Cambridge International AS & A Level

BIOLOGY (9700) PAPER 2

Past Paper Questions By Topic
+ Answer Scheme

2015 - 2020

Complete Syllabus

PapaCambridge

Chapter 8

Transport in mammals

8.1 The circulatory system

125. 9700_s20_qp_22 Q: 6

The mitotic cell cycle in dividing cells is very carefully controlled.

(a) Complete Table 6.1 to show the correct order of stages in the mitotic cell cycle.

Some of the stages have been completed for you.

Table 6.1

stage of cell cycle	
G_1 phase	
.....	.....
.....	
.....	
.....	mitosis
.....	
telophase	
cytokinesis	

[3]

At various points during the mitotic cell cycle, checks are made. A cell goes through cell death (apoptosis) if errors occur that cannot be repaired. This makes sure that the daughter cells produced are genetically identical to each other and to the original cell.

Drugs have been developed that can inhibit the mitotic cell cycle and cause the cell to carry out apoptosis. These drugs are used in the treatment of cancer.

(b) Vincristine and 5-fluorouracil are chemical compounds that act as cell cycle inhibitors and can lead to apoptosis.

- Vincristine binds to spindle microtubules and prevents the spindle from carrying out its function.
- 5-fluorouracil prevents the synthesis of thymine nucleotides.

Complete Table 6.2 to show which event in the cell cycle will occur when Vincristine or 5-fluorouracil are added to healthy dividing cells at the start of the interphase stage of the cell cycle.

Place a tick (✓) if the event will occur or a cross (✗) if the event will **not** occur.

All boxes in the table should be completed.

Table 6.2

event in cell cycle / compound	S-phase completes	cell enters prophase of mitosis	chromosomes line up at spindle equator	sister chromatids move towards opposite poles
Vincristine				
5-fluorouracil				

[2]

(c) Vincristine has been used in the treatment of certain types of leukaemia.

Fig. 6.1 is a photomicrograph of a blood smear of a person with one form of leukaemia, which affects lymphocytes.

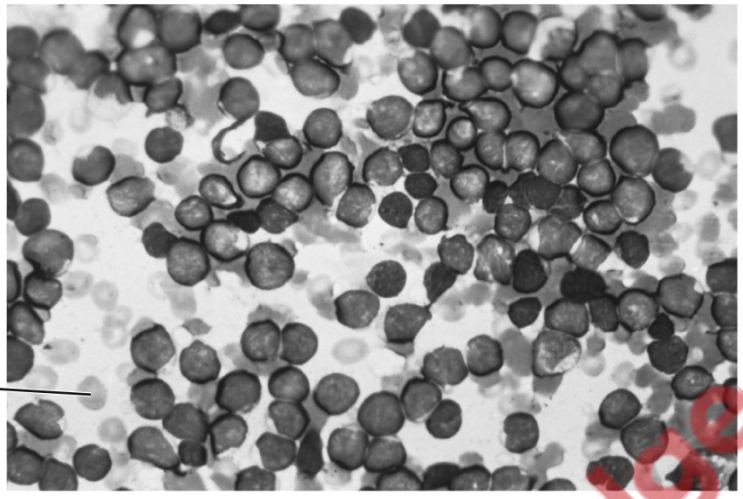

Fig. 6.1

Describe how:

- the blood smear shown in Fig. 6.1 differs from a blood smear of a healthy person
- the lymphocytes in a person with leukaemia, such as those shown in Fig. 6.1, differ from those of a healthy person.

blood smear differences .....

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.....

lymphocyte differences .....

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..... [3]

[Total: 8]

126. 9700_w20_qp_22 Q: 6

(a) Fig. 6.1 shows an oxygen dissociation curve for adult human haemoglobin.

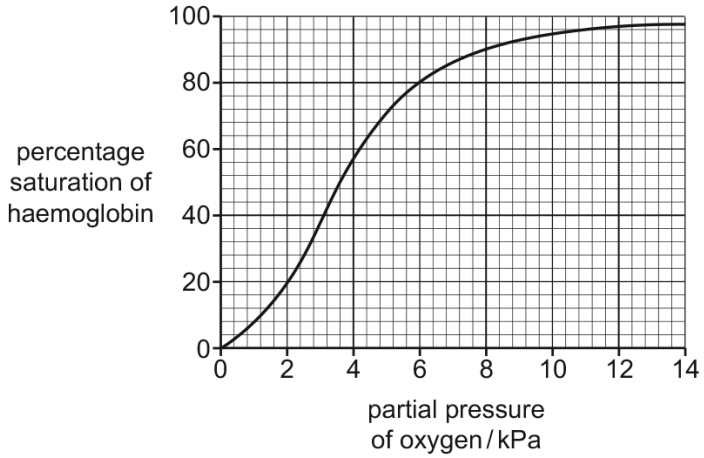

Fig. 6.1

An increase in the partial pressure of carbon dioxide (pCO_2) in respiring tissue causes the Bohr effect.

(i) Sketch on Fig. 6.1 to show how the Bohr effect changes the oxygen dissociation curve. [1]

(ii) Explain how an increase in pCO_2 produces the Bohr effect **and** state the benefit of this effect for the tissue.

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..... [3]

(b) Carbon dioxide (CO_2) is transported across the cell surface membrane of the red blood cell using a different mechanism to the transport of hydrogen carbonate ions (HCO_3^-).

Name the different mechanisms of transport used for CO_2 and for HCO_3^- **and** explain why they are transported across the membrane by different mechanisms.

CO_2 .....

HCO_3^- .....

explanation .....

.....

.....

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[4]

[Total: 8]

127. 9700_s19_qp_21 Q: 2

Linoleic acid is an unsaturated fatty acid that is found in some triglycerides and some phospholipids.

Phospholipids are components of cell membranes.

Fig. 2.1 shows a molecule of linoleic acid.

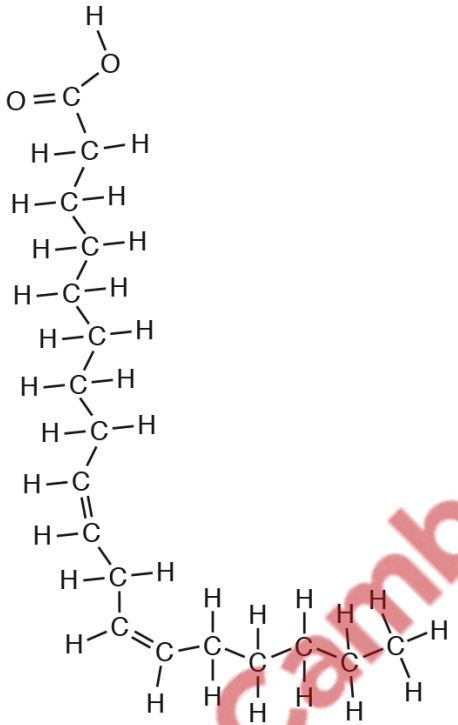

Fig. 2.1

(a) The composition of cell membranes of plants changes in response to changes in temperature.

At the start of the cold season there is an increase in the proportion of phospholipids with unsaturated fatty acids in the chickpea, *Cicer arietinum*. Chickpea plants that do not make this change do not survive.

Suggest how the increase in the proportion of phospholipids with unsaturated fatty acids helps plants, such as chickpea, survive decreases in temperature.

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..... [2]

(b) **(i)** State why triglycerides and phospholipids **cannot** be described as polymers.

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..... [1]

(ii) State two **differences** in the **structure** of triglycerides and phospholipids.

1 .....

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2 .....

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[2]

(c) Platelets metabolise linoleic acid to produce a molecule known as thromboxane.

Thromboxane is released by platelets when blood loss occurs. Thromboxane acts on smooth muscle cells in the walls of arteries. This causes arteries to constrict, which reduces blood flow.

Explain why the constriction of arteries following blood loss is an example of cell signalling.

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..... [4]

[Total: 9]

128. 9700_s19_qp_23 Q: 5

(a) Fig. 5.1 is a photomicrograph of human blood cells that have been placed in a solution of sodium chloride.

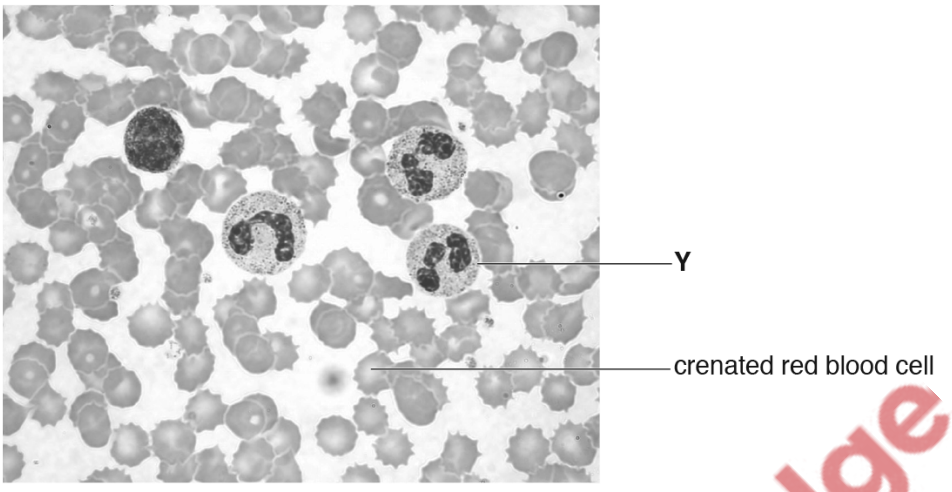

Fig. 5.1

(i) State the function of the cell labelled **Y**.

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..... [1]

(ii) The red blood cell labelled in Fig. 5.1 is described as crenated because it has an abnormal, shrivelled appearance.

Explain how this red blood cell has become crenated.

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..... [2]

(b) Researchers studied the effect of altitude on the red blood cell count of humans. They recorded the red blood cell count of healthy adults from populations living at four different altitudes in a mountainous region.

The results are shown in Table 5.1.

Table 5.1

population	altitude of population / m above sea level	mean red blood cell count / number of cells $\times 10^6$ mm^{-3}
A	695	4.50
B	1676	5.14
C	2003	5.04
D	2118	5.11

(i) Calculate the percentage increase in mean red blood cell count between population **A** and population **D**.

.....% [1]

(ii) Describe and suggest explanations for the data shown in Table 5.1.

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..... [4]

(c) Carbonic anhydrase is an enzyme found in red blood cells which has an important role in the transport of respiratory gases.

Explain why a non-competitive inhibitor of carbonic anhydrase will reduce the supply of oxygen to actively respiring tissues.

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..... [2]

[Total: 10]

129. 9700_w19_qp_22 Q: 3

A red blood cell goes through a number of stages in the bone marrow before it is released into the circulation to carry out its role of oxygen transport.

Fig. 3.1 is a transmission electron micrograph of developing red blood cells in the bone marrow. Each cell is known as an erythroblast.

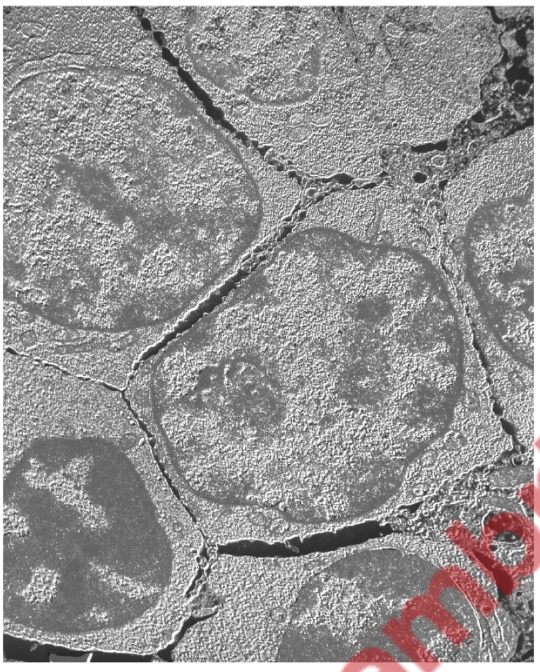

Fig. 3.1

(a) Fig. 3.1 shows erythroblasts at a higher magnification than can be obtained using the light microscope.

