STUDENT BOOK ANSWERS

Chapter 11 Animal systems for life

Question set 11.1

1 Plasma is the pale yellow fluid portion of the blood. It is composed of whole blood without the red and white blood cells and the platelets. It also contains proteins.

2 The main plasma protein, albumin, helps keep the water in the capillaries by osmosis; the immunoglobulins provide antibodies against disease-causing organisms; fibrinogen is involved in forming blood clots. The plasma proteins also carry substances such as calcium, drugs, hormones, lipids, vitamins and cholesterol; they keep the acidity of the blood at an optimal level and they provide a source of amino acids.

3 White blood cells function collectively to fight foreign substances that enter the blood. They engulf material and destroy poisons, produce antibodies and release chemical messages and enzymes.

4 Platelets are smaller than red blood cells and are shaped like flattened discs. They release chemicals at the site of injury in a blood vessel, causing it to contract and reduce blood loss. They also clump together to help form a clot.

5 Haemoglobin enables blood to carry 20 mL of oxygen per 100 mL of blood, about 70 times more oxygen than it could without this red protein. It can also release oxygen easily in regions of low concentrations. Haemoglobin also carries about a quarter of the carbon dioxide in the blood.

6 The internal environment is all material contained within a cell and the external environment is all the material outside a cell. The plasma membrane is the barrier between the two environments.

Question set 11.2

1 The main components of the circulatory system are the blood vessels; for example, the arteries, veins and capillaries. The main function of the circulatory system is to transport oxygen and nutrients to all cells in the body; wastes, such as carbon dioxide and urea, are also removed by the circulatory system.

2 The heart has four chambers. Blood from the body enters the right atrium via the vena cava. Contraction of cardiac muscle in the heart pushes the blood out of the atrium into the ventricle. Valves in the heart keep the blood flowing in one direction so that blood doesn't go back into the body.

3 The circulatory system is the collection of arteries, veins and capillaries that ensure that blood travels to all parts of the body. The cardiovascular system includes the blood vessels as well as the heart.

4 The heart has four chambers: there are two thin-walled atria and two more muscular ventricles. Blood enters the right atrium from the general body system of blood vessels and passes into the right ventricle. When the right ventricle contracts, it pushes the blood into the arteries that lead to the lungs. There, oxygen diffuses into the blood and carbon dioxide passes out into the air in the lungs. The now oxygen-rich or oxygenated blood passes back into the heart through the left atrium and into the left ventricle. When this ventricle contracts, the blood is forced into the aorta, the largest artery, which, through its many branches, takes blood to all parts of the body.

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5 Systemic circulation supplies oxygen and nutrients to all cells in the body; this form of circulation also removes wastes from the cells. Pulmonary circulation moves blood from the heart to the lungs and back to the heart, removing waste carbon dioxide and adding oxygen to the blood.

6 Arteries take blood away from the heart; veins carry blood to the heart. Capillaries are found between these two blood vessels. The walls of the arteries are thicker than those of veins. This is because arteries have a lot more muscle and elastic fibres than veins do. The lumen of the vein is larger than that of the artery. Veins have valves in them to help keep the blood flowing to the heart. Unlike arteries and veins, capillaries have very thin walls and are very narrow. Their walls are only one cell thick, allowing nutrients and wastes to diffuse into and out of neighbouring cells.

7 Both systems are responsible for circulating fluids through the body; while the circulatory system circulates blood, the lymphatic system returns excess fluid and the proteins from the tissues to the bloodstream.

8 Blood pressure forces some fluid as well as small protein molecules out of the capillaries at the arterial end. Most of the water passes back into the capillaries at the venous end, as the blood pressure has dropped off. The water moves back into the capillaries by osmosis, caused mainly by the high concentration of albumin molecules in the plasma. Albumin keeps fluid in circulation by maintaining osmotic pressure; if osmotic pressure is not maintained, fluid will leak out of the blood vessels and into the surrounding tissues.

