OCR A-LEVEL BIOLOGY A · H420

BIOLOGY



EXAM QUESTION PACK

3.1.2 TRANSPORT IN ANIMALS

SCORE	PERCENTAGE
/149	%

STEMUP

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Answer **all** the questions.

1(a). Blood contains erythrocytes and neutrophils.

Tissue fluid may contain neutrophils but does not contain erythrocytes.

Tissue fluid is formed from plasma by pressure filtration through the capillary walls.

All materials exchanged between the blood and cells pass through the capillary wall.

Explain why tissue fluid does not contain erythrocytes.

---

[2]

(b). Erythrocytes are full of haemoglobin.

Describe the role of haemoglobin in transporting oxygen around the body.

---

[3]

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(c). Most carbon dioxide is transported as hydrogencarbonate ions in the plasma.

Hydrogencarbonate ions are produced in the erythrocytes and diffuse into the plasma.

(i) Describe how the hydrogencarbonate ions are **produced** in the erythrocytes.

In your answer you should use appropriate technical terms, spelled correctly.

[4]

(ii) High concentrations of carbon dioxide in the blood reduce the amount of oxygen transported by haemoglobin.

Name this effect and explain why it occurs.

name _____

explanation _____

[3]

2. State the correct term for the following definition.

A type of circulatory system that does not keep the blood within blood vessels.

[1]

3. Dissolved material gives rise to oncotic pressure, which is related to water potential, Ψ.

Which of the following shows the typical oncotic and hydrostatic pressures in blood at the arterial and venous ends of capillaries?

	Pressure (mmHg)			
	Arterial end of capillary		**Venous end of capillary**	
	Oncotic	**Hydrostatic**	**Oncotic**	**Hydrostatic**
A	−20	13	−20	33
B	−20	−13	−20	13
C	20	33	−20	13
D	−20	33	−20	13

Your answer ☐

[1]

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4(a). Fig. 21.1 shows the cross sectional structure of a large artery and a large vein.

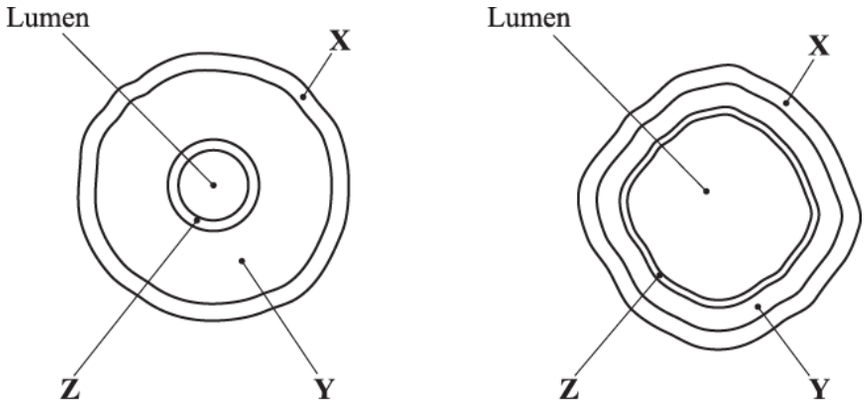


Fig. 21.1

Name the structure labelled **Z.**

---

[1]

(b). Use Fig. 21.1 to calculate the cross sectional area of the artery's lumen as a proportion of that of the vein.
(Assume that the artery is circular and the vein is a square in cross-section).
Show the steps in your calculation.

Answer_____ **[3]**

(c). Outline how the difference in **lumen size** between arteries and veins is related to their function.

---

[3]

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5. When you listen to a human heartbeat through a stethoscope you can hear a two stage ‘lub-dub’ sound.

Which of the following causes the first ‘lub’ component?

A closing of the atrioventricular valves
B sound of blood rushing into the atria
C sound of blood rushing into the ventricles
D closing of semilunar valves

Your answer ☐

[1]

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6. The following events occur when carbon dioxide enters an erythrocyte in a capillary.

1 Hydrogencarbonate ions diffuse into the plasma from the erythrocyte.
2 Dissociation of carbonic acid.
3 Carbon dioxide reacts with water forming carbonic acid.
4 Chloride ions diffuse into erythrocyte from plasma.

In which sequence do they occur?

	First step →			Final step
A	2	4	1	3
B	3	2	1	4
C	3	1	4	2
D	2	3	4	1

Your answer ☐

[1]

7. Which of the following statements correctly describes the mechanism behind water movement between plasma and tissue fluid at the venule end of a capillary?

A The hydrostatic pressure is greater than the oncotic pressure so water moves out of the capillary.
B The hydrostatic pressure is greater than the oncotic pressure so water moves into the capillary.
C The oncotic pressure is greater than the hydrostatic pressure so water moves out of the capillary.
D The oncotic pressure is greater than the hydrostatic pressure so water moves into the capillary.

Your answer ☐

[1]

8. Blood vessels are adapted for their function.

Which of the following statements is / are true?

Statement 1: The walls of arteries near the heart contain a lot of elastic fibres so that they can stretch and recoil to maintain blood pressure.
Statement 2: The walls of the venules contain little muscle.
Statement 3: The walls of arteries contain a lot of muscle fibres to contract and generate pressure in the blood.

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer ☐

[1]

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9(a). The electrical activity of the heart can be monitored using an electrocardiogram (ECG) trace.

Fig. 16.1 shows the ECG pattern for a single normal heartbeat.

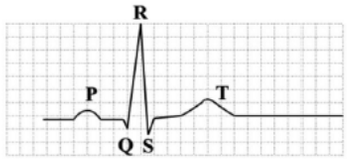


Fig. 16.1

Fig. 16.2 shows an ECG trace for a person with normal heart rhythm and **Fig. 16.3** shows the trace for a person with tachycardia.