Explain the advantages of using an electron microscope to obtain images such as that in Fig. 3.1.

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..... [2]

(b) Describe the differences between an erythroblast and a mature red blood cell.

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..... [3]

(c) The maturing red blood cell synthesises haemoglobin and other proteins.

(i) Complete Table 3.1 to:

- name **three** organelles (cell structures) that are involved in the synthesis of a fully functioning protein
- state **one** way in which the named organelle is involved in protein synthesis.

Table 3.1

organelle	how the organelle is involved in protein synthesis

[3]

(ii) Fig. 3.2 shows a reversible reaction that takes place within red blood cells.

$$CO_2 + H_2O \rightleftharpoons H_2CO_3$$

Fig. 3.2

Name the protein that catalyses the reaction shown in Fig. 3.2.

..... [1]

The *SPTB* gene codes for a protein that provides stability and support to the cell surface membrane of the red blood cell.

Mutations in *SPTB* result in red blood cells that are spherical in shape. This mutation leads to a disease known as spherocytosis type 2.

(d) Suggest why a person with spherocytosis type 2 has a reduced ability to take up oxygen in the pulmonary capillaries compared with a person who has normal red blood cells.

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..... [2]

(e) Increases in the water potential of the blood plasma have greater effects on red blood cells in people with spherocytosis type 2 than on normal red blood cells.

Compare **and** explain the effects of an **increase** in the water potential of blood plasma on spherocytosis type 2 red blood cells and normal red blood cells.

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..... [3]

[Total: 14]

130. 9700_w19_qp_23 Q: 1

Fig. 1.1 is a diagram of a molecule of haemoglobin.

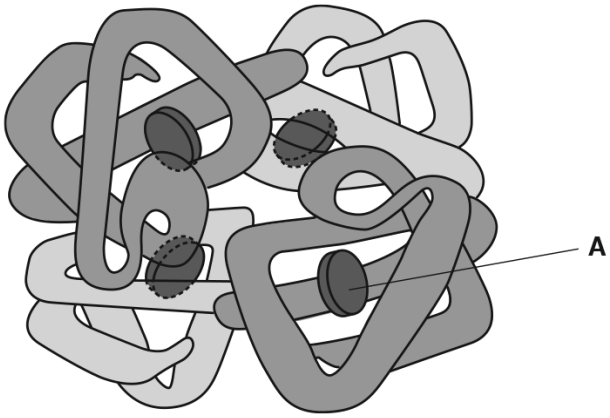

Fig. 1.1

(a) (i) Name the structure labelled **A** on Fig. 1.1.

..... [1]

(ii) State the function of structure **A**.

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.....

..... [1]

(b) Haemoglobin is described as a globular protein. Explain why this protein is described as *globular*.

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..... [2]

(c) The gene *HBB* codes for the β-globin polypeptide.

State why a polypeptide, such as β-globin, is described as a polymer.

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..... [2]

(d) A single base change in the DNA of the gene *HBB* results in a change to the amino acid sequence of β-globin. In the sequence, a single glutamic acid is replaced by valine.

Outline the effects of this change in the amino acid sequence of β-globin on the structure and function of a haemoglobin molecule.

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..... [3]

(e) Haemoglobin interacts with carbon dioxide and carbon monoxide.

Outline the role of haemoglobin in the transport of carbon dioxide.

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..... [3]

[Total: 12]

131. 9700_w19_qp_23 Q: 4

In mammals, arteries branch to form smaller blood vessels called arterioles.

Arterioles branch to form capillaries that supply blood to tissues.

(a) Explain the ways in which the structure of an artery is adapted to its function.

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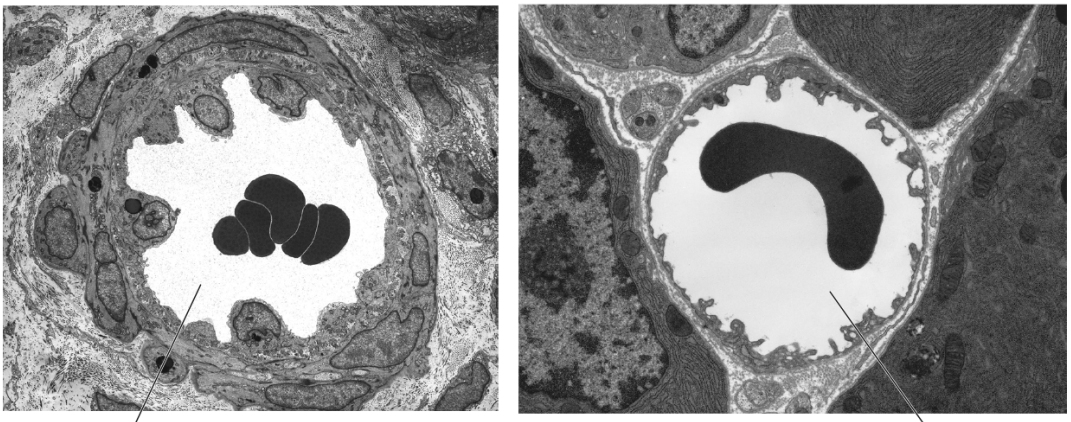
..... [4]

Fig. 4.1 shows transmission electron micrographs of cross-sections through an arteriole and a capillary.



arteriole magnification ×2000 **capillary** magnification ×6500

Fig. 4.1

(b) (i) Identify the cells inside the lumen of the arteriole in Fig. 4.1 **and** state **one** reason for your identification.

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..... [2]

(ii) Describe the differences between the arteriole and the capillary that are **visible** in Fig. 4.1.

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..... [4]

Fig. 4.2 shows a capillary network in a mammalian tissue.

The arrows indicate the direction of flow of body fluids.

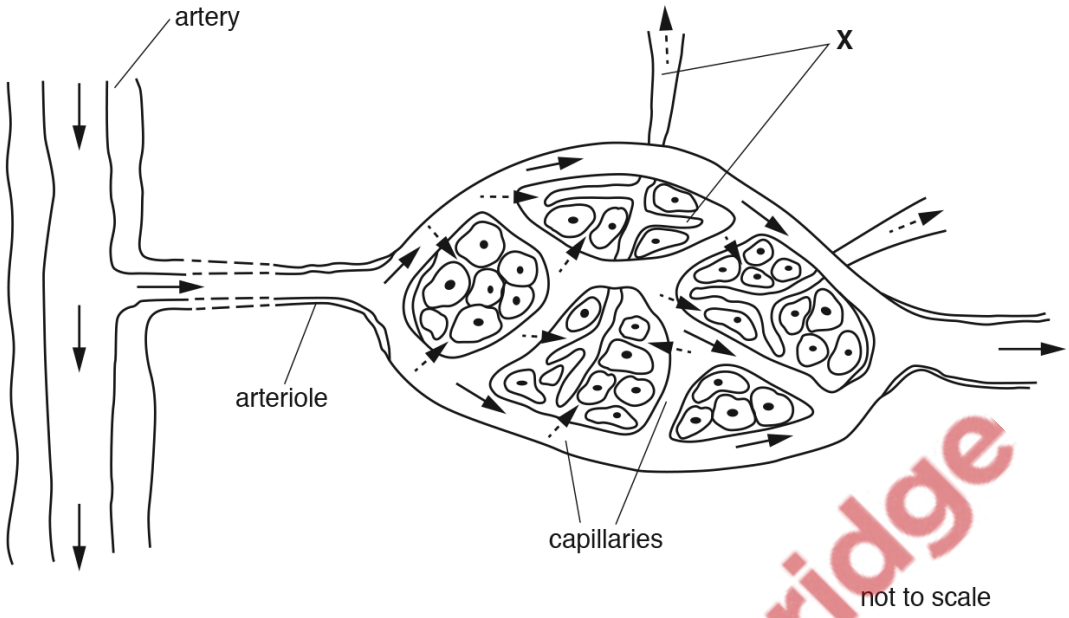

Fig. 4.2

(c) **(i)** Capillaries have a role in the formation of tissue fluid.

Explain how tissue fluid is formed in the capillary network.

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..... [2]

(ii) The vessels labelled **X** in Fig. 4.2 carry excess tissue fluid back into the circulatory system.

Name the fluid inside the vessels labelled **X and** state **one** way in which its composition differs from blood plasma.

name of fluid .....

difference .....

.....

[2]

[Total: 14]

132. 9700_s18_qp_21 Q: 4

Fig. 4.1 is a ribbon model of a molecule of haemoglobin.

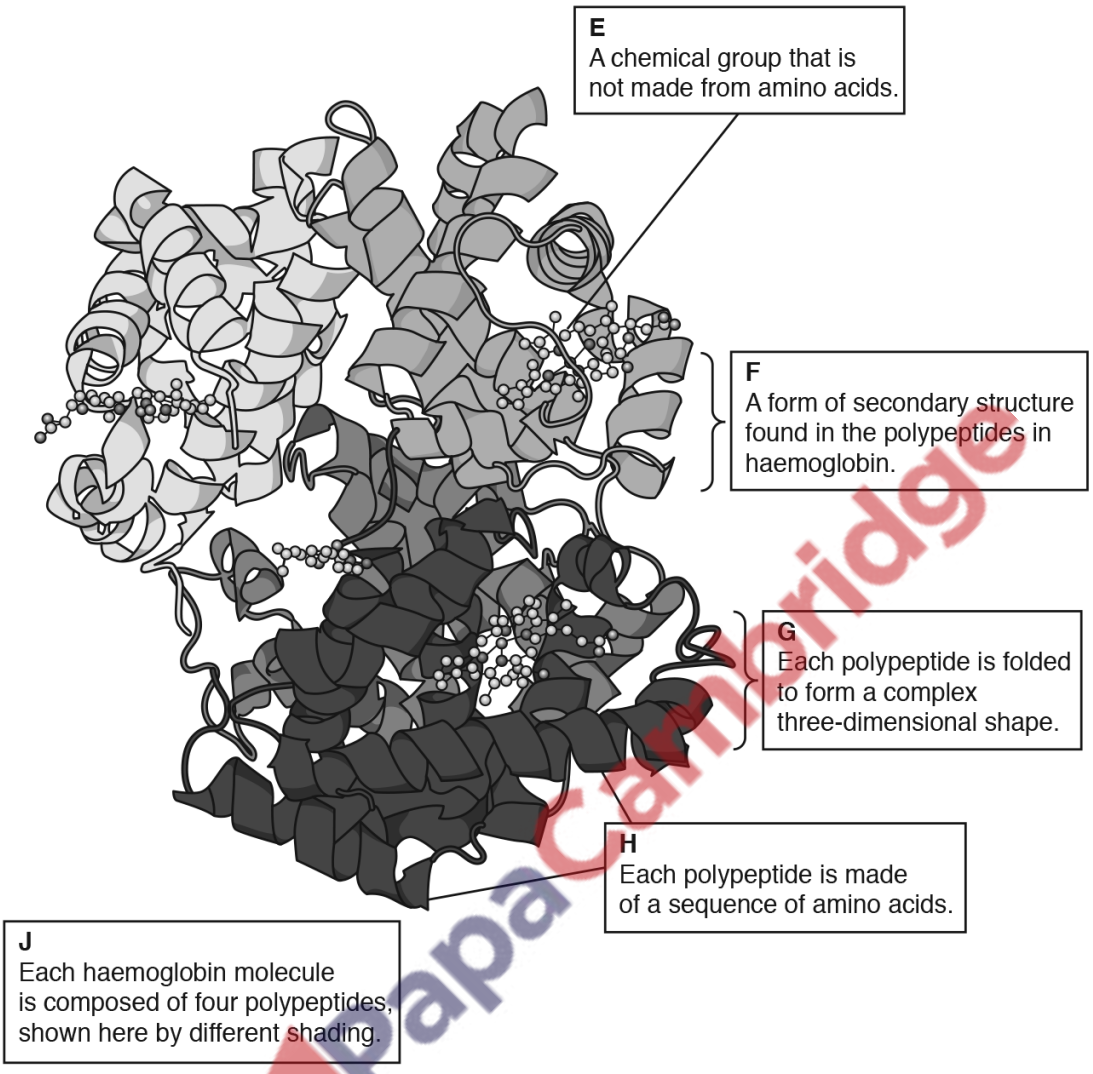

Fig. 4.1

(a) State the term that matches each of the descriptions given in boxes **E**, **F**, **G**, **H** and **J** in Fig. 4.1.