9 Some water and proteins would be left in the spaces between the cells if it were not for the lymph vessels. Lymphatic capillaries are small, blind-ending tubes, which allow the fluid and protein to enter through tiny flaps that act as one-way valves between the cells in their walls. The fluid flows in the lymph vessels to the heart to rejoin the normal blood circulation. It is pushed along in much the same way as blood in the veins is moved, by contracting muscles. Valves in the lymph vessel walls maintain a unidirectional flow to the heart.

10 To determine whether a blood vessel attached to the heart is an artery or a vein, the following would need to be taken into account:

- It is an artery if it is attached to a ventricle and coming out of the top of the heart.
- It is a vein if it is attached to an atrium and leading into the side of the heart.
- It is more likely to be an artery if it has a thick muscular wall.
- It is more likely to be a vein if it has a thinner, less muscular wall.

11 Students can use the diagram of the heart, Figure 11.7.

12

Open circulation	Closed circulation			
	One-chambered heart	Two-chambered heart	Three-chambered heart	Four-chambered heart
Arthropods	Squids	Fish	Amphibians	Birds
Most molluscs	Annelids		Most reptiles	Mammals

Question set 11.3

1 Generally the gas exchange surface has to:

- be thin and permeable so the molecules can move across it easily and quickly.
- be moist, so that the gases can dissolve in the water and diffuse from one side to the other.
- be as large an area as needed by the organism, especially to provide oxygen for its varying energy needs.
- have a greater supply of gas on one side than the other.

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2 The surfactant in mammalian lungs is a detergent-like lipoprotein that reduces the surface tension inside each alveolus. This prevents the alveolar walls from being pulled inwards so that the alveoli do not collapse and the lungs can expand.

3 Most of the carbon dioxide is carried as bicarbonate ions inside the red blood cells. The rest of the carbon dioxide is either dissolved in the plasma or carried in the haemoglobin molecules.

4 The processes of life require the constant supply of oxygen (for cellular respiration) and the removal of carbon dioxide, a by-product of cellular respiration.

5 During inhalation the muscles lift the ribs upwards and outwards at the same time as the diaphragm contracts and moves downwards. The lungs expand because the pressure around them has decreased. During exhalation the reverse happens, with the ribs coming down and in and the diaphragm moving up and forcing the air out.

6 Air inside the bronchioles is part of the external environment; it has not passed through the plasma membrane into cells.

7 The rate of breathing is controlled by the level of carbon dioxide in the blood. Carotid bodies, tiny organs found in the carotid arteries, detect the amount of carbon dioxide in the blood. If the level is too high, the brain sends impulses to the muscles of the ribs and diaphragm to contract and thus bring fresh air into the lungs, thereby increasing the rate at which carbon dioxide is lost in exhaled air and lowering the carbon dioxide level in the blood.

8

Characteristic	Fish (gills)	Mammal (lungs)
Moist	Live in water.	Alveoli are kept moist.
Thin	Gill plates are thin.	The distance across alveolar and capillary walls is less than 1 micrometre.
Large surface area (SA)	The upper and lower surfaces of the filaments have numerous gill plates, which greatly increase the surface area of the gill.	There are about 700 million alveoli in the human lung and they provide a surface area that is approximately the size of a tennis court.
Greater concentration of gas on one side	The concentration of oxygen is higher in the water than it is in the capillaries of the gills; the concentration of carbon dioxide is initially higher in the capillaries than it is in the water.	The concentration of oxygen is higher in the lungs than it is in the blood; the concentration of carbon dioxide is higher in the blood than it is in the lungs.

Question set 11.4

1 The main functions of the digestive system are to ingest, digest, absorb nutrients and eliminate wastes via egestion. The digestion of macromolecules so that they can be absorbed into the internal environment of the animal occurs like this:

- Carbohydrates are digested to produce glucose – monosaccharides.
- Proteins are digested to produce amino acids.
- Lipids are digested to produce fatty acids and triglycerides.

