer.

❑ 7. I am under high stress.

☑ 8. I am 20 or more pounds overweight.

☑ 9. My diet contains a lot of foods high in saturated fats, trans fats, and cholesterol, such as red meats, whole milk, cream, butter, cheese, fast foods, and fried foods.

1.4 Questions, page 54

Knowledge

1. **a.** angina **b.** stroke
c. septal defect **d.** atherosclerosis
e. plaque **f.** heart attack
g. aneurysm

Applying Concepts

2. The patient would most likely be asked if she smokes and eats a lot of high saturated fat and high cholesterol foods. She may be asked how much and what kind of exercise she does, or if she is under a lot of stress. Suggestions for reducing the risk of developing a cardiovascular disease include quitting smoking, having a more healthy diet, and exercising regularly.

3. **a.** If something is stuck in one of the pipes and causes some homes to lose water service, this situation is comparable to a blood clot in the human circulatory system.

b. If the water pressure is so high that a strain is put on the pipes, causing the pipes to leak, the situation is comparable to high blood pressure or hypertension in the human circulatory system.

c. A faulty valve in the water pump is comparable to a heart valve defect in the human circulatory system.

4. Fat accounts for 0.74% of the serving mass for moose meat. For beef, 22.55% of the serving mass is fat.

5. Fat is a very concentrated form of food energy. The fact that beef is nearly one-quarter saturated fat accounts for its higher energy content.

6. Saturated fat accounts for 0.22% of the serving mass for moose meat. For beef, 9.16% of the serving is saturated fat.

7. Due to its low saturated fat content, moose meat has a healthier effect on blood cholesterol levels than beef does. Beef has a greater tendency to raise LDL cholesterol levels due to its high saturated fat content.

8. The following calculations show the percentage of total fat that is due to omega-3 and omega-6 fatty acids in moose meat and beef.

Moose Meat

- omega-6 fatty acid

$m_{O6} = 0.14\ \text{g}$
$m_{TF} = 0.74\ \text{g}$
$\% = ?$

$$\% = \left(\frac{m_{O6}}{m_{TF}}\right) \times 100\%$$
$$= \left(\frac{0.14\ \text{g}}{0.74\ \text{g}}\right) \times 100\%$$
$$= 19\%$$

Of the total fat in moose meat, 19% is composed of omega-6 fatty acids.

- omega-3 fatty acid

$m_{O3} = 0.03\ \text{g}$
$m_{TF} = 0.74\ \text{g}$
$\% = ?$

$$\% = \left(\frac{m_{O3}}{m_{TF}}\right) \times 100\%$$
$$= \left(\frac{0.03\ \text{g}}{0.74\ \text{g}}\right) \times 100\%$$
$$= 4.1\%$$

Of the total fat in moose meat, 4.1% is composed of omega-3 fatty acids.

Beef

- omega-6 fatty acid

$m_{O6} = 0.57\ \text{g}$
$m_{TF} = 22.55\ \text{g}$
$\% = ?$

$$\% = \left(\frac{m_{O6}}{m_{TF}}\right) \times 100\%$$
$$= \left(\frac{0.57\ \text{g}}{22.55\ \text{g}}\right) \times 100\%$$
$$= 2.5\%$$

Of the total fat in beef, 2.5% is composed of omega-6 fatty acids.

- omega-3 fatty acid

$m_{O3} = 0.23\ \text{g}$
$m_{TF} = 22.55\ \text{g}$
$\% = ?$

$$\% = \left(\frac{m_{O3}}{m_{TF}}\right) \times 100\%$$
$$= \left(\frac{0.23\ \text{g}}{22.55\ \text{g}}\right) \times 100\%$$
$$= 1.0\%$$

Of the total fat in beef, 1.0% is composed of omega-3 fatty acids.

9. The moose meat has a greater percentage of omega-6 and omega-3 fatty acids in its total fat content. This means that the moose meat has a better chance of raising HDL cholesterol levels and lowering LDL cholesterol levels.

10. Moose meat has less saturated fat that will raise LDL levels and a greater percentage of its fat consists of polyunsaturated fatty acids that will lower LDL levels and raise HDL levels. Overall, moose meat is a good choice for reducing risk factors associated with cardiovascular diseases.