E .....

F .....

G .....

H .....

J .....

[5]

(b) The effect of carbon dioxide on the percentage saturation of haemoglobin with oxygen was investigated.

A sample of mammalian blood was exposed to a gas mixture that contained increasing partial pressures of oxygen (pO_2). Throughout the investigation the partial pressure of carbon dioxide (pCO_2) was maintained at 5.3 kPa. The percentage saturation of haemoglobin in the sample was determined as the pO_2 increased.

The investigation was repeated with a second sample of blood in which the pCO_2 was maintained at 10.7 kPa.

The results are shown in Fig. 4.2.

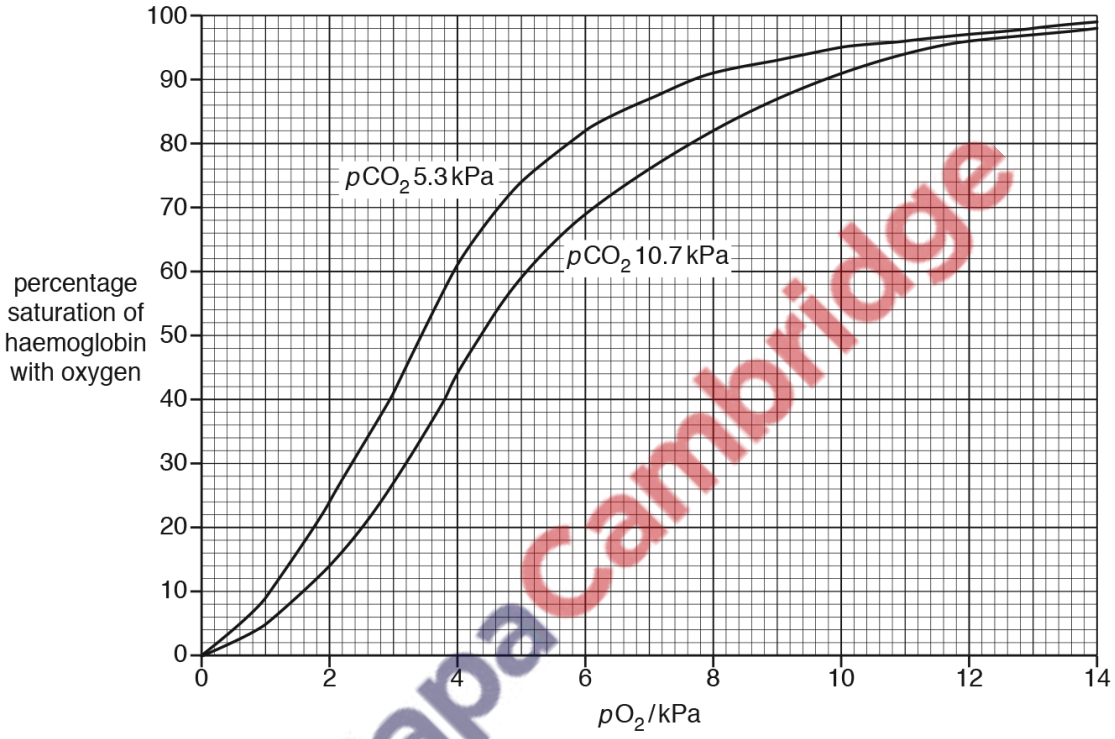

Fig. 4.2

(i) The pO_2 in alveolar air is 13.0 kPa and the pCO_2 is 5.3 kPa.

Use Fig. 4.2 to suggest the percentage saturation of haemoglobin in blood entering the pulmonary veins.

.....[1]

(ii) Use the information in Fig. 4.2 to state **and** explain the effect of increasing pCO_2 in muscle tissues during strenuous exercise.

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.....

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.....[4]

[Total: 10]

133. 9700_w18_qp_21 Q: 6

(a) Haemoglobin is a globular protein which is able to transport oxygen and is soluble in water.

(i) Explain how the structure of a haemoglobin molecule makes it able to transport oxygen efficiently.

.....

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.....

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..... [3]

(ii) Explain how the structure of a haemoglobin molecule allows it to be soluble in water.

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..... [2]

(b) Llamas are mammals that are adapted to live at high altitudes.

Fig. 6.1 shows oxygen dissociation curves for haemoglobin of llamas and humans.

(i) The partial pressure of oxygen in the lungs of mammals at 3500 m is 6.4 kPa.

Use Fig. 6.1 to state the percentage saturation of haemoglobin of llamas and humans at an oxygen partial pressure of 6.4 kPa.

llamas ..... %

humans ..... % [1]

(ii) With reference to Fig. 6.1, explain the advantage to llamas of having an oxygen dissociation curve positioned to the left of the curve for humans.

.....

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.....[2]

[Total: 8]

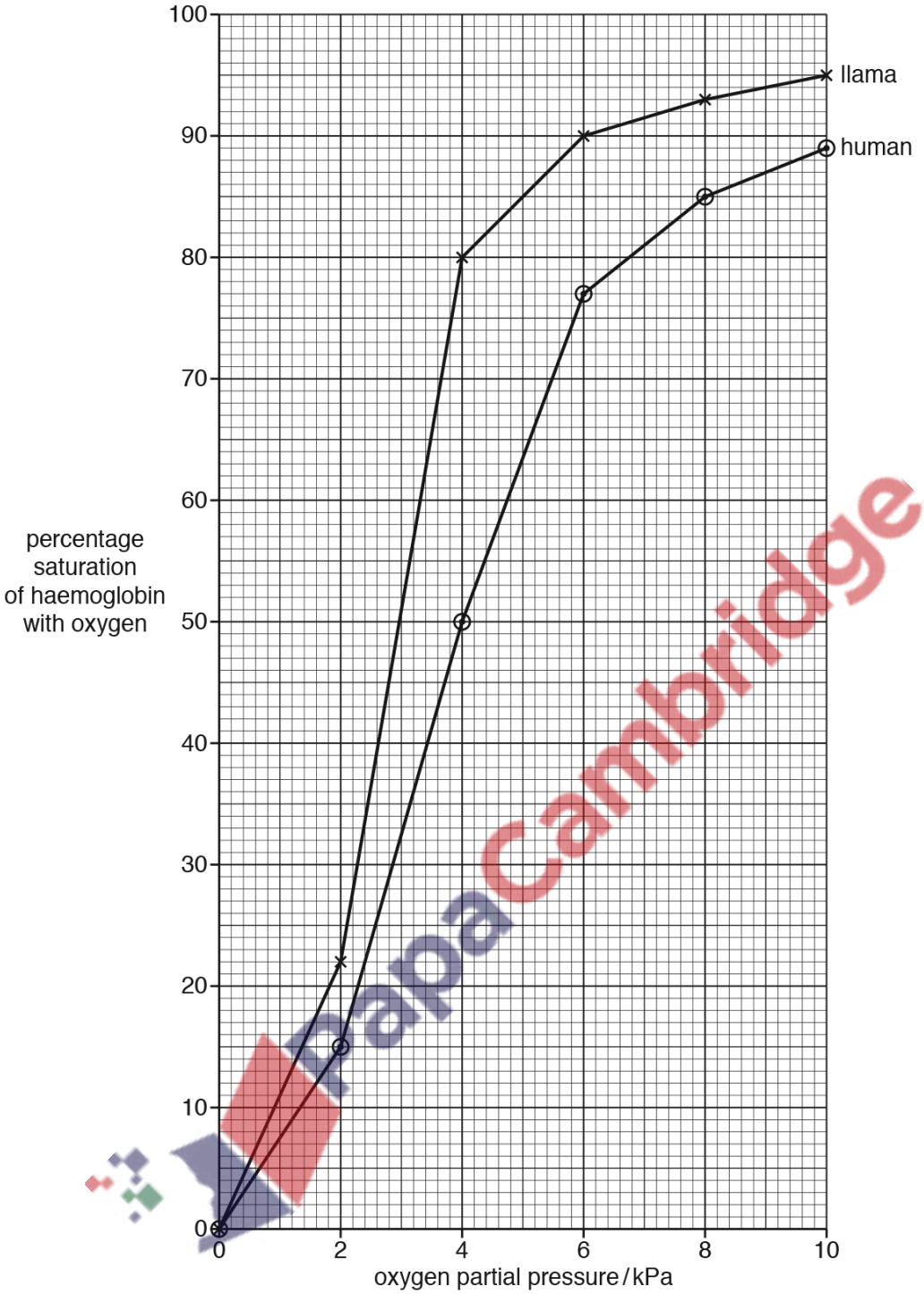

Fig. 6.1

134. 9700_w18_qp_22 Q: 6

As a red blood cell matures, cell organelles are lost from the cell. This provides more space for the haemoglobin molecules that have been synthesised.

(a) The red blood cell has a short lifespan due to the loss of the nucleus and other organelles.

State **one** function performed by each of the organelles listed, before they are lost from the developing red blood cell.

rough endoplasmic reticulum

.....

Golgi body

.....

centrioles

.....

[3]

(b) State the most appropriate term to match each of the descriptions **A** to **C**.

A The part of the haem group that binds oxygen in each haemoglobin polypeptide.

.....

B The compound formed when carbon dioxide binds to haemoglobin.

.....

C The compound formed when hydrogen ions (H^+) bind to haemoglobin.

.....

[3]

[Total: 6]

135. 9700_s17_qp_22 Q: 6

As a result of transcription and translation, a polypeptide chain is produced. Proteins with quaternary structure contain two or more polypeptide chains.

An antibody molecule and a haemoglobin molecule both show quaternary structure.

(a) Table 6.1 shows some features of an antibody molecule and a haemoglobin molecule.

Complete Table 6.1 to produce a summary of the features of the two molecules.

Table 6.1

feature	antibody	haemoglobin
fibrous or globular		
number and names of polypeptide chains	two heavy and two light chains	
type of bond holding polypeptide chains together		ionic

[3]

(b) The base sequence shown in Fig. 6.1 is a short section of a longer length of DNA that is transcribed to produce mRNA. When translated, this short section produces the amino acid sequence threonine (Thr), proline (Pro), cysteine (Cys).

Fill in the two **unshaded** boxes in Fig. 6.1 to show:

- the mRNA codon for Cys
- the tRNA anticodon for Thr.

You do **not** need to give the codon and anticodon sequences in the shaded boxes.

DNA strand transcribed	TGT	GGC	ACA
mRNA strand produced			
tRNA anticodon sequence		GGC	
amino acid sequence	Thr	Pro	Cys

Fig. 6.1

[2]

[Total: 5]

136. 9700_w17_qp_22 Q: 2

Triglycerides and phospholipids are types of lipid.

Fig. 2.1 shows the structure of one type of phospholipid known as phosphatidylcholine.
F1 and F2 are fatty acid residues.

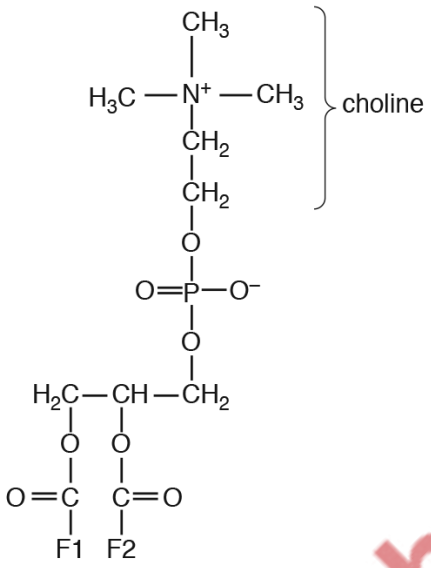

Fig. 2.1

(a) Phospholipase is an enzyme that can break down phospholipids. This enzyme is found in the venom of some insects, such as bees.

