Review for Unit 6: The Cardiovascular System

1. Know, and be able to apply, the meaning of the following terms:

cardiovascular system	antibody	systole	plaque
artery	leucocyte	depolarize	angioplasty
vein	erythrocyte	repolarize	stent
arteriole	hemoglobin	bicuspid valve	coronary bypass
venule	platelets	tricuspid valve	myocardial cells
capillary	prothrombin	pulmonic valve	heart attack
endothelial cells	thrombin	aortic valve	myocardial infarction
macrophage	fibrinogen	coronary arteries	arrhythmia
phagocyte	fibrin	atherosclerosis	heart murmur
T-cell	hemophilia	hypertension	ischemic stroke
B-cell	diastole	sphygmomanometer	FAST

2. Be able to label these structures on a diagram of the human body or heart. Know their functions:

coronary artery	aorta	right ventricle	bicuspid (mitral) valve
carotid artery	vena cava	left atrium	coronary artery
brachial artery	pulmonary artery	left ventricle	sinoatrial (SA) node
radial artery	pulmonary vein	aortic valve	atrioventricular (AV) node
femoral artery	septum	pulmonic valve	Bundle of His
iliac artery	right atrium	tricuspid valve	Purkinje fibres

Long and Short Answer Questions:

1. Write the balanced overall chemical equation for cellular respiration. How is the cardiovascular system involved in this process?

   Equation: $C_6H_{12}O_6 + 6\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O$

   Cardiovascular system delivers glucose from the small intestine and oxygen from the lungs to the cells. Cardiovascular system also removes water (excess water is excreted by the kidneys) and carbon dioxide which is carried to the lungs where it is exhaled.

2. Explain why planaria, a type of very simple flat worm, do not require a vascular system.
   - simple animals are very small or very thin
   - enough of their surface is in direct contact with their watery environment that sufficient oxygen can diffuse in and carbon dioxide gas can diffuse out directly

3. Which kingdom(s) include organisms that have vascular systems? plantae and animalia

4. Describe the two types of vascular tissue in plants, including the role of each.
   - phloem carries sugar from the leaves to the rest of the tree (can travel upwards or downwards)
   - xylem carries water and minerals from the roots up to the rest of the tree (always upwards)

5. Distinguish between an open transport and a closed transport system. Give an example of one organism that has an open system and one animal that has a closed system.
   - in open transport systems, the vascular fluid (eg. the blood) leaves the blood vessels and bathes the cells. Nutrients and wastes diffuse directly from the vascular fluid into/out of the cells. eg. grasshoppers (insects) and crustaceans (crayfish, lobster)

- in closed transport systems, the vascular fluid (eg. the blood) remains inside the blood vessels. Nutrients and wastes must diffuse between the fluid in the blood vessels, through the ECF and then into the cells. eg. mammals, segmented worms

6. What are five main functions of the cardiovascular system?
   - Deliver nutrients and dissolved oxygen to all cells of the body
   - Remove cellular wastes from all cells of the body
   - Transport hormones for communication between different parts of the body
   - Transport antibodies and immune cells to fight disease
   - Distribute heat and regulate body temperature

7. Describe the composition of whole blood.
   - 55% plasma (the watery fluid), 44% red blood cells and 1% (ish) platelets and white blood cells

8. Describe the composition of plasma.
   - plasma is 92% water, the rest is dissolved proteins, minerals and other dissolved substances being transported

9. Describe the function of each component of the 'formed' part of the blood.
   - platelets are involved in initiating the formation of blood clots (when blood vessels are broken)
   - red blood cells carry oxygen (bound to hemoglobin) and a small amount of carbon dioxide
   - white blood cells are involved in detecting and destroying foreign proteins (antigens) and pathogens

10. What is hemoglobin? What is the name of the disorder when a person does not have enough hemoglobin or red blood cells in their blood?
    - hemoglobin is the protein found in red blood cells which carries oxygen in the blood (one hemoglobin can carry 4 oxygen atoms, one RBC contains millions of hemoglobin molecules)
    - if a person does not have enough hemoglobin or RBCs, it is called anemia

11. Look back at our earlier notes on the immune system. For three types of white blood cells, describe their role in immunity and whether each type of WBC is specific or non-specific.
    - phagocytes (eg. macrophages) detect and engulf foreign proteins and pathogens
    - T cells detect foreign proteins and pathogens and "tag" them for destruction. They also remember foreign materials so they respond more quickly when there is a second exposure
    - B cells make antibodies to the foreign proteins (antigens) to agglutinate them, making it easier for phagocytes to detect and destroy