Fig. 16.2

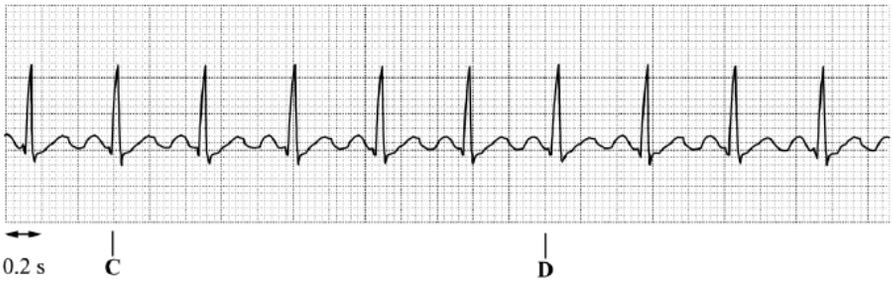


Fig. 16.3

(i) Calculate the percentage increase in heart rate for the person with tachycardia compared to the person with normal heart rhythm.

Use the data between points **A** and **B** on **Fig. 16.2** and points **C** and **D** on **Fig. 16.3** for your calculations. Show your working. Give your answer to the nearest whole number.

Answer_____ % **[4]**

(ii) The most obvious feature of tachycardia is an increased heart rate.

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Using the information in **Fig. 16.1**, **Fig. 16.2** and **Fig. 16.3**, what are **other** key features of tachycardia?

---**[2]**

(b). **Fig. 16.4** is an ECG trace of a person with an abnormal heart rhythm.



Fig. 16.4

Using the information from **Fig. 16.4**, what conclusions can you draw about the way in which this person's heart is functioning abnormally?

---**[3]**

10. Respiration is an important metabolic process that takes place in all living cells.

Fig. 19.2 shows an electrocardiogram trace (ECG) of a patient's heart after a black widow spider bite.



Fig. 19.2

What heart abnormality is suggested by this trace?

---

[1]

11(a). The rhythm and rate at which a human's heart beats can be determined by several factors.

Fig. 5.1 shows electrocardiogram traces (ECGs) from two different individuals, **X** and **Y**.



Fig. 5.1

(i) Describe and explain the differences between the two ECGs.

---

[4]

(ii) An individual's cardiac output is calculated using the following equation:

The individual who produced ECG **Y** on Fig. 5.1 had a stroke volume of 80 cm^3.

Calculate the cardiac output of the individual responsible for ECG **Y**.

Include appropriate units in your answer.

Answer _____ **[3]**

(b). Draw an ECG trace **on Fig. 5.1** (next to **Z**) to represent a recording from a patient with an ectopic heartbeat.

Show at least three cardiac cycles.

[2]

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12(a). * Describe how the structure of llama hamoglobin is likely to be different from that of camel haemoglobin with reference to the four levels of protein structure.

---

[6]

(b). Haemoglobin is a protein that carries oxygen in the blood of all mammals. The structure of haemoglobin can vary slightly between species.

Fig. 4.1 shows a llama, a relative of the camel.



Fig. 4.1

- Llamas live at high altitudes and camels live at low altitudes.
- At high altitudes the partial pressure of oxygen is low.
- Llama and camel haemoglobin consists of 2 α subunits and 2 β subunits.
- Each subunit contains a haem group and is able to bind to one molecule of oxygen.

- In the β subunits, one amino acid present in camel haemoglobin has been replaced by a different amino acid in llama haemoglobin.

Fig. 4.2 shows dissociation curves for llama haemoglobin and camel haemoglobin.

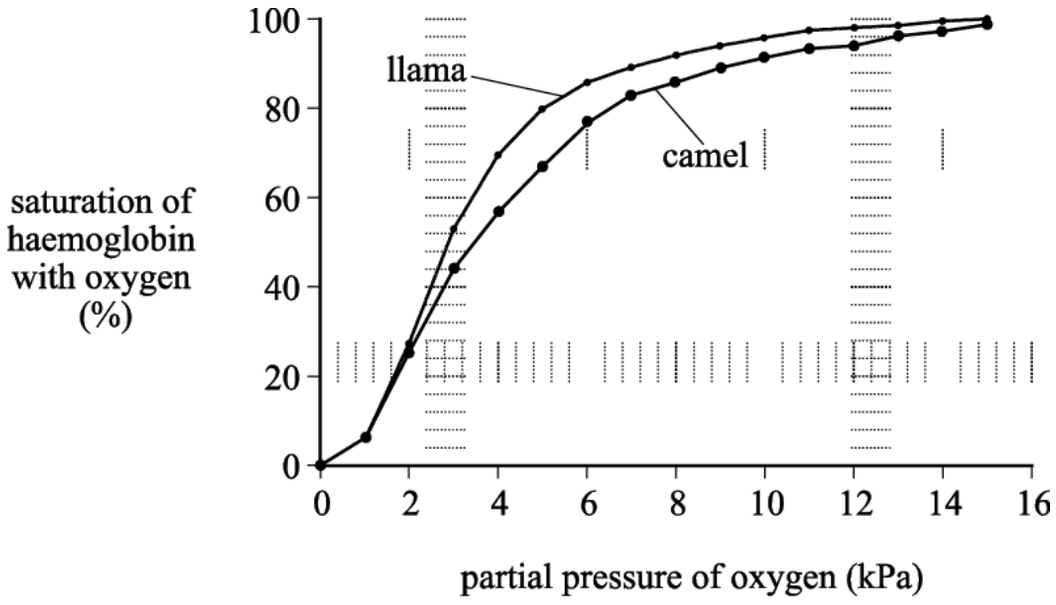


Fig. 4.2

(i) State the partial pressure of oxygen that results in a saturation of 50% in llama haemoglobin.

Answer_____ **[1]**

(ii) Explain why it is important for the survival of the llama that the llama haemoglobin dissociation curve is to the left of the camel haemoglobin dissociation curve.

_____

_____

_____ **[2]**

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13(a). A school biology class carried out a dissection of a mammalian heart. A student drew the diagram shown in Fig. 3.1.