Bee venom can destroy red blood cells, a condition known as haemolysis.

Suggest how bee venom destroys red blood cells.

.....

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.....[2]

(b) Compare, stating similarities and differences, the structure of the phosphatidylcholine shown in Fig. 2.1 with the structure of a triglyceride molecule.

similarities .....

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.....

differences .....

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.....

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.....[4]

(c) Name **and** describe the cell structure in which the synthesis of triglycerides and other lipids takes place.

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.....[3]

[Total: 9]

137. 9700_M16_qp_22 Q: 3

Erythropoietin, also known as EPO, is a large glycoprotein synthesised by specialised cells in the kidney. These cells are very sensitive to changes in oxygen concentration in the blood passing through the kidney and respond to a low oxygen concentration by increasing the synthesis of EPO.

EPO acts at the surface of particular target cells, such as cells in the bone marrow. These bone marrow cells are stimulated to produce red blood cells.

(a) (i) A low oxygen concentration also leads to an increase in the quantity of mRNA in the specialised cells in the kidney.

Suggest and explain why there is this increase in the quantity of mRNA.

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.....[2]

(ii) EPO is stored in secretory vesicles before being released from the specialised kidney cells.

Outline how EPO is released from the cells.

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.....[2]

(b) All cells of the body are exposed to circulating blood plasma containing EPO, but only particular target cells respond.

(i) Suggest and explain how EPO acts on target cells and why other cells are **not** affected.

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.....[3]

(ii) EPO cannot pass through the cell surface membrane to enter the bone marrow cells.

Suggest **one** reason why this is so.

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.....[1]

(c) Red blood cells originate from undifferentiated cells in the bone marrow that are capable of continuous mitotic cell division.

State the name of this type of undifferentiated cell.

.....[1]

(d) As part of an investigation into the body's response to EPO, a group of healthy young men were given injections of EPO every day for four weeks.

The haemoglobin (Hb) concentration for each subject was measured at the start of the investigation and then at intervals of one week for the next ten weeks. The first measurement was taken two weeks before the first EPO injection was given.

Fig. 3.1 shows the mean results for the subjects.

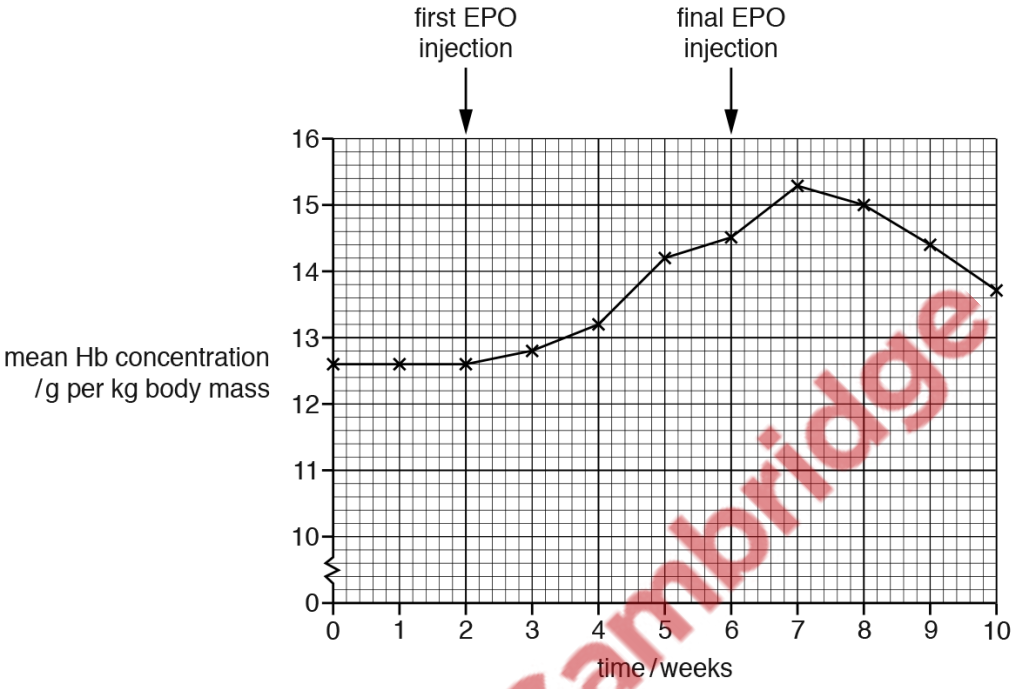

Fig. 3.1

Describe the results shown in Fig. 3.1 **and** suggest explanations for these results.

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.....[4]

(e) The concentration of EPO in the blood plasma of a person will increase when travelling from sea level to a high altitude. This is in response to the decrease in oxygen partial pressure in the atmosphere.

Explain why an increase in EPO blood plasma concentration will be of benefit if the person remains at high altitude.

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.....[3]

[Total: 16]

138. 9700_s16_qp_21 Q: 5

(a) Fig. 5.1 is a diagram of part of an animal cell in a stage of mitosis.

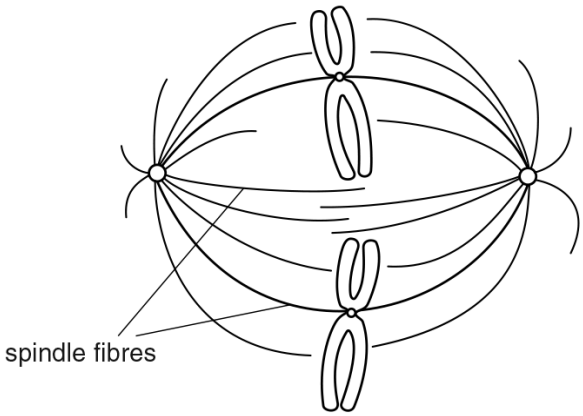

Fig. 5.1

(i) Draw a diagram in the space below to show the stage of mitosis that follows the stage in Fig. 5.1.

[3]

(ii) Describe the roles of the spindle fibres during mitosis.

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.....[2]

Bone marrow contains many stem cells. Some of these stem cells are responsible for the replacement of red blood cells.
During the production of red blood cells a series of changes occur to the cell structure.

Fig. 5.2 shows the production of a red blood cell from one of these stem cells.

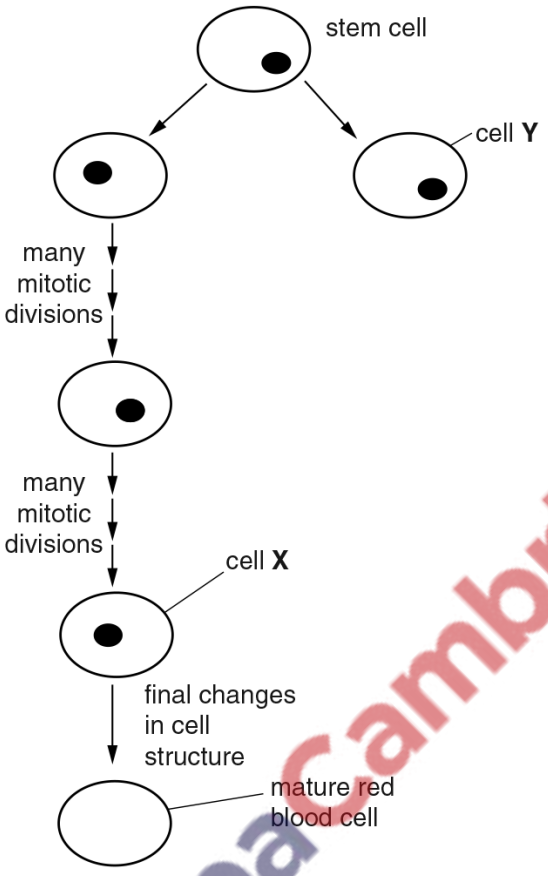

Fig. 5.2

(b) (i) Outline the changes that occur as cell **X** becomes a mature red blood cell.

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.....

.....[3]

(ii) Suggest what may happen to cell **Y**.

.....[1]

(c) People who travel to high altitude become acclimatised to the conditions.

Athletes often train at high altitude before competing at sea level.

A group of male and female athletes who trained at sea level moved to high altitude for further training. Sports scientists analysed blood samples taken from the athletes to measure any changes in the concentration of haemoglobin in the blood and changes in the haematocrit.

Haematocrit is the volume of red blood cells expressed as a percentage of the total volume of a sample of blood.

The results are shown in Table 5.1.

Table 5.1

feature of the blood	at sea level	after 19 days at high altitude	percentage increase
mean concentration of haemoglobin in the blood / g 100 cm^{-3}	13.3	15.1	.....
mean haematocrit	41.0	42.5	3.7

(i) Complete Table 5.1 by calculating the percentage increase in haemoglobin concentration. [1]

(ii) Explain why it is necessary for the athletes to increase the concentration of haemoglobin in their blood when acclimatising to high altitude.

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.....[4]

[Total: 14]

139. 9700_w16_qp_22 Q: 4

Fig. 4.1 is a cross-section of a human renal artery, a vessel that supplies blood to the kidney.

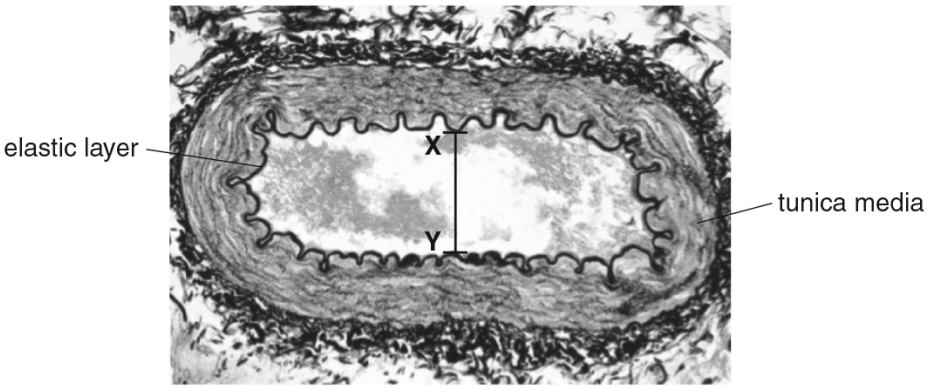


Fig. 4.1

(a) The elastic layer shown in Fig. 4.1, located between the endothelium and the tunica media, is one feature that suggests that the blood vessel is the renal artery and not the renal vein, which may be of a similar size.

Complete the sentence to state **one** additional structural feature, **visible in Fig. 4.1**, that would identify the blood vessel as an artery.

This is an artery because it has .....

.....

.....

.....[1]

(b) Explain the relationship between the structure of the tunica media and the function of an artery, such as the renal artery.

.....

.....

.....

.....

.....

.....[2]

(c) The actual diameter of the lumen of the renal artery at the point **X–Y** in Fig. 4.1 is 5.2 mm.

Calculate the magnification of the image shown in Fig. 4.1. Write down the formula you will use to make your calculation and show your working.

formula

magnification × .....[3]

(d) Blood plasma contains approximately 90% water. Many of the properties of water are due to its ability to form hydrogen bonds.

Outline how the properties of water make it ideal as the largest component of plasma.

.....

.....

.....

.....

.....