12. Describe the main steps in the clotting process, including what initiates clotting.
    - If a blood vessel is injured, cells lining the blood vessel release chemicals which attract platelets.
    - Platelets are activated and change from a smooth round shape to an irregular spiky shape. Some platelets rupture and release chemicals to initiate clotting.
    - Chemicals released by platelets cause prothrombin, a blood protein, to react with calcium ions in the blood (Ca^{2+}) to form thrombin. Thrombin is an enzyme that changes fibrinogen, another blood protein, into fibrin.
    - Fibrin fibres form a mesh over the wound, trapping RBCs and more platelets. This forms a clot which stops the bleeding.
    - The clot dries and hardens into a scab which protects the damaged area while new cells grow underneath it and repair the wound site.

13. What is the name of the genetic disorder that results if a person has a mutation in one of their clotting factors? Why is this serious?
    - if a person has a mutation in a clotting factor, it is called hemophilia
    - it is serious because it takes much longer for a blood clot to form. The person can lose a significant amount of blood from quite a small injury, and perhaps even bleed to death.

14. Compare and contrast arteries and veins.

ARTERIES	VEINS
• carry blood away from the heart • thick muscular walls to withstand high blood pressure during systole • narrow inside diameter • no valves • blood is pushed along by the heart and elasticity of the arterial wall • branch into arterioles	• carry blood toward the heart • thinner muscular walls because blood is at lower pressure • wider inside diameter • valves prevent backflow • blood is pushed along by contractions of skeletal muscles around the veins • form when venules merge

15. Explain **<u>why</u>** the structure of an artery is so different from the structure of veins.
    - arteries must be able to withstand the high pressure exerted when the left ventricle contracts, so the walls of arteries are thicker and have more elastic fiber
    - when arteries "snap back" after the bolus of blood passes, this helps to push the blood along
    - the blood in the veins is much lower pressure so veins need less muscle in their walls
    - to keep the blood moving toward the heart, they have valves to prevent blood from flowing backwards

16. What is one significant difference in the structure and function of arterioles and venules?
    - arterioles are small arteries which supply the blood to the capillaries. Arterioles have bands of smooth muscle around them. The smooth muscle can contract and constrict, reducing blood flow into the capillaries so arterioles can control how much blood is going to certain areas of the body. For example, when it is cold, the arterioles under the skin constrict so less blood flows to the skin and extremities (fingers and toes) and this minimizes heat loss.
    - venules are small veins which collect blood from the capillaries. Venules do not have smooth muscle around them so they can not control the flow of blood.

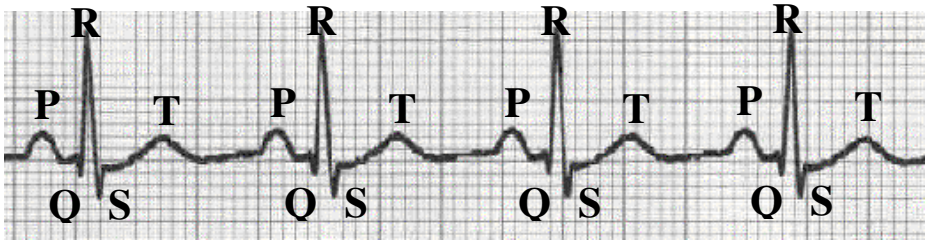
17. Starting in the right atrium, describe the flow of blood (in order) as it passes through the blood vessels, chambers of the heart and valves as it makes one complete circuit through the cardiovascular system. Name the large vessels that enter and leave the heart.
    - right atrium
    - through the tricuspid valve to right ventricle
    - through the pulmonic valve to the pulmonary artery
    - from the pulmonary artery to the capillaries around the alveoli in the lungs
    - from the capillaries around the alveoli to the pulmonary veins
    - back into the left atrium of the heart
    - through the bicuspid valve to the left ventricle
    - from the left ventricle through the aortic valve into the aorta
    - from the aorta to the head and body (aorta → arteries → arterioles → capillaries → venules → veins)
    - veins from the head and body collect blood and return it to the inferior and superior vena cava
    - the vena cava feed back into the right atrium

18. Describe the structure of capillaries and give two specific ways that their structure is ideally suited to their function.
    - the walls of the capillaries are only one endothelial cell thick, so nutrients and wastes can diffuse across them readily, so dissolved materials pass easily between the blood and the ECF
    - the capillaries themselves are microscopic in diameter, only wide enough to allow RBCs to pass through in single file. This ensures that the RBCs will have their surface exposed to increase their ability to absorb oxygen in the lungs or release it in the tissues
    - the endothelial cells making up the capillaries also have tiny gaps between the cells. These gaps are large enough to allow some proteins and WBCs to escape into the tissues. The proteins help to regulate fluid balance and the WBCs provide immune protection to the cells.