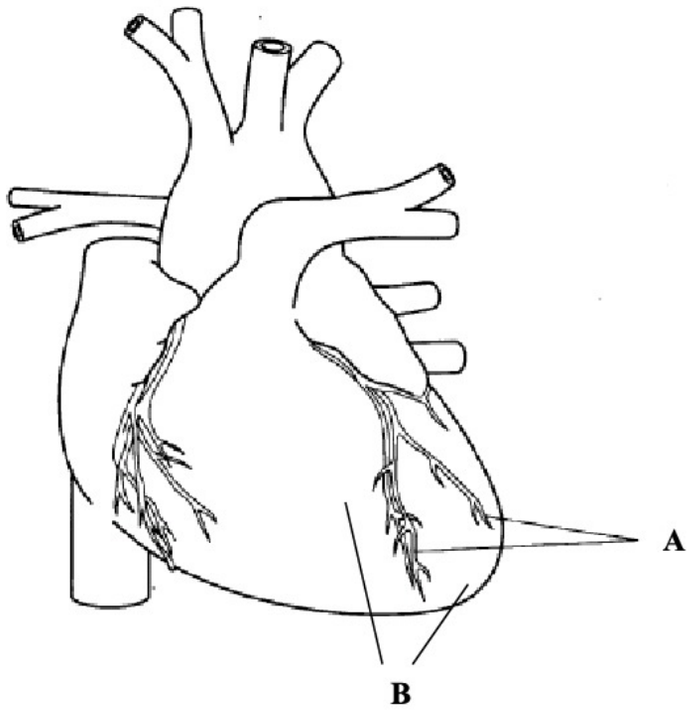


Fig. 3.1

(i) Name the structures labelled **A**.

---

[1]

(ii) Name the tissue labelled **B**.

---

[1]

(iii) Table 3.1 lists some features of a mammalian heart.

One heart being examined in the lesson had both atria missing. The internal structure of this heart was examined by a pair of students.

Complete Table 3.1 to indicate which features were **visible to the naked eye** on the heart with **no atria**.

Feature	Visible (✓) or Not Visible (X)
AV valve	

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bundle of His	
left ventricular wall	
Pulmonary vein	
Purkyne fibres	
SA node	
semi-lunar valve	
septum	

Table 3.1

[3]

(b). Fig. 3.2 shows the changes in pressure inside the heart during one cardiac cycle.

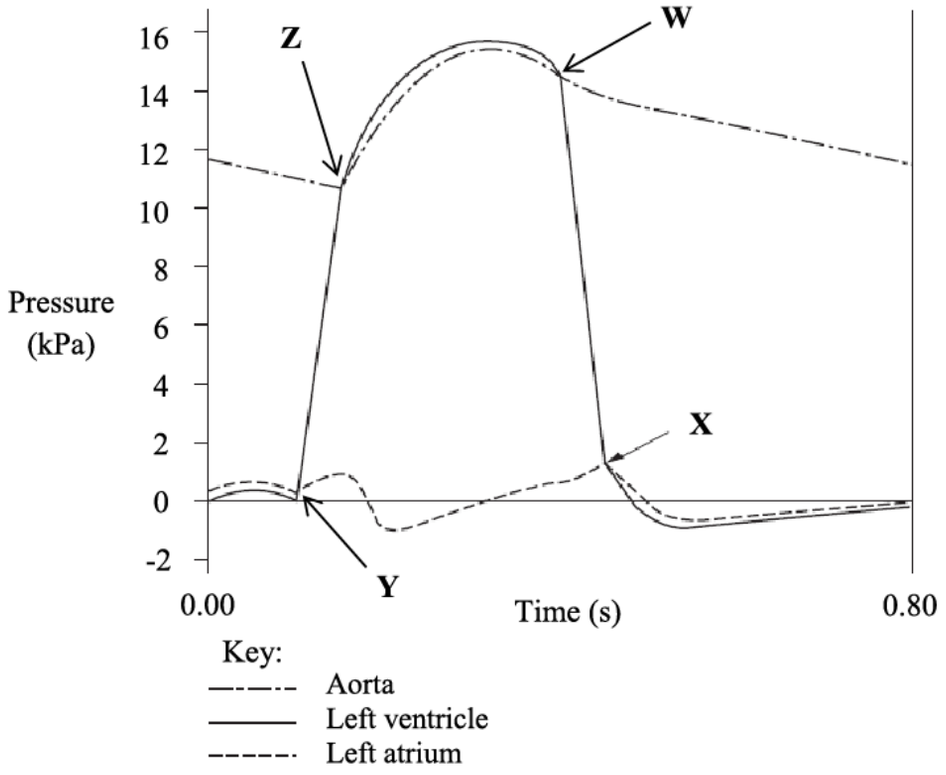


Fig. 3.2

(i) Draw a line **on Fig. 3.2** that shows the pressure changes in the **right ventricle**.

[2]

(ii) * Describe the events taking place at the points marked **W**, **X**, **Y** and **Z** and explain how these events are related to the changes in pressure shown in the diagram.

---

[6]

(c). Fig. 3.3 shows two ECG traces.

- **Trace A** is a normal trace
- **Trace B** is from a patient that has been treated with the drug digoxin.