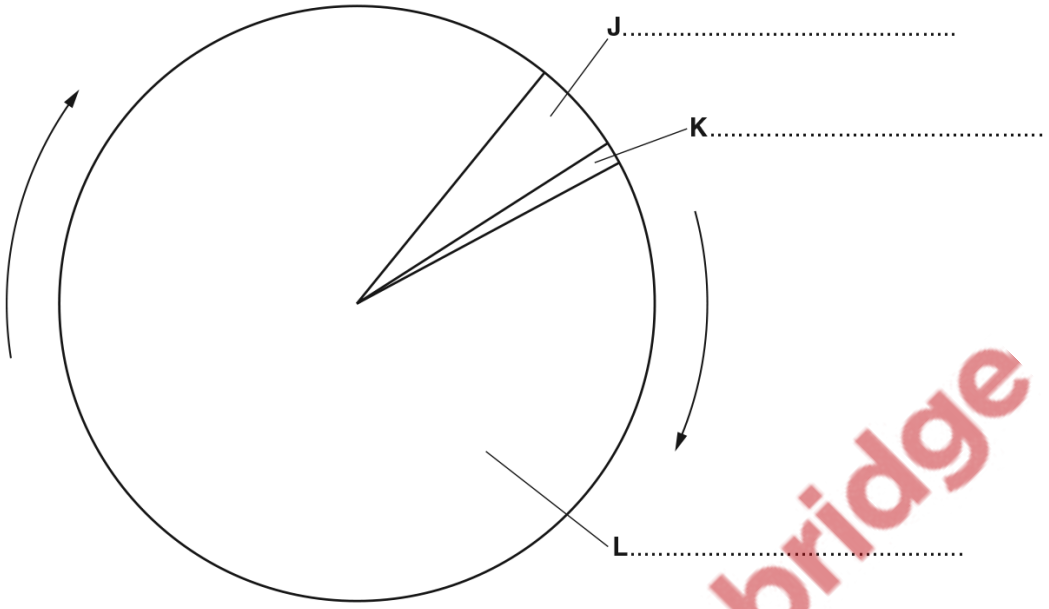
.....[3]

[Total: 9]

140. 9700_w16_qp_22 Q: 6

(a) Fig. 6.1 represents one complete cell cycle for a eukaryotic cell.

(i) Complete Fig. 6.1 by naming the stages represented by **J**, **K** and **L**.



[3]

Fig. 6.1

(ii) Name the stage in the cell cycle in which semi-conservative replication of DNA occurs.

.....[1]

The development of stem cells to become neutrophils occurs in several stages. Some of these stages are capable of cell division.
Fig. 6.2 is a summary of neutrophil development. Some details of cellular structure are included.

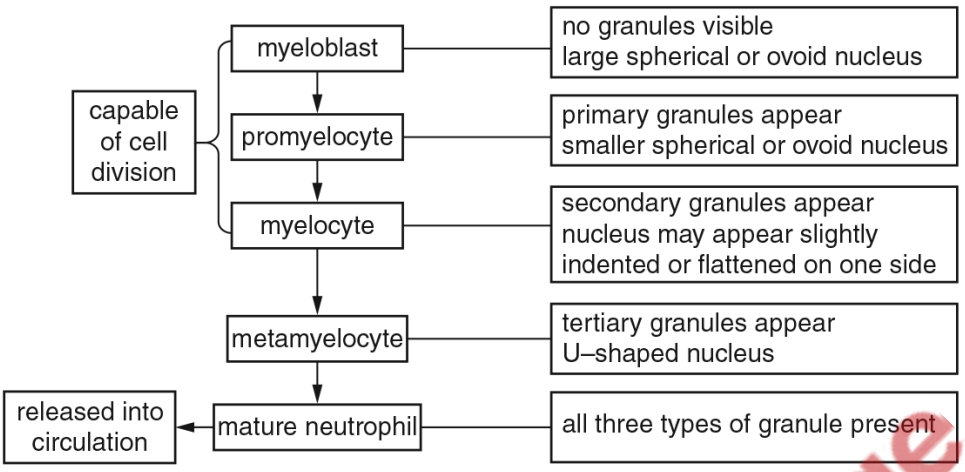


Fig. 6.2

All three types of granule indicated in Fig. 6.2 are membrane-bound cell structures containing hydrolytic enzymes. Each type of granule contains a different group of enzymes and other chemicals that enable the neutrophil to carry out its role.

(b) (i) State the location in the body where development and maturation of the neutrophil occurs.

.....[1]

(ii) Describe the shape of the nucleus in the mature neutrophil.

.....[1]

(iii) State the alternative name of the cell structures described in Fig. 6.2 as “granules”.

.....[1]

(c) **(i)** Primary granules contain proteins known as defensins. These bind to cell surface membranes of bacteria and form very small pores in the membrane.

Suggest how defensins contribute to the role of the neutrophil in killing bacteria.

.....

.....

.....

.....

.....[2]

(ii) Secondary granules contain lysozyme. This is an enzyme that breaks bonds in peptidoglycan molecules.

Explain how the action of lysozyme will lead to the destruction of the bacterial cell.

.....

.....

.....

.....

.....[2]

[Total: 11]

141. 9700_w16_qp_23 Q: 5

In an investigation, the volume of oxygen that combined with haemoglobin at different partial pressures of oxygen was determined. The results are shown in Fig. 5.1.

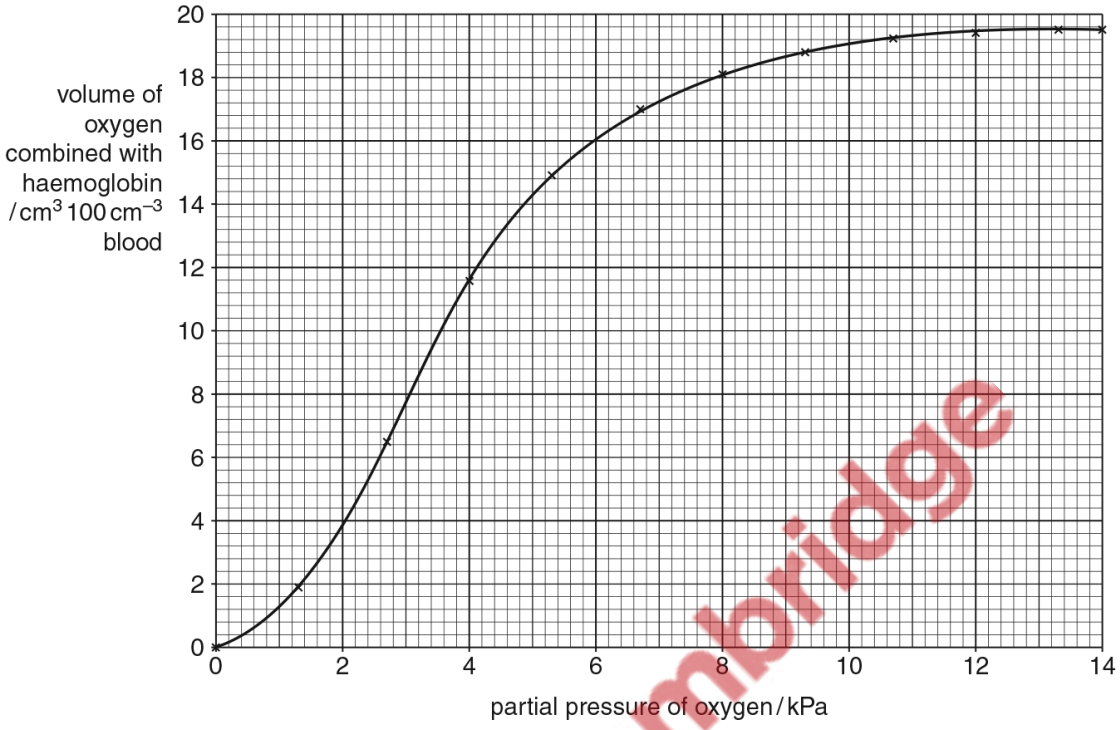


Fig. 5.1

(a) The partial pressure of oxygen in the alveoli is 13.3 kPa. At this partial pressure of oxygen the **total volume of oxygen** that is carried by 100 cm^3 blood is 19.78 cm^3 at pH 7.4 and 37 °C.

The volume of oxygen that combines with haemoglobin at 13.3 kPa is 19.48 cm^3 100 cm^{-3} blood.

(i) Calculate the percentage of oxygen that is combined with haemoglobin in 100 cm^3 blood.

answer .....% [1]

(ii) Suggest how the oxygen that is **not** combined with haemoglobin is transported in the blood.

.....

.....[1]

(iii) Explain why a long-term smoker would have a lower volume of oxygen combined with haemoglobin in the alveoli at 13.3 kPa.

.....

.....

.....

.....

.....[2]

(b) Describe the role of carbonic anhydrase in the transport of carbon dioxide.

.....

.....

.....

.....

.....

.....

.....[3]

(c) The investigation was repeated in the presence of carbon dioxide. The volumes of oxygen combined with haemoglobin at partial pressures of oxygen below 8.0 kPa were less than shown in Fig. 5.1.

Name this effect **and** explain the advantage of this decrease at partial pressures of oxygen below 8.0 kPa.

name .....

advantage .....

.....

.....

.....

.....

.....

.....[3]

[Total: 10]

142. 9700_s15_qp_21 Q: 4

(a) Fig. 4.1 shows two ways in which enzymes interact with their substrates.

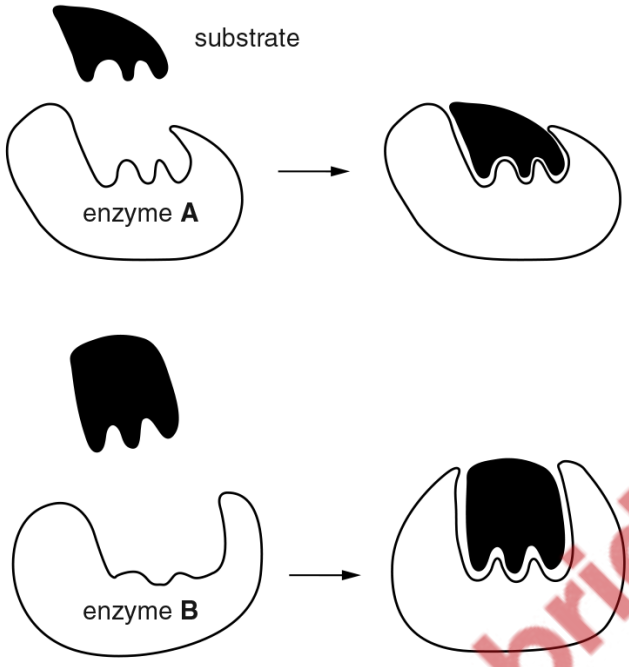


Fig. 4.1

Explain the difference between the two ways in which enzymes interact with their substrates as shown in Fig. 4.1.

.....

.....

.....

.....

.....

.....

.....[3]

(b) Carbonic anhydrase is an enzyme that is found in blood, liver and kidneys.
Fig. 4.2 shows a molecular model of this enzyme.

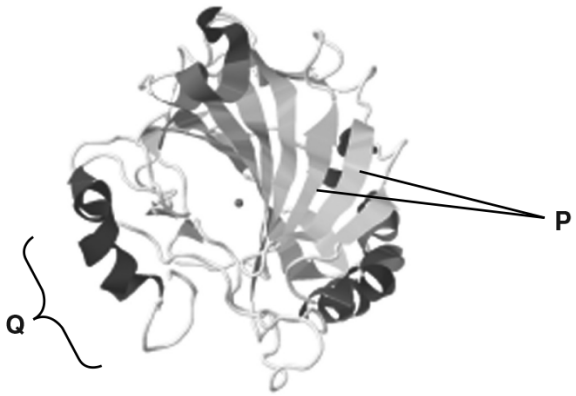


Fig. 4.2

(i) With reference to Fig. 4.2 and the parts labelled **P** and **Q**, explain the term *secondary structure*.

.....

.....

.....

.....

.....

.....

.....[3]

(ii) Describe the role of carbonic anhydrase in the blood.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 10]

143. 9700_s15_qp_22 Q: 3

Outside the body, red blood cells can be maintained in an intact state by keeping the cells in a 0.9% solution of sodium chloride. This is known as a normal saline solution.

Fig. 3.1 shows intact red blood cells.