19. Identify the parts of the pulmonary and systemic circulatory systems.
    - the pulmonary circulatory system consists of the right ventricle, left and right pulmonary arteries, left and right pulmonary veins and left atrium
    - the systemic circulatory system consists of the left ventricle, aorta, system arteries to the head and body, systemic veins returning from the head and body, inferior and superior vena cava and right atrium

20. Explain what causes the "lub dub" sound made by the heart.
    - the 'lub' sound is made by blood hitting the closed tricuspid and bicuspid valves after the atria contract
    - the 'dub' sound is made by blood hitting the closed aortic and pulmonic valves after the ventricles contract
    - the tri- and bicuspid valves both close at the same time, so there should be a single 'lub'
    - the aortic and pulmonic valves both close at the same time, so there should be a single 'dub'

21. Draw what a 'normal' ECG trace looks like. Explain what is happening at each part of the trace.
    - during the P wave, the SA node depolarizes ('discharges') and the electrical current travels across both atria to the AV node, causing the muscle cells in the atria to contract



    - during the QRS complex, the AV node depolarizes ('discharges') and the electrical current travels down the Bundle of His, through the bundle branches and along the Purkinje fibers, causing the muscles cells (myocardial cells) in the ventricles to contract
    - during the T wave, the AV node and nerve fibers in the ventricles repolarise ('recharge' or 'reset') to get ready for another cardiac cycle
    - the SA node and nerve fibers in the atria repolarise during the QRS complex, so this electrical signal is not seen on its own

22. Describe the path of the electrical signal through the heart for one heart beat, naming all parts of the conduction system in order.
    - SA node → AV node → Bundle of His → bundle branches → Purkinje fibers

23. What is the critical role of the SA node?
    - it is the primary pacemaker for the heart
    - it is self-excitatory and depolarizes without any message from the brain
    - the brain can speed up or slow down the rate at which the SA node fires, but the brain is not needed to make the SA node depolarize

24. What is the correct name for heart muscle cells? myocardial cells (myo means muscle, cardio means heart)

25. Compare and contrast diastole and systole.
    - diastole and systole both refer to the contraction and relaxation of the ventricles of the heart
    - diastole is when the ventricles are 'dilated' or relaxed and receiving blood from the atria
    - systole is when the ventricles are 'squeezing' or contracting to push blood out into the arteries

26. Explain the difference between depolarization and repolarization.
    - depolarization is when a nerve cell sends an electrical signal (it 'discharges'). It does this by allowing positive ions to move into the cell (more about this in Grade 12)
    - repolarization is when a nerve cell 'recharges' so it is ready for the next depolarization. It does this by pumping the positive ions back out of the nerve cell

27. How is the left ventricle different from the right ventricle? Explain why.
    - the muscle wall of the left ventricle is much thicker and stronger than the wall of the right ventricle
    - this is because the left ventricle must pump blood to the entire body and head, so it must be able to pump with great force. The right ventricle only has to pump blood to the lungs, which requires much less force to the wall of the right ventricle contains much less muscle

28. What is the name of the device used to measure blood pressure? a sphygmomanometer

29. Where are the iliac, brachial, carotid and radial pulses found?
    - the iliac pulse is found where the legs join the body (in the front of the groin)
    - the brachial pulse is found in the upper arm (this is usually the pulse used to measure blood pressure)
    - the carotid pulse is found on both sides of the trachea, at the bottom of the neck
    - the radial pulse is found in the wrists (this is usually the pulse used to measure heart rate)

30. What are the values that define normal blood pressure? High blood pressure?
    - 'normal' resting blood pressure is 120/80 (measured in millimetres of mercury)
    - high blood pressure is when systolic pressure (the top number) is consistently above 140 at rest