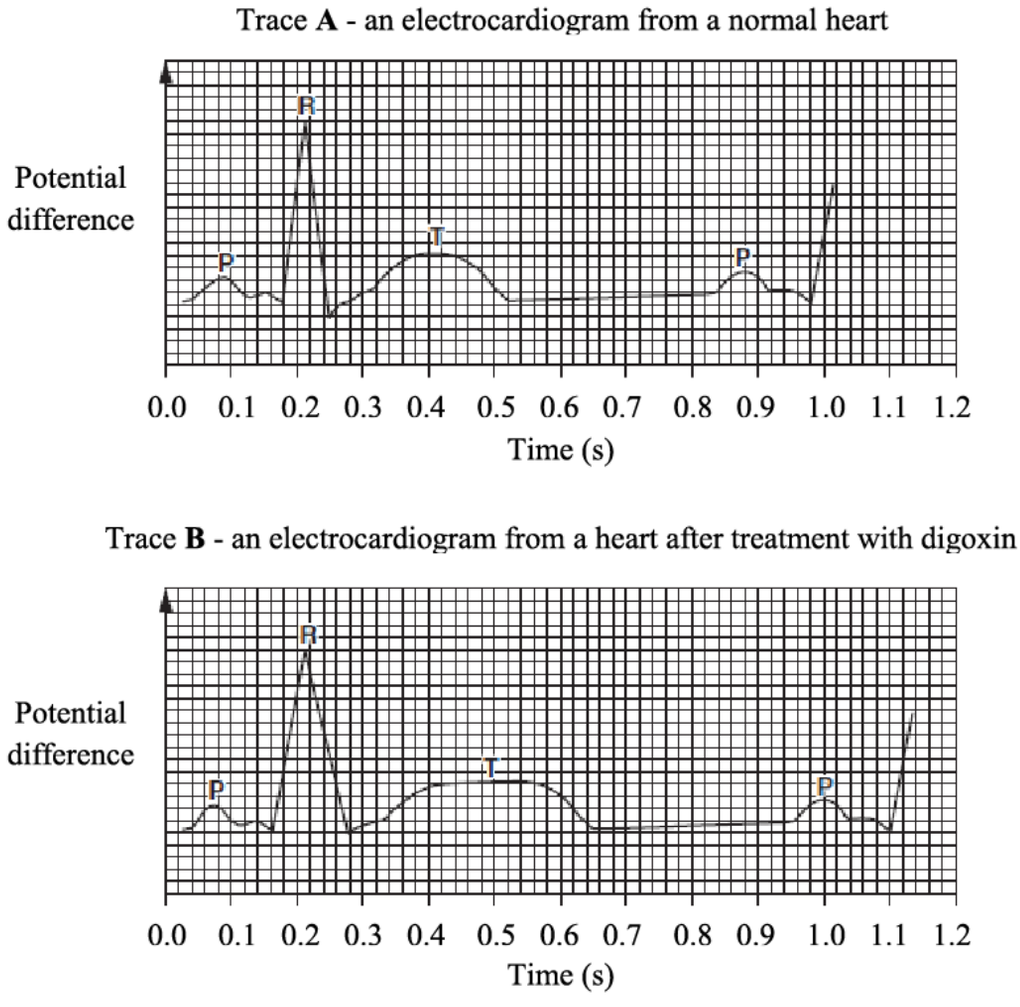


Fig. 3.3

(i) Before being given digoxin, the patient's heart rate was 75 beats per minute.

Using **Trace B** in Fig. 3.3, calculate the percentage change in the patient's heart rate after receiving digoxin.

Answer _____ % **[3]**

(ii) Explain why the answer calculated in part **(i)** may not be an accurate representation of the patient's heart

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rate **and** suggest how a more accurate answer could be obtained.

---

[3]

(iii) Digoxin caused the heart rate to change.

Identify **one other** effect of digoxin evident from Fig. 3.3.

---

[1]

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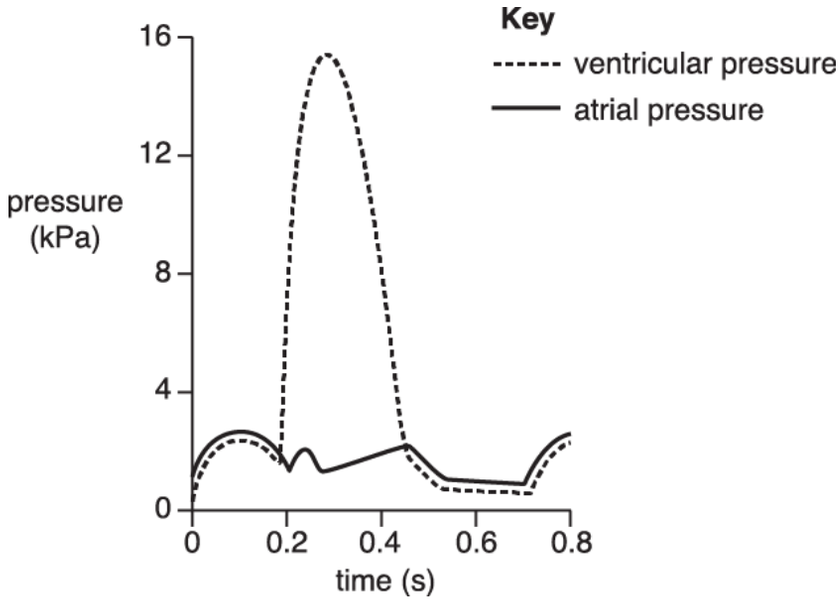
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14. * A student cut their hand during a field trip. The bleeding stopped within a few minutes and formed a scab over the cut. However, over the next three days they noted that the area around the cut became swollen, red and tender. They also noted a small swelling and discomfort in their armpit.

Describe the non-specific defences against pathogens that would explain **all** these observations.

[6]

15. The pressure changes in one mammalian cardiac cycle are shown in the graph below.



Which of the following time periods, **A** to **D**, shows ventricular systole?

A 0.0 to 0.1 s
B 0.2 to 0.3 s
C 0.4 to 0.5 s
D 0.6 to 0.8 s

Your answer

[1]

16. Pressure varies in different parts of the mammalian circulatory system.

	Blood in aorta	Tissue fluid	Lymph	Blood in vena cava
Pressure				

Which of the following options, **A** to **D**, correctly completes the table above?