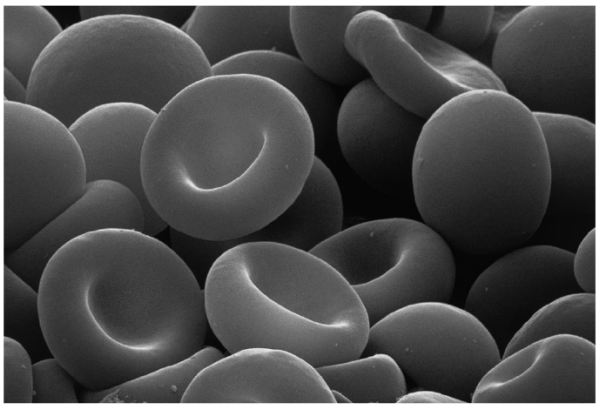


Fig. 3.1

(a) Explain why red blood cells can be maintained in an intact state by keeping them in a normal saline solution.

.....

.....

.....

.....

.....[2]

(b) In the blood, red blood cells are suspended in plasma. The main component of blood plasma is water.

Suggest **one** other component of blood plasma that could enter red blood cells **and** describe how it would cross the cell surface membrane.

component .....

description .....

.....

.....

.....

.....

.....[3]

Fig. 3.2 shows red blood cells within a capillary. The capillary shown in Fig. 3.2 allows the rapid exchange of substances between the blood, tissue fluid and body cells.

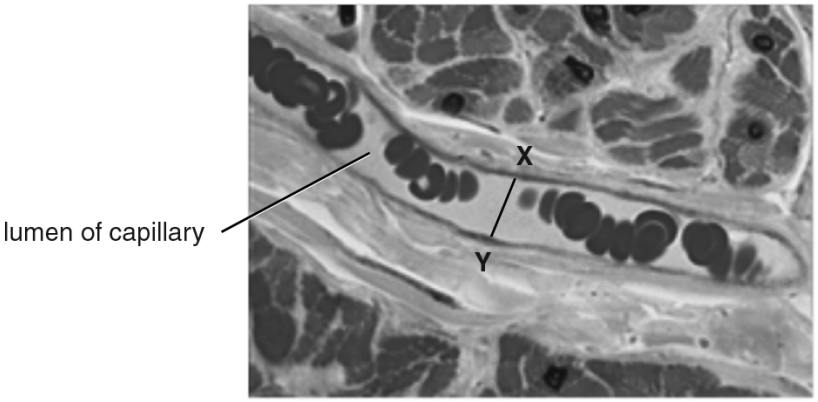


Fig. 3.2

(c) The actual diameter of the lumen of the capillary at the point **X**–**Y** in Fig. 3.2 is 9.5 μm.

Calculate the magnification of the image shown in Fig. 3.2. Show your working.

magnification × ..... [2]

(d) With reference to Fig. 3.2, explain **one** feature that enables the surrounding body cells to receive an adequate supply of oxygen from the blood supplied by the capillary.

.....

.....

.....

.....[2]

(e) Some areas of the brain, known as blood-brain barriers, have a type of capillary that is relatively impermeable to substances.

Suggest **one** way in which the structure of a capillary in the blood-brain barrier differs from the structure of the capillary shown in Fig. 3.2.

.....

.....[1]

[Total: 10]

144. 9700_s15_qp_23 Q: 4

Fig. 4.1 shows how blood pressure changes in the human systemic circulation.

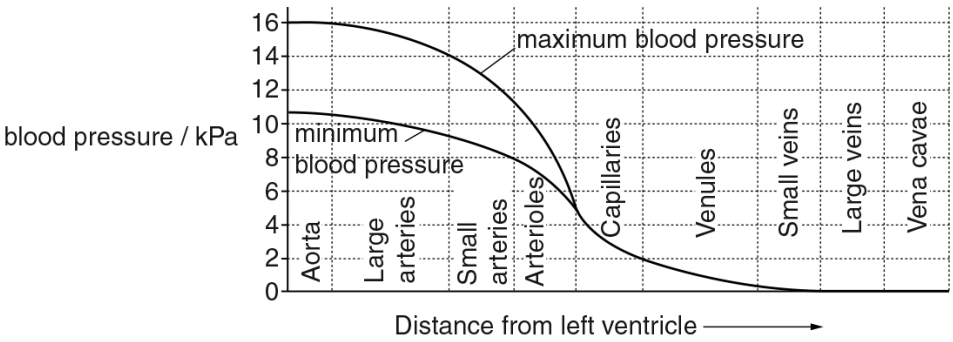


Fig. 4.1

(a) (i) Describe the changes in blood pressure shown in Fig. 4.1.

.....

.....

.....

.....

.....

.....

.....[3]

(ii) Explain how the structure of veins is related to their function in returning blood to the heart.

.....

.....

.....

.....

.....[2]

(b) Angiotensin is a polypeptide produced in the body to raise blood pressure.
Angiotensin converting enzyme (ACE) catalyses the final step in angiotensin production.
Fig. 4.2 shows this step.

Fig. 4.2

Describe the step shown in Fig. 4.2.

.....

.....

.....

.....

.....

.....

.....[3]

(c) People with high blood pressure can be treated with a drug which lowers the concentration of angiotensin in the blood.

This drug is a competitive inhibitor of ACE.

Explain how this drug acts as a competitive inhibitor.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 11]

8.2 The heart

145. 9700_m20_qp_22 Q: 3

During one cardiac cycle:

- blood enters the heart from the lungs and from the rest of the body
- blood leaves the heart to be transported to the lungs and to the rest of the body.

(a) Name the blood vessels entering the heart that bring blood from the rest of the body.

.....

..... [1]

(b) One phase of the cardiac cycle is ventricular diastole (ventricular relaxation). A number of events occur in the heart during this phase.

Outline **and** explain the events that occur in the heart during ventricular diastole.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

Blood arriving in the lungs from the heart is oxygenated as it passes through the pulmonary capillaries.

Sickle-shaped red blood cells are present in a person with sickle cell anaemia. These cells have a very high quantity of abnormal (sickle cell) haemoglobin and take up and transport less oxygen than red blood cells containing normal haemoglobin.

(c) The cause of the differences between sickle cell haemoglobin and normal haemoglobin is a mutation in the gene that codes for one of the two types of polypeptide found in a haemoglobin molecule. This mutation leads to a change in the mRNA produced during transcription, causing a change in the primary structure of the polypeptide formed.

Fig. 3.1 shows some of the changes that occur as a result of this gene mutation.

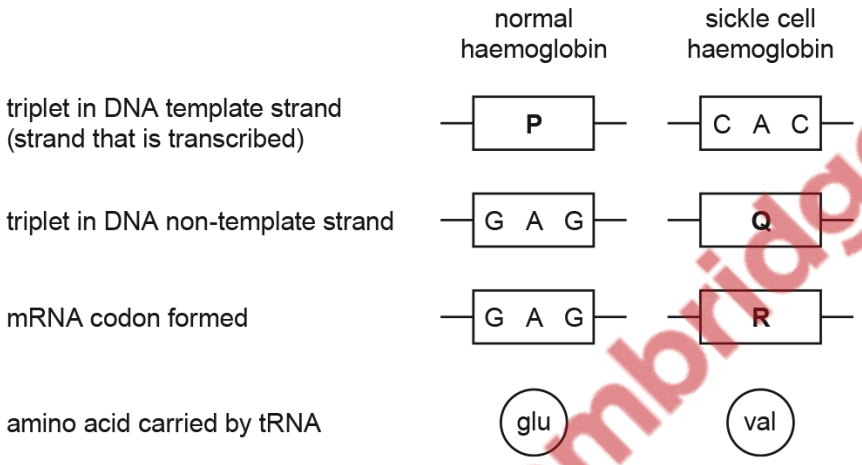


Fig. 3.1

(i) With reference to Fig. 3.1, state:

- the base sequence of DNA triplet **P**

  .....

- the base sequence of DNA triplet **Q**

  .....

- the base sequence of mRNA codon **R**.

  .....

[3]

(ii) Name the type of polypeptide in a haemoglobin molecule that is different in sickle cell haemoglobin compared to normal haemoglobin.

..... [1]

(d) Fig. 3.2 shows the oxygen dissociation curve for adult haemoglobin in a person who does not have sickle cell anaemia.

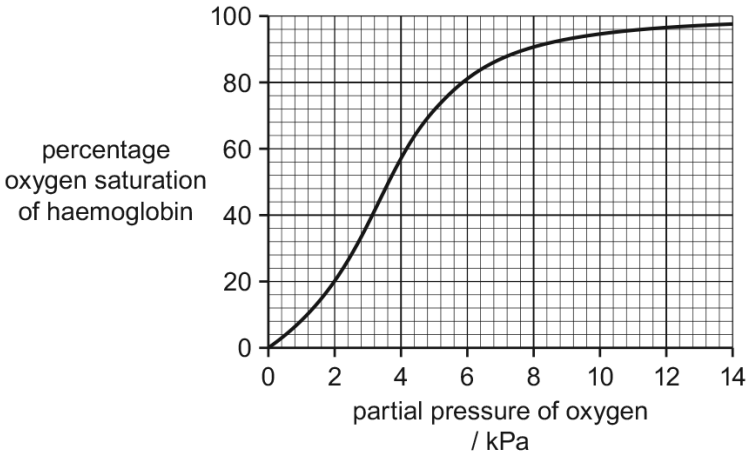


Fig. 3.2

Compared to Fig. 3.2, the oxygen dissociation curve for adult haemoglobin in a person with sickle cell anaemia is shifted to the right.

The uptake of oxygen by haemoglobin in the lungs and the release of oxygen by haemoglobin in respiring tissues is different in a person with sickle cell anaemia compared with a person who does not have the disease.

With reference to Fig. 3.2, state **and** explain these differences.

uptake of oxygen .....

.....

.....

.....

.....

release of oxygen .....

.....

.....

.....

.....

.....

[3]

[Total: 12]

146. 9700_s20_qp_22 Q: 2

In a healthy mammalian heart, contraction of the four chambers is coordinated by the action of the sinoatrial node (SAN) and atrioventricular node (AVN).

(a) After the atria fill with blood, atrial systole (contraction) occurs.

State the events that occur to initiate and cause atrial systole.

.....

.....

.....

.....

.....

..... [2]

(b) State **and** explain how the structure of the heart allows the atria to contract before the ventricles.

.....

.....

.....

.....

.....

.....

.....

..... [2]

(c) Fig. 2.1 shows blood pressure changes that occur in the left ventricle, left atrium and aorta during one cardiac cycle.

E, **F**, **G** and **H** are the points at which a valve opens or closes as a result of blood pressure changes.

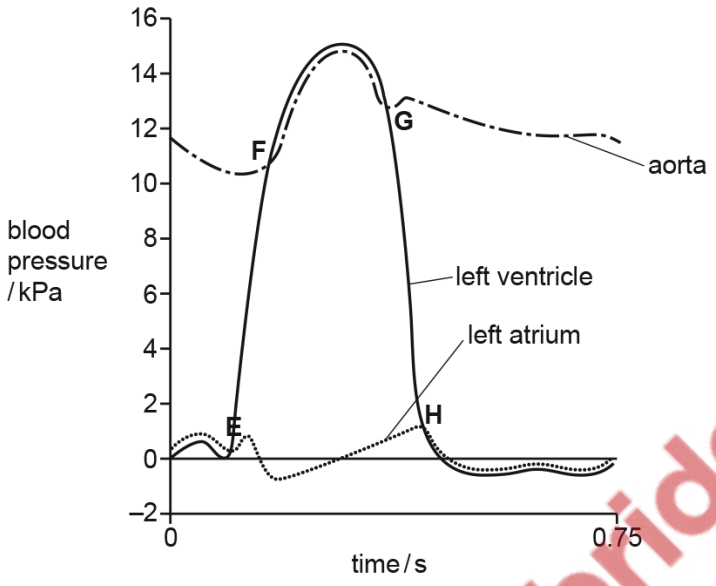


Fig. 2.1

(i) For each of the points **E**, **F**, **G** and **H** on Fig. 2.1, name the valve concerned **and** state whether the valve opens or closes.

E .....

F .....

G .....

H ..... [3]

(ii) Explain how Fig. 2.1 provides evidence that the wall of the left atrium has a different thickness to the wall of the left ventricle.