    OR diastolic pressure (the lower number) is consistently above 90 at rest

31. What is hypertension and why is it dangerous? What parts of the body are the most susceptible to damage from hypertension?
    - hypertension is the medical name for high blood pressure (see question 30)
    - it is dangerous because the increased pressure inside the arteries and arterioles damages the walls of these blood vessels, causing them to harden (arteriosclerosis) and become stiffer
    - the higher blood pressure can cause significant damage to the blood vessels in the brain, kidneys and retinas of the eyes
    - high blood pressure can also cause artery walls to bulge in places and perhaps form an aneurysm
    - in severe cases, high blood pressure can cause a hemorrhagic stroke by causing blood vessels in the brain to burst, so there is bleeding in the brain (this is different from ischemic strokes which are caused by a blockage in one of the arteries to the brain, often because of atherosclerosis)

32. What is atherosclerosis and why it is dangerous? What two parts of the body are most susceptible to damage from atherosclerosis?
    - atherosclerosis is hardening and narrowing of the arteries due to the build up of plaque in the walls of arteries
    - the coronary arteries that 'feed' the heart muscles may become narrowed and blocked, causing angina or a heart attack
    - the arteries to the brain may become narrowed and blocked, causing a stroke

33. What is an aneurysm and why it is dangerous?
    - an aneurysm is where a weak spot in the artery wall bulges because of pressure in the artery
    - it is dangerous because aneurysms may rupture, causing serious internal bleeding

34. What is a cardiac arrhythmia? Why are cardiac arrhythmias so dangerous?
    - 'arrhythmia' means 'without rhythm', so the atria and ventricles are beating without a proper rhythm (either too fast, too slow or very irregularly)
    - when the heart beats out of rhythm, the atria and ventricles don't fill completely, so they pump when they are only partially full. This is very inefficient and the body will not be supplied with enough oxygenated blood to meet its needs
    - if an arrhythmia in the ventricles is serious, the person may have a heart attack

35. Describe two treatments for atherosclerosis in the coronary arteries.
    a) angioplasty involves inserting a catheter (small tube) into an artery and feeding the catheter to the coronary arteries
    - when the catheter is in place, a balloon in the catheter is inflated and this exerts pressure inside the artery, compressing the plaque and opening the artery
    - a stent (wire mesh tube) is often inserted inside the artery to help keep the artery wall open

    b) coronary bypass surgery is open-heart surgery. It involves sewing (grafting) a piece of an artery or vein into place around the blocked artery in the heart
    - the bypass allows blood from the aorta to flow into the coronary artery past the blockage and this supplies the heart with blood and nutrients (it is like a detour around the blockage)

36. Describe what happens during a heart attack. What are the common symptoms of a heart attack?
    - during a heart attack, one or more coronary arteries (the blood vessels that supply the heart with nutrients and oxygen) is blocked so no blood can get to the heart muscle past the blockage
    - the heart muscle past the blockage becomes ischemic (starved for oxygen) and dies. Muscle cells can not regenerate, so these heart cells are gone forever
    - symptoms of a heart attack are pain or numbness in the left arm, neck and shoulder, a feeling of squeezing or pressure in the chest, severe pain in the chest area, nausea and vomiting, difficulty breathing, severe sweating, a distinct grey/blue colour to the skin (called 'pallor')
    - women often have very vague symptoms, such as mild indigestion or 'heart burn'. If their skin is grey, take them to the hospital

37. Describe what happens during an ischemic stroke. What are the common symptoms of a stroke?
    - during an ischemic stroke, one or more arteries to the brain is blocked by plaque or a blood clot, so no blood can get to the brain past the blockage
    - the brain tissue past the blockage becomes ischemic (starved for oxygen) and dies. Nerve cells do not regenerate well, so these brain cells are gone forever
    - symptoms of a stroke can be remembered as "FAST": F for face (is it uneven, does one eye-lid droop, does one eyebrow droop, are the wrinkles smoothed out, are the pupils unequal sizes, is their smile 'lop-sided'?)

      A is for arms – if the person closes their eyes and raises both arms, does one arm 'drift' or drop down?

      S is for speech – if the person can speak, does their speech seem slurred or garbled (it may help to ask them to repeat a simple phrase)

      T is for time – act quickly. If the person can get to the hospital within 3 hours of the first symptoms, and if it is an ischemic stroke, they may be treated with tPA (tissue plasminogen activator) to dissolve the clot and prevent permanent damage to the brain

38. What causes a heart murmur? a leaky valve in the heart, so blood flows backward creating a 'pshhhh' sound

Genetics Problems Related to the Cardiovascular System

1. Hemophilia is an X-linked recessive trait (X^H is normal, X^h is the hemophilia allele). A man with hemophilia (X^h Y) has a daughter of normal phenotype (she must be $X^H X^h$; she gets one of her X chromosomes from her dad, so it will have the hemophilia allele). She marries a man who does not have hemophilia (he must be X^H Y) .