2 The structures through which food must pass are, in order, the mouth, teeth and tongue; epiglottis and oesophagus; stomach; small intestine (duodenum, jejunum and ileum); and the large intestine (colon and rectum).

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3

Enzyme	Function
Amylase	Digestion of starch to produce glucose
Pepsin	Digestion of protein to produce peptides
Trypsin	Breaks down long-chain polypeptides to shorter-chain peptides
Lipase	Digestion of fats to produce fatty acids and triglycerides

4 Absorbed nutrients can leave the small intestine via either the bloodstream or the lymphatic system. Fatty acids and triglycerides enter the lymphatic system via the lacteals in the villi, whereas amino acids and monosaccharides enter the bloodstream via the capillaries in the villi.

5 A number of structures increase the surface area of the digestive system. These include the folds in the stomach and the layers of villi in the small intestine. Each villus is supplied with a network of capillaries and lymph vessels that allow for greater absorption.

6 The purpose of chewing the cud is to attempt to break down the tough cellulose wall of the plant material in order to increase the surface area available for the action of enzyme-producing bacteria.

7 Students should be able to construct this using the information in the text.

8 Undigested food that is egested has not entered body cells at any stage so is part of the external environment.

9 The structure of the cow's stomach is quite different to that of the human stomach as its function is quite different. The human stomach is the site of protein digestion. Cattle do not usually consume protein; however, their consumption of low-energy plant material is high. The cow's stomach is divided into four chambers with plant material at various stages of digestion.

10 Responses will vary. The human digestive system ensures the digestion of many materials as humans are generally classified as omnivores. Other animals included in the text have a less varied diet and this is reflected in their digestive systems.

Experiment 11.1: Dissection of a kidney

Analysis of results and Discussion

1 **a** Renal artery

b Renal vein

c The kidney is surrounded by fat.

2 The pelvis of the kidney is whitish and harder than the rest of the kidney. The ureter leads away from the pelvis. It goes to the bladder.

3 These organs are found in the cortex of the kidney. This is where the nephrons are situated.

4 Blood should not leave blood vessels. Blood cells are too large to enter the glomerulus. If blood is found in urine, it must be because of damage to the glomerulus.

Question set 11.5

1 Renal artery → Glomerulus → Proximal tubule → Loop of Henle → Distal tubule → Collecting duct

2 The final amount of water is reabsorbed from the collecting duct.

3 **a** Substances that are reabsorbed into the bloodstream from the tubules include salts, glucose, amino acids and water.

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b Substances that are secreted or released into the lumen of the tubule are ammonia, potassium and hydrogen ions, histamine, creatinine, and drugs such as aspirin and penicillin.

4 Refer to Figure 11.24.

5 The blood in the glomerulus is under a lot of pressure because the arteriole coming out is narrower than that going in, so some of the blood is pushed, or filtered, out of the capillaries into the Bowman's capsule. This contains everything that was in the blood except the blood cells and large proteins such as albumin, fibrinogen and antibodies.

6 The kidney uses more energy proportionally than the heart because of the amount of energy it uses in active transport reabsorbing substances such as amino acids, sodium ions, phosphate ions and glucose.

7 The kidneys assist in maintaining water balance by either increasing or decreasing the urine output. If there is excess water intake, less water is reabsorbed in the nephron, thus creating more urine. Conversely it adjusts for increased exercise or reduced water intake by lowering the urine output.

Chapter review questions

1 a Heart and blood vessels

b Arteries, veins and capillaries

c Trachea and lungs comprising the bronchi, bronchioles and alveoli

d Stomach, liver, gallbladder, large intestine, small intestine

e Kidneys, ureters, bladder and urethra

2 a Kidney

b Small intestine

c Large intestine

d Alveoli in the lungs

e Stomach

f Mouth

g Mouth

3 a Respiratory system

b Digestive system

c Excretory system

4

Section of gut	What happens
Mouth	Chewing breaks down the food into smaller pieces. Saliva mixes with food and breaks it down chemically.
Oesophagus	Food is passed into stomach by means of muscular contractions.
Stomach	Food is mixed with enzymes and acid.
Small intestine	Food is mixed with digestive enzymes from the pancreas and liver. Broken down food is absorbed into the blood.
Large intestine	Undigested food material is compacted; water and some salts are absorbed back into the body.
Anus	Faeces is released.