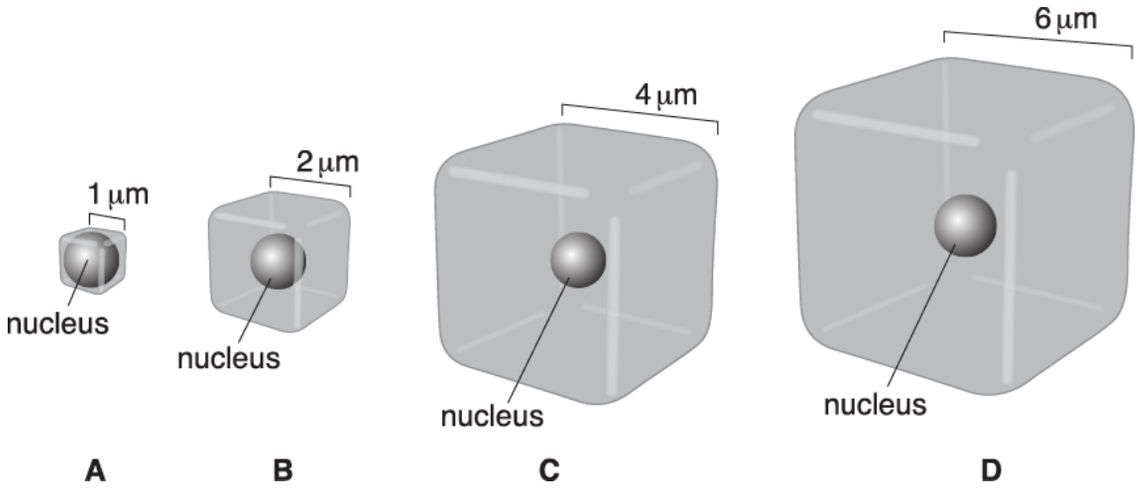
A high high low low
B high low high low
C high low low low
D high low low high

Your answer

[1]

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17. Which of the cells below, represented by cubes **A** to **D**, has a surface area to volume ratio of 3 : 1?



Your answer ☐

[1]

18(a). In mammalian blood, oxygen is mainly transported combined with haemoglobin. The presence of haemoglobin greatly increases the oxygen carrying capacity of blood.

- 100 cm^3 of plasma contains 0.3 cm^3 of oxygen when fully saturated.
- 100 cm^3 of blood contains 20.1 cm^3 of oxygen when fully saturated.

Calculate the percentage increase in oxygen carried in fully saturated **blood** compared with oxygen carried in fully saturated **plasma**.

Show your working.

Answer = _____ % **[2]**

(b). Oxygenated blood returns from the lungs to the heart before being pumped around the body.

- Normal cardiac output is 5 dm^3 min^{-1}.
- 100 cm^3 of blood contains 20.1 cm^3 of oxygen when fully saturated.

Calculate the volume (cm^3) of oxygen being transported to the tissues per minute.

Show your working and give your answer to **four significant figures**.

Answer = _____ cm^3 **[2]**

(ii) With reference to the structure of blood vessels, explain why oxygen is **not** released until the blood reaches the capillaries.

_____

_____

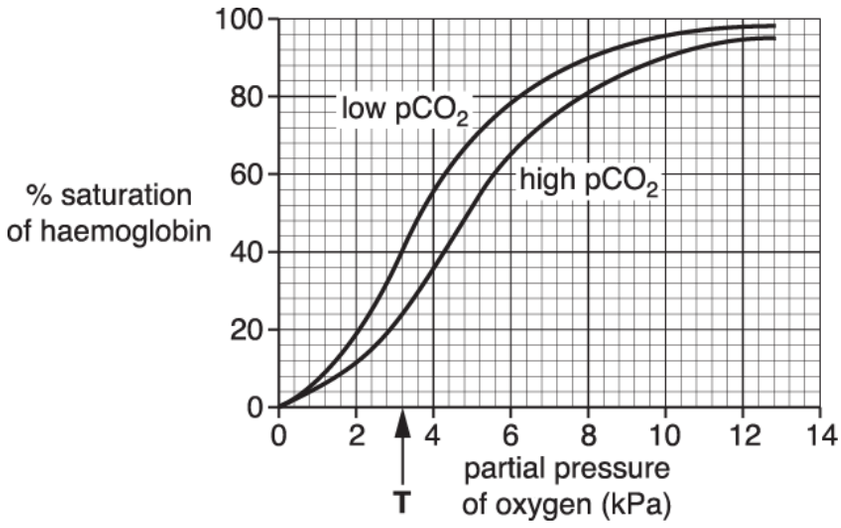
_____

_____

_____ **[2]**

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(c). The figure shows the oxygen dissociation curves at different carbon dioxide concentrations.



(i) What name is given to a change in the oxygen dissociation curve due to increasing carbon dioxide concentration?

---

[1]

(ii) Letter **T** in the figure indicates the partial pressure of oxygen in actively respiring tissues.

Explain why the blood off-loads more oxygen to actively respiring tissues than to resting tissues.

---

[2]

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19(a). Fig. 5.1 shows the circulatory systems of three groups of animals.