	X^H	Y
X^H	$X^H X^H$	X^H Y
X^h	$X^H X^h$	X^h Y

a) What is the probability that their **daughter** will have hemophilia?
   - to have hemophilia, a girl would have to be $X^h X^h$ because it is a recessive disorder
   - none of their daughters can be $X^h X^h$ so none of the girls will have hemophilia (0% chance)

b) What is the probability that their **son** will have hemophilia?
   - 50% probability that boys will be X^H Y so they will not have hemophilia
   - **50% probability that boys will be X^h Y so they will have hemophilia**

2. A man with hemophilia (he must be X^h Y) marries a normal, homozygous woman (she must be $X^H X^H$).

	X^h	Y
X^H	$X^H X^h$	X^H Y
X^H	$X^H X^h$	X^H Y

a) What is the probability that their daughter will have hemophilia?
   - none of their daughters can be $X^h X^h$ so none of the girls will have hemophilia
   - both of the girls will be carriers for the hemophilia gene

b) What is the probability that their son will have hemophilia?
   - none of their sons can be X^h Y so none of the boys will have hemophilia or be carriers

3. A human female "carrier" for hemophilia marries a normal male.

	X^H	Y
X^H	$X^H X^H$	X^H Y
X^h	$X^H X^h$	X^h Y

a) What is the probability that their daughter will have hemophilia?
   - none of their daughters can be $X^h X^h$ so none of the girls will have hemophilia
   - 50% chance that a girl will be carriers for the hemophilia gene

b) What is the probability that their son will have hemophilia?
   - 50% chance that a son will have hemophilia

4. A man with AB blood is married to a woman with AB blood. Predict the blood types of their children and the probability of each of these blood types.
   - 25% of children will be $I^A I^A$
   - 50% of children will be $I^A I^B$
   - 25% of children will be $I^B I^B$

	I^A	I^B
I^A	$I^A I^A$	$I^A I^B$
I^B	$I^A I^B$	$I^B I^B$

5. A man who is homozygous Type B blood marries a woman with Type O blood. Predict the blood types of their children and the probability of each of these blood types.
   - 100% of children will be $I^B I^O$

	I^B	I^B
I^O	$I^B I^O$	$I^B I^O$
I^O	$I^B I^O$	$I^B I^O$

6. A woman with Type A blood (hybrid) is married to a man who is heterozygous for Type B. Predict the blood types of their children and the probability of each of these blood types.
   - 25% of children will be $I^A I^B$
   - 25% of children will be $I^A I^O$
   - 25% of children will be $I^B I^O$
   - 25% of children will be $I^O I^O$

	I^B	I^O
I^A	$I^A I^B$	$I^A I^O$
I^O	$I^B I^O$	$I^O I^O$

7. A woman with Type A blood (unknown genotype) gives birth to a child with type AB blood. The woman claims that a man with type AB blood is the father of her child. Is this possible? Show the possible crosses; remember the woman can have AO or AA genotypes.

	I^A	I^B
I^A	$I^A I^A$	$I^A I^B$
I^A	I^A	$I^A I^B$

	I^A	I^B
I^A	$I^A I^A$	$I^A I^B$
I^O	$I^A I^O$	$I^A I^O$

   - if the child has AB type blood, it is possible that the man could be the father of the child, regardless of whether the mother is Type AA or Type AO
   - however, this does not prove that the man is the father, just that it is a possibility

8. A man with Type AB blood is married to a woman with Type O blood. They have two natural children, and one adopted child. The children's blood types are: A, B, and O. Which child was adopted?
   - the child with Type O blood had to be adopted
   - in order to have Type O blood, both parents must have at least one copy of the 'O' allele
   - since the man has Type AB blood, he does not have an 'O' allele

Answers to Multiple Choice:

1. c	6. c	11. b	16. a	21. a	26. c	31. c	36. c	41. b	46. d
2. d	7. b	12. a	17. c	22. a	27. d	32. a	37. d	42. c	47. a
3. c	8. d	13. b	18. a	23. c	28. b	33. c	38. a	43. c	48. d
4. d	9. c	14. c	19. d	24. d	29. d	34. b	39. d	44. a	49. d
5. b	10. a	15. a	20. b	25. b	30. b	35. a	40. c	45. b	50. c