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5 During systemic circulation, arteries carry blood from the heart and veins carry blood to the heart. The blood flow for pulmonary circulation is reversed; pulmonary arteries carry blood to the heart and pulmonary veins carry blood from the heart.

6 The fibrous nature of valves allows blood to push the flaps open, when being pushed by muscular contractions of blood vessels or the heart, but prevents blood flowing backwards.

7 Students will complete the quiz.

8 **a** The renal pelvis is the section of the kidney where urine is collected and directed to the ureter.

b The nephron is the structure of the kidney where filtration of the blood occurs.

c The loop of Henle is the portion of a nephron that connects the proximal convoluted tubule to the distal convoluted tubule.

d The collecting duct is the nephron's last region where urine is collected before leading to the kidney's central cavity.

9 The fish will be mechanically digested in the mouth by the teeth with the addition of saliva. As it moves down the oesophagus into the stomach, the protein will be digested by the enzymes pepsin and trypsin in the highly acidic environment. The rest of the food will be churned until it becomes a thick soupy consistency, called chyme. As it passes out of the stomach, the acid will be neutralised by the bicarbonate juices released by the pancreas into the top part of the small intestine. As the chyme moves down the duodenum, bile that is produced by the liver and stored in the gall bladder, will enter the tract and work as a detergent on the fat globules, mechanically digesting the fat. Then lipases and proteases will enter from the pancreas and complete the digestion of the meal prior to absorption by the villi.

10 Placing a person in a thermal blanket after severe blood loss ensures that the warm fluid lost does not have a negative impact on the person's body temperature. The fluid lost must be restored, hence the intravenous drip. This fluid may not be at body temperature, causing the body to expend further energy to maintain temperature.

11 The food cows ingest (grass) requires a great deal of mechanical digestion. In this way, a greater surface area is exposed to the action of enzymes produced by the bacteria that populate parts of their digestive tract. As grass is very low in energy, the more that is able to be ground up ready for the action of enzymes, the better for the animal. The grinding molars allow maximum mechanical digestion of the grass material.

12 It is along the loop of Henle that water is reabsorbed into the bloodstream. The longer the loop, the better the opportunity the water has of being reabsorbed.

13 When a person is suffering diarrhoea, the matter in the large intestine moves through quickly; thus water is not able to be absorbed and the waste that is eliminated is quite runny. In constipation, waste moves slowly through the large intestine; all available water is absorbed, producing a hard, dry faecal body that is difficult to expel. In an ideal situation, at least 50 mL of water needs to be absorbed into the body via the large intestine. It is important that enough fluid remains in the waste material to allow for an easy passage out of the body but not enough to produce a runny discharge.

14 Arteries are required to carry oxygenated blood to all parts of the body; blood needs to reach its location very quickly and this is assisted by the pumping of the heart. The arteries, therefore, need to be clear of obstructions so that the oxygenated blood can reach the cells that require oxygen. Any blockage slows down the movement of the blood and can lead to the death of cells if they do not receive the oxygen they need.

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15 A ventricular septum defect (VSD) would allow the mixing of oxygenated and deoxygenated blood and the circulation of oxygen-rich blood. This could lead to low oxygen supply in vital organs and muscles. The pressure generated by the simultaneous contraction of the ventricles would also reduce the pressure in the movement of blood out of the ventricle into the aorta. ASD would most likely be an atrial septum defect where blood would mix in the atrial chambers.

16 Students need to discuss the breakdown of food, by digestion, to the basic nutrients, which can then be used to build up tissues.

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