Practice, page 57

45. The following table compares the roles and parts of a castle fortress to the parts of the immune system.

Part of Immune System	Role	Part of a Castle
skin	protective barrier that keeps out invaders	castle walls
cilia and mucous secretions	trap invaders as they try to enter	guarded entrances and moat
platelets	patch holes in protective barrier	stonemasons
white blood cells	destroy invaders who make it past first line of defence	defensive army

RUBRIC FOR KNOWLEDGE

Score	Scoring Description
Standard of Excellence (4 marks)	The response is well organized and addresses all the major points of the activity. Relevant scientific, technological, and/or societal concepts and examples are identified and interrelationships are explicit. The descriptions and/or explanations of these concepts are correct, well organized, and reflect thorough understanding and logical consistency of thought. The student uses complete sentences that make effective use of scientific vocabulary. When appropriate, suitable metaphors, similes, diagrams, and/or sketches are used to illustrate descriptions and/or explanations.
(3 marks)	The response is organized and addresses most of the major points of the activity. Relevant scientific, technological, and/or societal concepts and examples are identified and interrelationships are evident. The descriptions and/or explanations of these concepts are organized and reflect correct understanding. The student uses complete sentences that employ correct scientific vocabulary. When appropriate, suitable diagrams or sketches are used.
Acceptable Standard (2 marks)	The response addresses most major points. Relevant scientific, technological, and/or societal concepts and examples are identified, and interrelationships are shown. The descriptions and/or explanations of concepts may be disorganized but demonstrate correct understanding. The student uses complete sentences but is inconsistent in the use of appropriate scientific vocabulary, diagrams, and sketches.
(1 mark)	The response addresses few major points. Concepts are identified, but interrelationships are not evident. The student superficially describes concepts in sentences, but organizational skills, scientific vocabulary, diagrams, and sketches are minimal.
(0 marks)	The response does not address any of the major points of the question at an appropriate level for a 30-level course.

Practice, page 62

46.

MICROSCOPIC PATHOGENS

Type of Pathogen	Defining Characteristics	Example of a Disease Caused by This Type of Pathogen
protozoans	microscopic, single-celled organisms with a nucleus—most can only divide within a host organism and cause disease	Malaria is caused by protozoans that infect red blood cells.
fungi	organisms that absorb food directly through cell walls and do not conduct photosynthesis	Athlete's foot is a fungal infection.
bacteria	microscopic, single-celled organisms that don't have their genetic material contained in a nucleus	Salmonella bacteria cause food poisoning.
viruses	extremely tiny particles consisting of a protein coat enclosing genetic material; viruses are not considered to be living organisms	Influenza is caused by a virus.

47. The reason that viruses could not be seen through a light microscope or isolated using filters is that these particles are extremely small. Since they are only about 1/100 the size of a bacterium, they are difficult to observe.

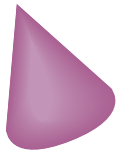
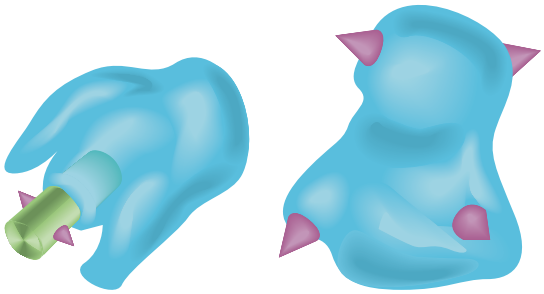
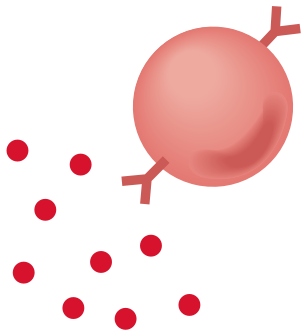
Practice, page 66

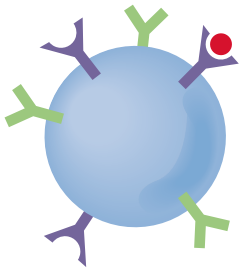
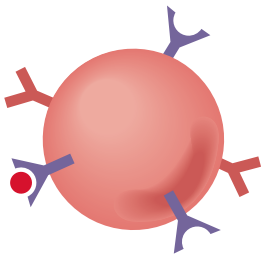
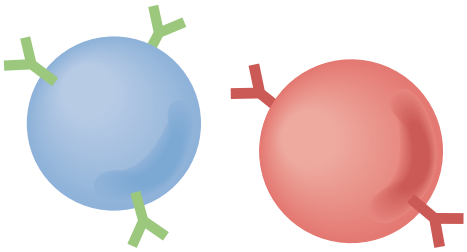
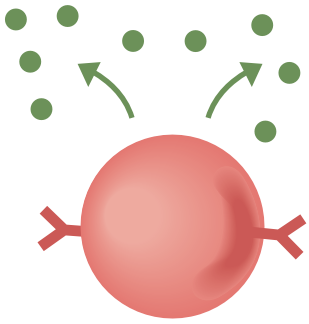
48. **a.** and **b.**

The answers to these questions can be found on the illustration labelled, "Overview of Immune Response" in the textbook.