.....

.....

.....

.....

..... [2]

[Total: 9]

147. 9700_s19_qp_21 Q: 5

(a) The mammalian circulatory system is described as a closed double circulation.

Explain why it is called a *closed* **and** *double* circulation.

closed .....

.....

double .....

..... [2]

(b) Fig. 5.1 shows a drawing of an external view of a mammalian heart.

Two cross-sections were made of the heart:

- section 1 was made across the line **A**–**B**.
- section 2 was made across the line **C**–**D**.

Drawings of the two sections were viewed from above as shown by the arrow on Fig. 5.1.
Fig. 5.2 is a drawing of section **A**–**B**. Fig. 5.3 is a drawing of section **C**–**D**.

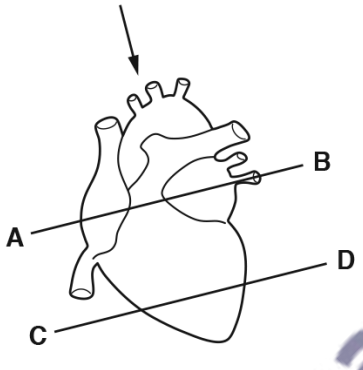


Fig. 5.1

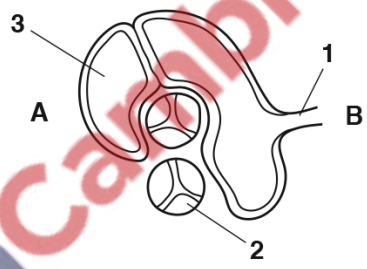


Fig. 5.2

Fig. 5.3

(i) Name structures **1**, **2** and **3**, as shown in Fig. 5.2.

1 .....

2 .....

3 .....

[3]

(ii) Explain why the wall of chamber **Y** is thicker than the wall of chamber **X**, as shown in Fig. 5.3.

.....

.....

.....

.....

..... [3]

(c) Explain how the contractions of the chambers of the heart are coordinated during one cardiac cycle.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 12]

148. 9700_s19_qp_23 Q: 6

Fig. 6.1 is a diagram of a vertical section of the human heart and the associated blood vessels.

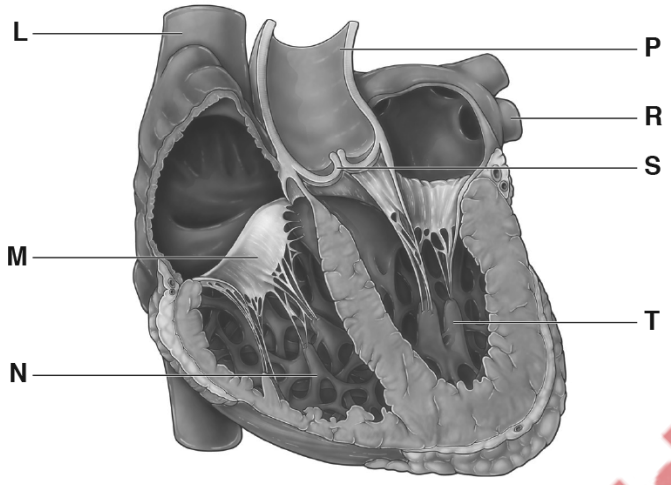


Fig. 6.1

(a) Complete Table 6.2 by writing the letter from Fig. 6.1 that identifies each of the structures described.

Table 6.2

structure in the heart	letter
valve preventing back flow of blood into a ventricle	
blood vessel carrying blood under highest pressure	
chamber that pumps blood to the lungs	

[3]

(b) Describe the short-term effects of nicotine on the cardiovascular system.

.....

.....

.....

.....

.....

..... [3]

(c) Cardiac myocytes are heart muscle cells.

Fetal cardiac myocytes are present before birth and divide rapidly during fetal development.

Soon after birth the cell cycle in most of these fetal cardiac myocytes stops, forming adult cardiac myocytes. Most of the adult cells have completed the cell cycle but in some the cell cycle stops at the end of mitosis.

(i) State the difference between adult cardiac myocytes that have completed the cell cycle and those that have stopped at the end of mitosis.

..... [1]

(ii) Suggest why it could be a disadvantage that the cell cycle has stopped in most adult cardiac myocytes.

.....

.....

.....

.....

..... [2]

[Total: 9]

149. 9700_m18_qp_22 Q: 5

(a) The sinoatrial node (SAN) and the atrioventricular node (AVN) are two regions of the heart.

Outline the roles of the SAN **and** the AVN in the initiation and control of heart action.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Fig. 5.1 shows features that are observed in transverse sections of the three main types of blood vessel.

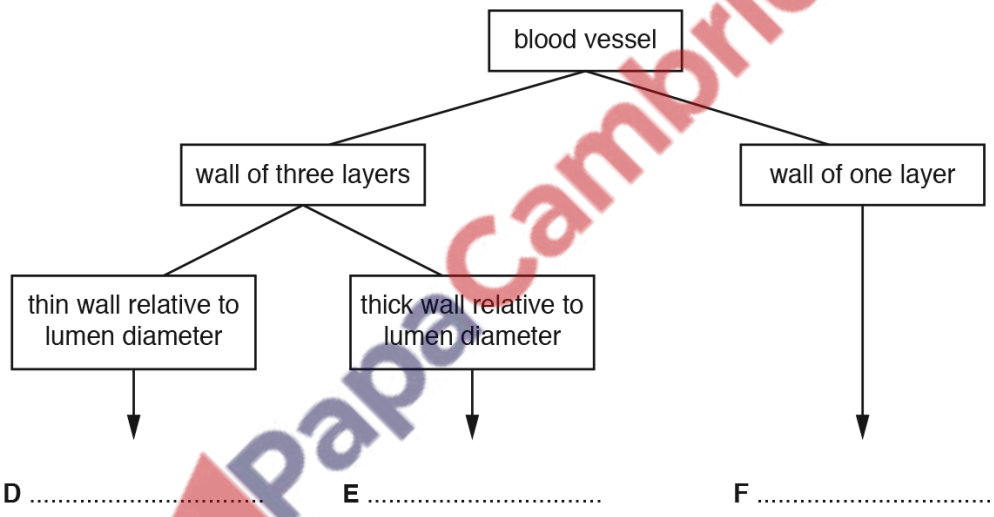


Fig. 5.1

(i) Complete Fig. 5.1 by stating the type of blood vessel indicated by **D**, **E** and **F**. [1]

(ii) The inner layer of the walls of **D** and **E** is composed of endothelial tissue.

List two structural features of this tissue.

1 .....

.....

2 .....

.....

[2]

[Total: 6]

150. 9700_w18_qp_22 Q: 2

Woolly foxglove, *Digitalis lanata*, shown in Fig. 2.1**A**, and common oleander, *Nerium oleander*, shown in Fig. 2.1**B**, are plants grown for the attractive flowers that they produce.

Both plants are poisonous, as their leaves produce toxic organic compounds known as cardiac glycosides. Cardiac glycosides have a powerful effect on the action of cardiac muscle.

A

B

Fig. 2.1

(a) *N. oleander* is able to grow in very dry conditions. The leaves have adaptations to reduce water loss by transpiration.

State the term used to describe a plant, such as *N. oleander*, that has adaptations to allow it to grow in conditions where water is in short supply.

..... [1]

(b) Aphids are small insects that feed on plant fluids using piercing and sucking mouthparts. When aphids feed on the sap present in vascular tissue of leaves and stems, a sugary liquid called honeydew is passed out of the gut. The honeydew can be analysed to find out what is present in the sap.

(i) State the name of the vascular tissue from which the aphids feed.

..... [1]

(ii) An investigation found that aphids feeding on *D. lanata* produced honeydew containing cardiac glycosides.

Suggest why cardiac glycosides were present in the sap from the vascular tissue.

.....

.....

.....

.....

..... [2]

Cardiac glycosides have an effect on the movement of ions into and out of cardiac muscle cells. The outcome is an increased ability for the cells to contract.

(c) Investigations into the action of the cardiac glycoside oleandrin, extracted from *N. oleander*, have shown that it acts to prevent the correct functioning of Na/K-ATPase, a membrane transport protein.

Na/K-ATPase has a role as an enzyme **and** as a transport molecule.

- ATPase is an enzyme that catalyses the hydrolysis of ATP to ADP and inorganic phosphate.
- Energy released from this hydrolysis is used to transport sodium ions (Na^+) out of cardiac muscle cells and potassium ions (K^+) into the cells.

(i) Explain what is meant by the *hydrolysis of ATP*.

.....

.....

..... [2]

(ii) Name the type of transport mechanism involved in the transport of Na^+ and K^+ across the cell surface membrane of cardiac muscle cells.

..... [1]

(iii) Oleandrin is a non-competitive reversible inhibitor of ATPase.

Describe the mode of action of oleandrin **and** explain how this will affect ion movement through Na/K-ATPase transport proteins of the cell surface membranes of cardiac muscle cells.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(d) Digoxin, a cardiac glycoside extracted from *D. lanata* leaves, can be purified and used as a drug to treat some heart disorders.

Examples of these heart disorders are:

- atrial fibrillation, where the normal rhythmic cardiac cycle is disrupted
- heart failure, where cardiac muscle is contracting weakly.

(i) Describe the **sequence** of events occurring in the left side of the heart during one **normal** cardiac cycle. Include reference to blood pressure changes.

The first event in the sequence is described for you.

The left atrium fills with blood during relaxation of the left atrium and left ventricle.

..... [4]

(ii) Suggest how the health of a person with heart failure can be improved by treatment with the drug digoxin.

..... [3]

[Total: 18]

151. 9700_w18_qp_23 Q: 4

(a) Describe the roles of the sinoatrial node (SAN) and the atrioventricular node (AVN) in the initiation and control of the cardiac cycle.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) The Purkyne fibres pass down the septum and extend to the cardiac muscle at the base (apex) of the heart.

Explain why it is important that the Purkyne fibres extend to the base of the heart.

.....

.....

.....

.....

..... [2]

(c) The activity of the SAN is controlled by the nervous system. Noradrenaline is released by nerve cells in the SAN.

Fig. 4.1 shows the role of noradrenaline in causing calcium ions (Ca^{2+}) to enter a cell in the SAN.

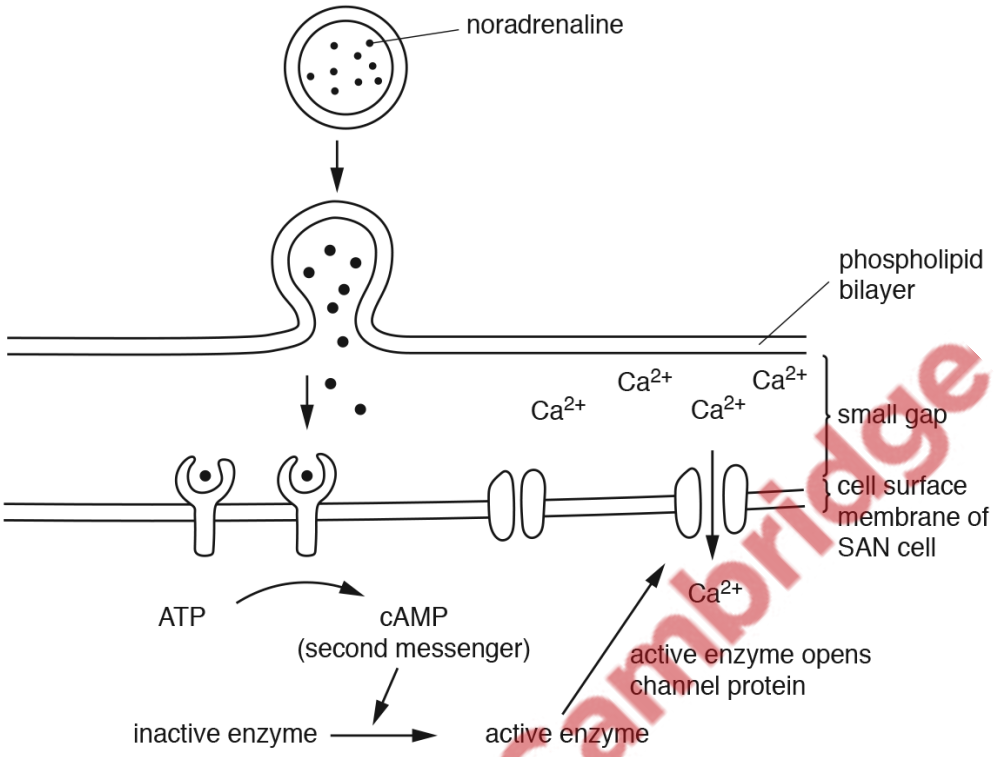


Fig. 4.1

With reference to Fig. 4.1, outline the process of cell signalling.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

152. 9700_m17_qp_22 Q: 4

The transport systems of plants and mammals both function to transport substances to and from cells.