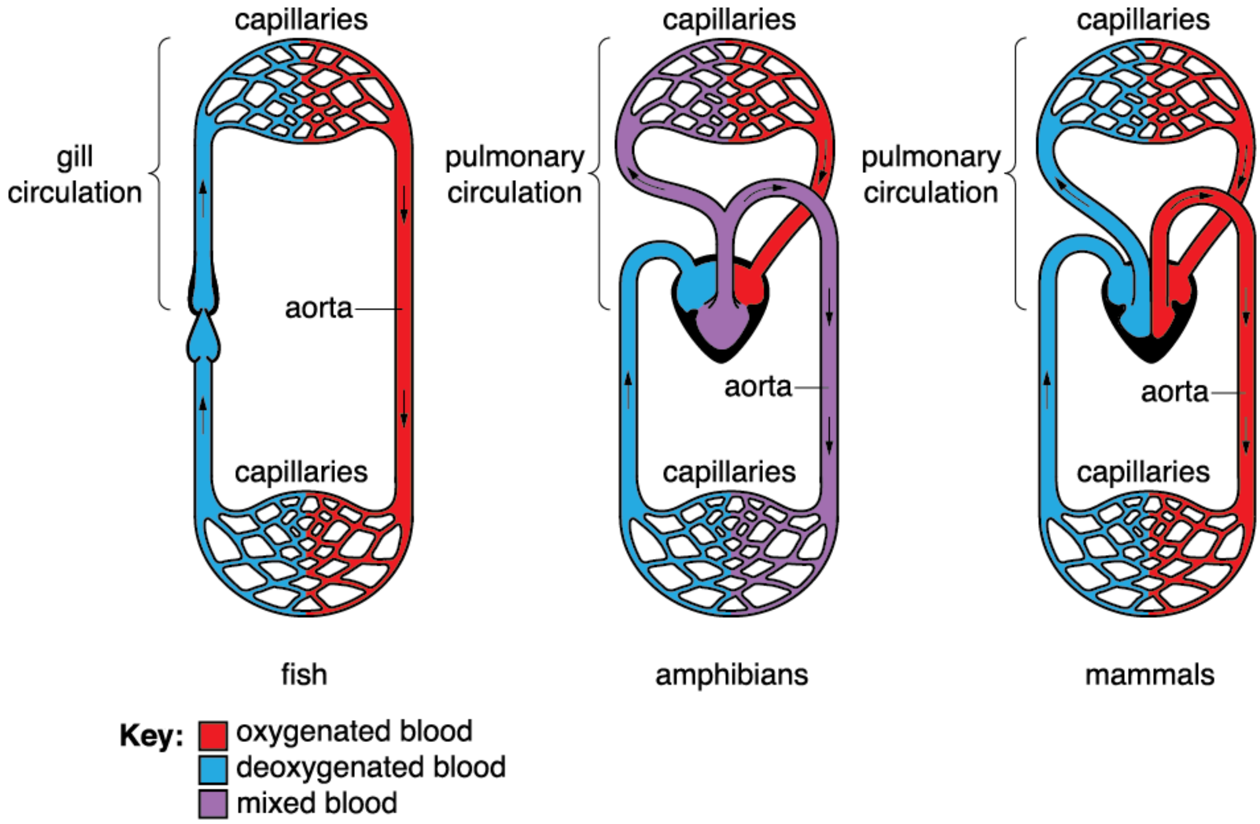


Fig. 5.1

(i) What type of circulatory system is shown in **all** these animals?

____ **[1]**

(ii) How does the circulatory system of a fish compare to that of a mammal?

____

____

____ **[1]**

(b). Fig. 5.2 shows the flow of blood through the heart of an amphibian such as a frog.

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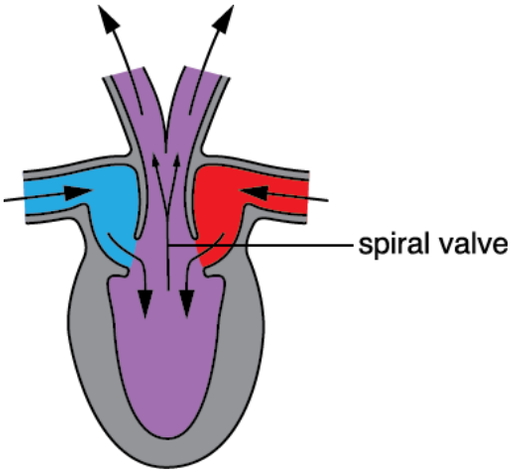


Fig. 5.2

Use the information in Fig. 5.1 **and** Fig. 5.2 to compare the circulations of a frog and a mammal and the relative effectiveness of each type of circulation.

[6]

20(a). Table 6.1 contains a number of statements that can be used to explain some features of the mammalian heart and blood vessels.

A	Both atria pump blood into the ventricles.
B	The pressure is very high.
C	The left ventricle wall creates higher pressure than the right ventricle wall.
D	The pressure fluctuates a lot.
E	Mammals have a double circulatory system.
F	The muscle contracts to maintain blood pressure.
G	The ventricles are larger than the atria.

Table 6.1

Table 6.2 lists some structural features of the heart or blood vessels.

Select the most appropriate statement, **A** to **G**, from Table 6.1 to explain each feature.

The first one has been completed for you.

Structural features of the heart or blood vessels	**Statement (A to G)**
The wall of the left ventricle is two to three times thicker than the wall of the right ventricle.	**C**
Small arteries have muscular walls.	
The wall of the left atrium is the same thickness as the wall of the right atrium.	
Arteries close to the heart have a lot of elastic tissue in their walls.	
There is a septum that divides the left side of the heart from the right.	

Table 6.2

[4]

(b). Fig. 6.2 shows a **transverse** section through the heart.