49. **a.** and **b.**

THE IMMUNE RESPONSE—COMPONENTS AND ROLES

Sketch of Components	Name of Components	Role(s) in the Immune Response
	Antigen	allow white blood cells to recognize foreign invaders
	Macrophage	patrol and engulf foreign disease-causing organisms and display antigens on their cell membranes
	Helper T-cell	identify antigens of foreign invaders and signal response of B-cells and killer T-cells

	B-cell	produce specific antibodies to antigens
	Antibody	attach to antigen of foreign material
	Killer T-cell	destroy cells that have become mutated or infected with viruses
	Memory B-cell and Memory T-cell	remain after invading organism has been destroyed to allow for quicker response to future encounters with that antigen
	Suppressor T-cell	signal for immune response to end

Practice, page 67

50. Although most of you will have access to your own vaccination records, some of you may not have received vaccinations due to religious or other reasons.

Practice, page 69

51. Although it was very beneficial to society for Jenner to test out his theory on a human subject, James Phipps could have died from the smallpox virus. This was not an ethical practice since James Phipps was not old enough to consent to this treatment.

52. These people were particularly susceptible to the smallpox virus because they had never been exposed to this disease-causing organism, so no one had memory cells to make antigens (natural immunity) against smallpox. This means that the virus could spread very quickly through the population.

53. a. The major concern with keeping the viral stock is that since no one gets vaccinated anymore—due to the danger of handling the virus and the dangerous (even fatal) side effects of the vaccination—a released virus would cause major sickness in an unvaccinated population. Some people worry that the virus could even be used as a bioterrorism weapon if it was purposely released into a population.

b. Keeping these stocks is beneficial because there are specimens to study and to produce a vaccine from. If a virus is released in a bioterrorism act, then a laboratory sample of the smallpox virus is available to be examined.

1.5 Questions, page 70

Knowledge

1. a. Malaria is a vector-borne disease that gets into the body via a mosquito that punctures the skin barrier. Malaria lives inside red blood cells, which makes it difficult for white blood cells to detect it as a foreign invader.

b. Hepatitis C is a blood-borne disease that is usually transmitted through the skin barrier through the sharing of needles or by sexual intercourse.

c. Tuberculosis is an airborne disease caused by inhaling droplets from an infected person's lungs.

d. Salmonella is a food-borne disease that comes from eating improperly cooked food or food contaminated by feces. Stomach acid is unable to kill all the invading organisms.

2. Although autoimmune diseases and infectious diseases can both make you sick, an autoimmune disease cannot be caught because it does not come from an invading pathogen as does an infectious disease. An autoimmune disease occurs when a person's white blood cells target and attack some or all of the body's cells. Autoimmune diseases cannot usually be cured, so this condition often lasts for the remainder of a person's life.

3. A table follows comparing the similarities and differences between bacteria and viruses.

Similarities	Differences
Both cause sickness.	Bacteria can be treated by antibiotics.
Both are too small to see with the naked eye.	Viruses are much smaller than bacteria.
Both must break through the body's first line of defenses (e.g., skin, mucus) to make you sick.	Viruses are considered non-living.
You can be vaccinated against both types of pathogens.	Bacteria reproduce by splitting in two.
Both come in a variety of shapes.	Some bacteria can be harmless or even beneficial, while all viruses cause disease.

4. You can check your work by replaying the applet and comparing the information presented with the information presented in the textbook. One minor discrepancy is that the video shows the killer T-cell actually attacking the membrane of the invading pathogen—the current understanding is that killer T-cells destroy tissue cells that have the antigens of the pathogen on their cell membranes.

Applying Concepts

5. a. If a person with hemophilia has blood that does not clot properly, cuts or breaks in the skin will be repaired and plugged more slowly. This delay in repairing the skin increases the chances for disease-causing organisms to cross the skin barrier.

b. Without the skin barrier, body tissues will be exposed to disease-causing pathogens that can more easily enter the bloodstream.

c. If someone with HIV has T-cells destroyed by the virus, then diseases that enter the body can only be eaten by the macrophages. There will be no directed attack with specific antibodies to target these invaders. Unfortunately, people with HIV can die from diseases and rare cancers that the body could normally deal with if T-cells were present.

6. a. When vaccinations are given at birth, memory cells are produced so that future disease encounters are easily dealt with.

b. If antibiotics are prescribed when you have an infection, bacteria growth is inhibited.

c. Antiseptics used during operations destroy most disease-causing agents that have gone into a wound or incision.

7. Role-playing an immune response is an excellent way to have participants perform self-assessment. Teachers may want to develop or use a performance/presentation rubric or have students hand in their scripts for review.