(a) Table 4.1 contains descriptions concerning the mammalian circulatory system and the structure of the heart.

Complete Table 4.1 by writing down the term that matches each description.

Table 4.1

description	term
a transport system where blood is enclosed in blood vessels and passes through the heart twice in one complete circuit of the body	
blood vessel, with a lumen of approximately 7 μm in diameter, that supplies substances to cells	
the blood vessel that carries oxygenated blood from the lungs to the heart	
the chamber of the heart that receives deoxygenated blood from the body	
the structure dividing the heart into the left and right sides	

[5]

(b) Water is the main component of the fluids associated with transport in mammals and plants.

(i) One property of water is its ability to act as a solvent.

Suggest why this property is important in the mammalian transport system.

.....

.....

.....

.....

.....

..... [2]

(ii) The transport of water in plants depends on the ability of water molecules to form hydrogen bonds.

Explain how hydrogen bonding is involved with the movement of water in the xylem.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

153. 9700_w17_qp_21 Q: 2

Fig. 2.1 is a transmission electron micrograph of a section through a blood vessel.

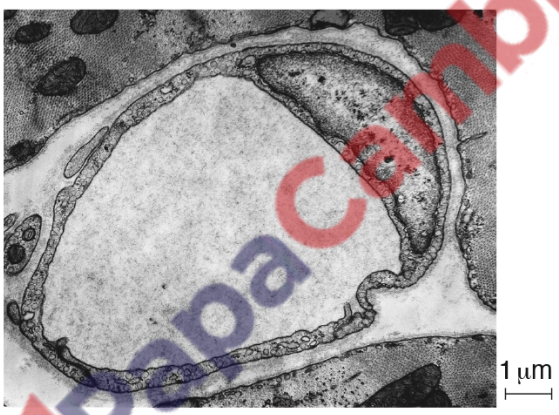


Fig. 2.1

(a) State the type of blood vessel shown in Fig. 2.1 **and** give **two** reasons for your choice.

type of blood vessel .....

reason 1 .....

.....

reason 2 .....

.....[3]

Fig. 2.2 is a graph showing how the blood pressure in the pulmonary artery and in the right ventricle changes during one cardiac cycle.

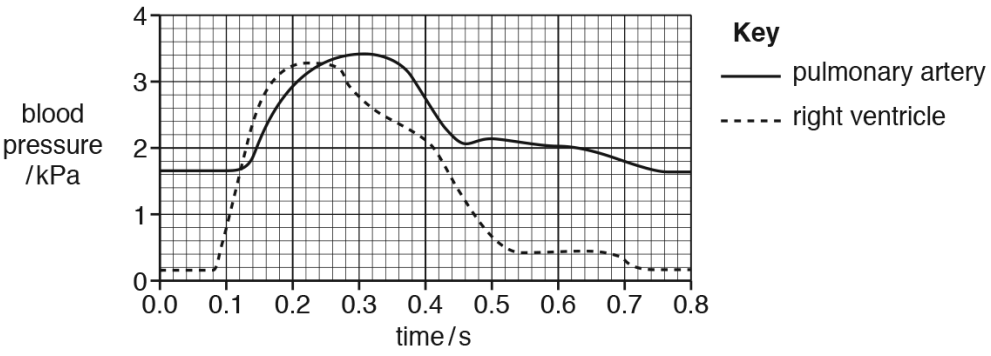


Fig. 2.2

(b) Use Fig. 2.2 to state the time at which:

(i) the valve between the right ventricle and the pulmonary artery closes

.....[1]

(ii) the ventricle begins to contract.

.....[1]

(iii) State **and** explain the similarities and differences between Fig. 2.2 and a graph showing how the blood pressure for the **left** ventricle changes during the same cardiac cycle.

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.....[4]

[Total: 9]

154. 9700_w17_qp_22 Q: 6

Fig. 6.1 is a diagram of a vertical section through the mammalian heart. The labels **Q** to **X** represent valves and blood vessels of the heart.

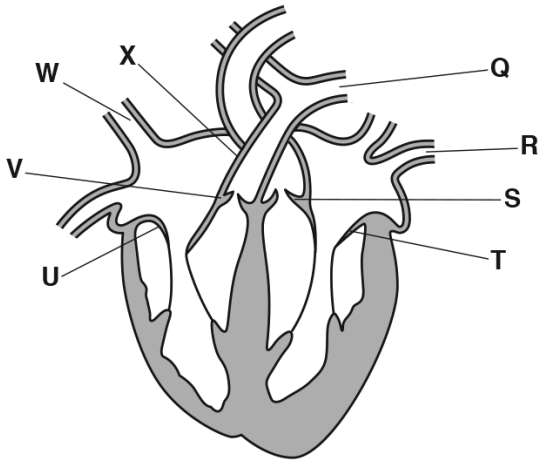

Fig. 6.1

(a) **(i)** State which label represents the valve that prevents the backflow of blood from the aorta into the ventricle.

.....[1]

(ii) Name the blood vessel that carries oxygenated blood from the lungs to the heart **and** state which label represents this blood vessel.

name .....

label .....[2]

(b) State **precisely** where the sinoatrial node is located.

.....[1]

(c) Explain the role of the atrioventricular node in the coordination of heart action.

.....

.....

.....

.....[2]

[Total: 6]

155. 9700_w17_qp_23 Q: 2

(a) Explain why the wall of the left ventricle in the heart is thicker than the wall of the right ventricle.

.....

.....

.....

.....

.....

.....[2]

Fig. 2.1 shows the heart and blood vessels at three stages of the cardiac cycle.

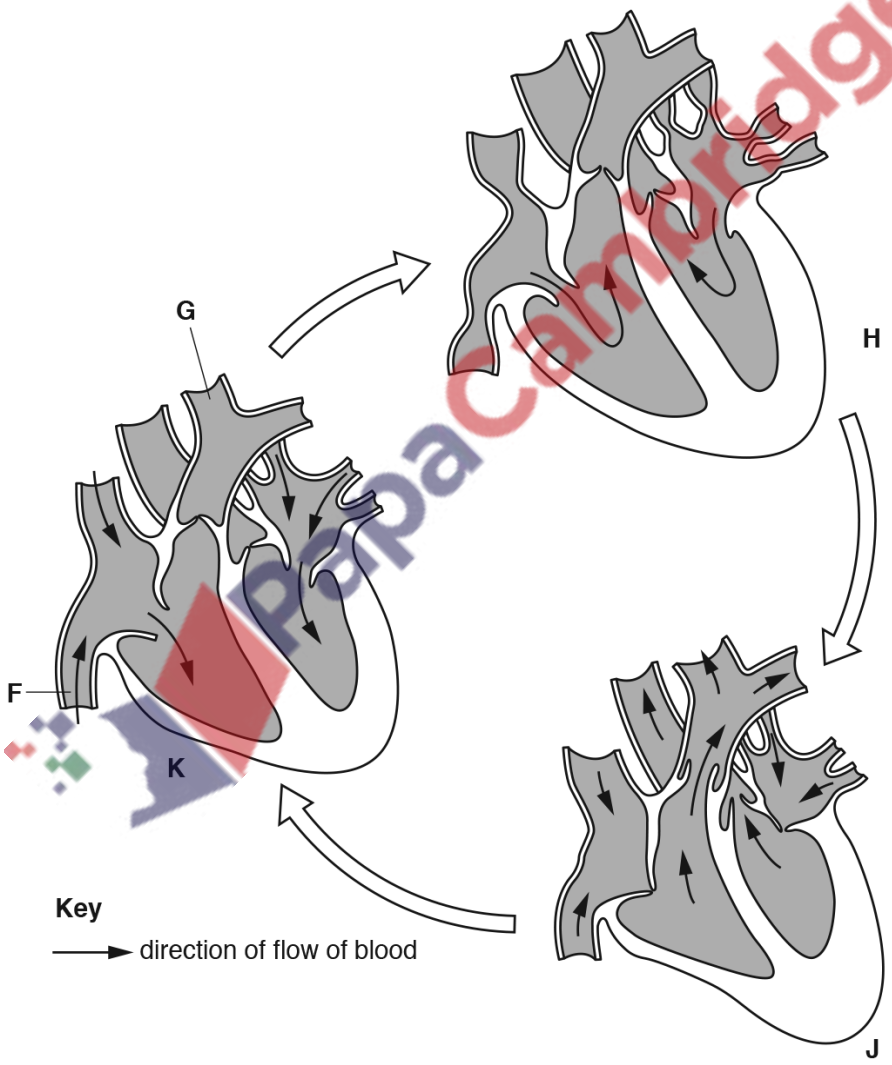

Fig. 2.1

(b) **(i)** Name the blood vessels labelled **F** and **G**.

F .....

G .....[2]

(ii) Name the stage of the cardiac cycle at **K**.

.....[1]

(c) Describe what happens in the heart between stages **H** and **J** as shown in Fig. 2.1.

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.....[5]

[Total: 10]

156. 9700_s16_qp_23 Q: 6

Fig. 6.1 is a diagram of a section through a mammalian heart.

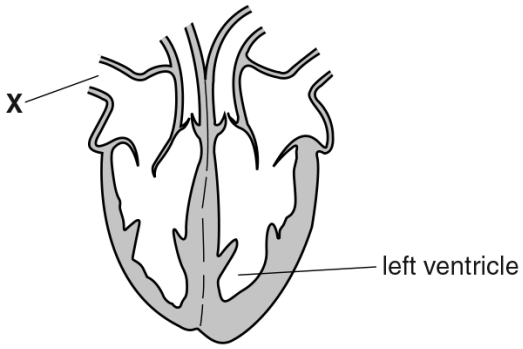

Fig. 6.1

(a) Name the blood vessel labelled **X**.

.....[1]

(b) Explain the difference in thickness between the muscle walls of the left and right ventricles.

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.....[3]

(c) Name the structure in the heart that acts as the pacemaker to initiate the cardiac cycle.

.....[1]

[Total: 5]

157. 9700_s15_qp_22 Q: 1

Each of statements **A to E** describe a structure associated with the mammalian heart.

For each statement, identify the structure that is being described.

A The chamber that pumps blood into the pulmonary artery.

.....

B A blood vessel that transports deoxygenated blood into the right atrium.

.....

C The specialised tissue responsible for delaying the conduction of impulses from the atria to the ventricles.

.....

D The blood vessels that supply cardiac muscle with oxygenated blood.

.....

E The valve that prevents the backflow of blood from the ventricle that contains oxygenated blood.

.....

[5]

[Total: 5]

158. 9700_w15_qp_22 Q: 6

(a) The thickness of the different chambers of the mammalian heart is due to the amount of cardiac muscle present. The atria have less cardiac muscle than the ventricles, and hence thinner walls.

In terms of their functions, explain why the atria have thinner walls than the ventricles.

.....

.....

.....

.....

..... [2]

(b) Name the dividing wall separating the right and left sides of the mammalian heart.

..... [1]

(c) Transpiration and translocation are both processes occurring in plants.

(i) State **one** way in which transpiration differs from translocation.

.....

.....

..... [1]

(ii) State **one** way in which transpiration and translocation are similar.

.....

.....

..... [1]

[Total: 5]