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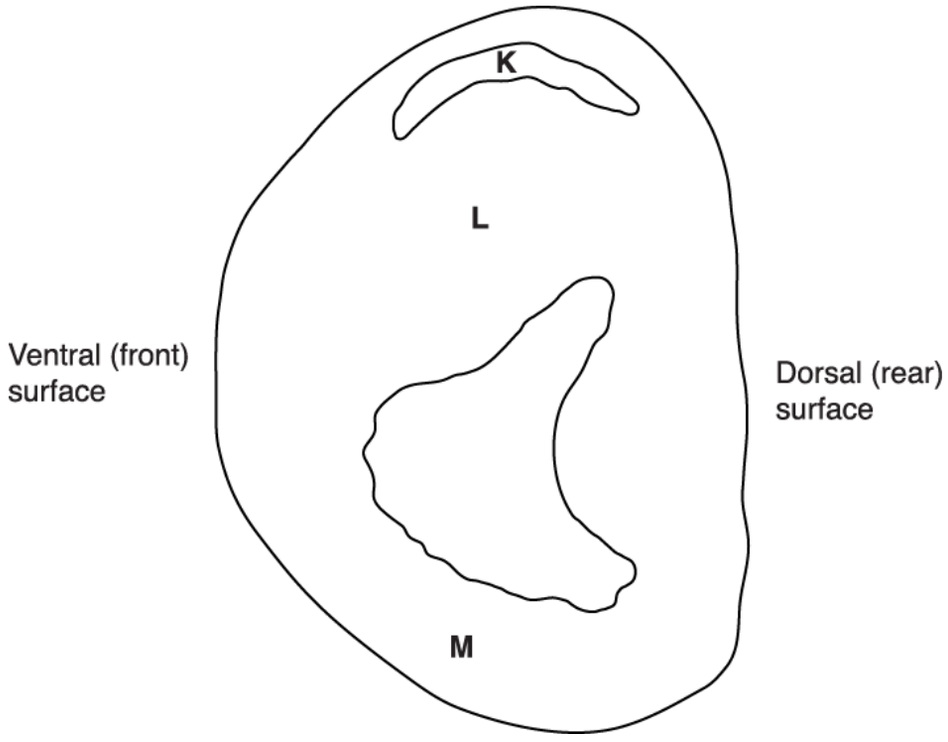


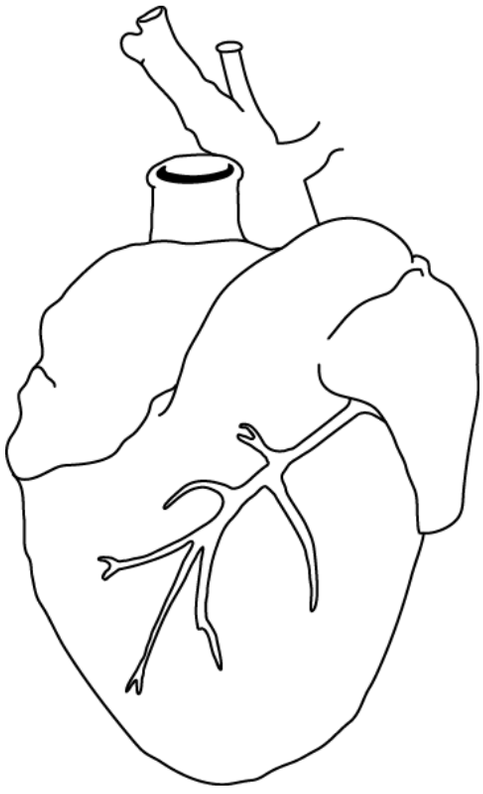
Fig. 6.2

(i) **On the diagram below** draw a line to show where the section in Fig. 6.2 has been taken.

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[1]

(ii) Identify the features represented by **K, L** and **M** on Fig. 6.2.

K

L

M

---

[3]

21. Heart rate is controlled by nervous and hormonal mechanisms.

(i) For each of the following statements, indicate whether the statement is true or false.

Statement	True or False
Heart rate is accelerated by stimulation from the vagus nerve.	
Stimulation by the sympathetic and parasympathetic nerves have opposite effects on the heart rate.	
The vagus nerve releases acetylcholine.	

[2]

(ii) Hormonal control of heart rate is achieved by hormones acting on the sino-atrial node (SAN).

Using your knowledge of the way in which heart action is coordinated, suggest why it can be deduced that hormones act on the SAN rather than on individual cardiac muscle cells.

---

[2]

(iii) Suggest how adrenaline brings about a response inside the cells of the SAN.

---

[2]

22(a). Table 5.1 and Table 5.2 list events that occur during the cardiac cycle.

Each event in Table 5.1 is immediately followed by one of the events listed in Table 5.2.

Complete Table 5.1 by inserting the appropriate letters of the events from Table 5.2.

The first row has been completed for you.

Event in the order in which they occur	**Letter describing the event that follows**
atrial walls start to relax	D
sinoatrial (SA) node generates electrical signals	
atrioventricular (AV) node receives electricalsignals from SA node	
ventricle walls start to contract	
ventricle walls relax	

Table 5.1

Event	**Letter**
atrioventricular valves close	A
semilunar valves close	B
walls of atria contract	C
ventricle walls start to contract	D
electrical signals transmitted down septum	E

Table 5.2

[4]

(b). Fig. 5.1 shows a normal ECG trace. The electrical activity of the heart is measured in millivolts (mV).

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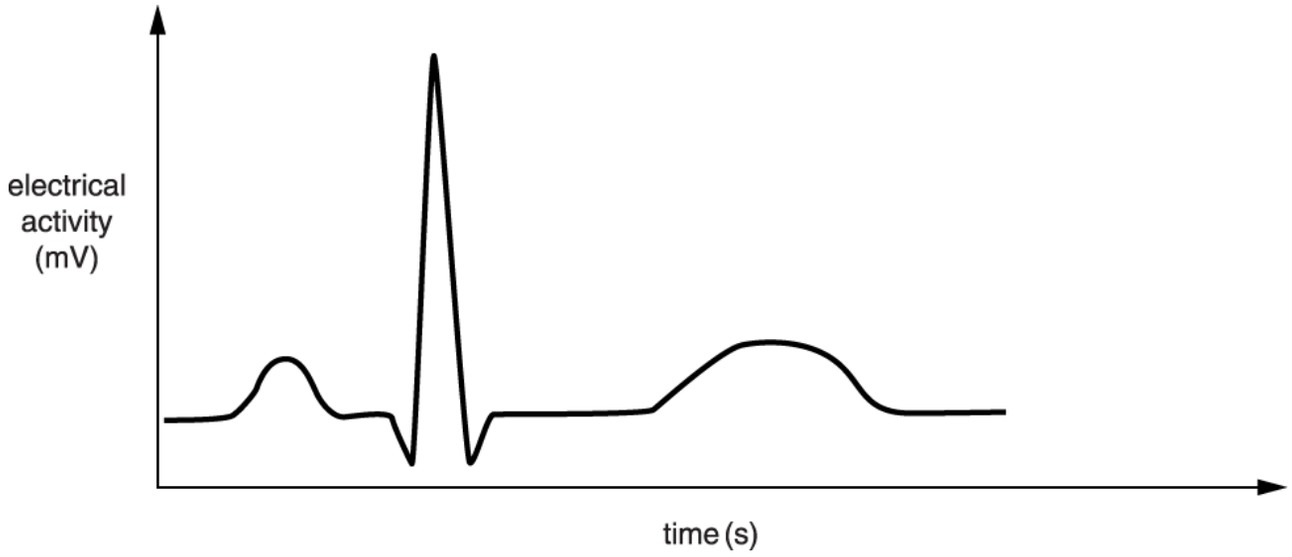
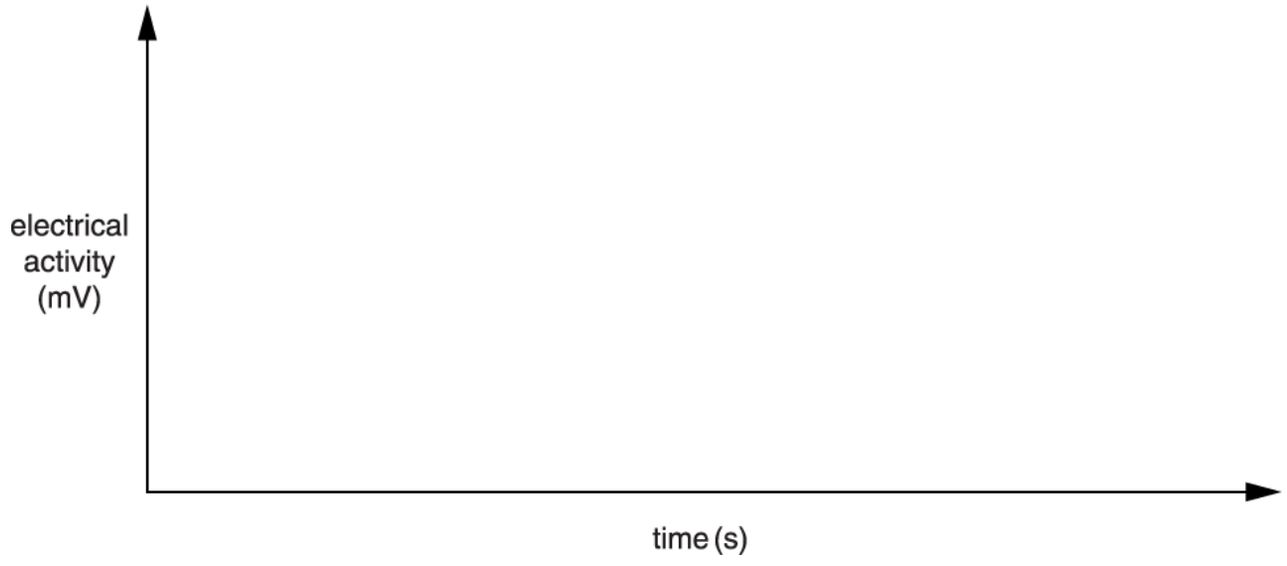


Fig. 5.1

In a condition known as supraventricular tachycardia, electrical signals leak from the atrial walls directly to the top of the ventricles. This causes the ventricle walls to contract twice for every atrial contraction.

(i) Using the axes below, sketch an ECG trace that might be expected in a patient with this condition.



[1]

(ii) Suggest and explain what effect supraventricular tachycardia might have on blood flow from the heart.

---

[2]

(c). The blood circulatory system of a mammal undergoes changes at, or soon after, birth.

(i) One of these changes is that the foramen ovale, a hole in the septum between the right and left atria, closes. In the fetus, the foramen ovale allows blood to flow directly from the right atrium to the left atrium.

Suggest why the foramen ovale is open in the fetus before birth.

---**[2]**

(ii) Another change occurring after birth is that fetal haemoglobin is replaced with adult haemoglobin.

State one difference between fetal haemoglobin and adult haemoglobin **and** give one reason why this difference is essential to the fetus.

difference

---

reason

---**[2]**

23. Describe how the components of tobacco smoke can affect the **cardiovascular system** of smokers.



In your answer you should link the chemicals in tobacco smoke to their effects on the cardiovascular system.

[7]

24. Nicotine is a toxic chemical. Smokers take in low doses of nicotine that are not toxic in the short term, but these low doses affect cardiovascular health in the longer term.

Nicotine increases blood pressure and increases the likelihood of a thrombosis (formation of a blood clot). Either of these effects can lead to a stroke, which is when cells in part of the brain die, leading to loss of function.

(i) Suggest how each of these stated effects of nicotine could contribute to cell death in the brain.

increased blood pressure _____

_____

_____

_____

thrombosis _____

_____

_____

_____ **[4]**

(ii) It is important that the correct treatment is given when a stroke is suspected.

Research has led to the ability to identify whether a stroke has resulted from a thrombosis or from increased blood pressure.

The standard emergency treatment for a suspected stroke is to give a drug that will counteract a thrombosis. If, however, the cause of the stroke is found to be high blood pressure, an alternative treatment would be more appropriate.

Explain why.

_____

_____

_____

_____ **[1]**

(iii) The effects of a stroke will depend on which part of the brain has been affected.

Some possible effects of a stroke are listed below.

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- Problems with coordination of movement.
- Loss of memory and speech.
- Paralysis of the body below the neck.

With reference to named parts of the brain, explain how each of these specific effects is caused.

---

[4]

25. Which of the statements, **A** to **D**, correctly explains why tissue fluid forms from plasma in capillaries?

A hydrostatic pressure > oncotic pressure

B oncotic pressure > hydrostatic pressure

C osmosis > muscle contractions

D solute potential < osmotic pressure

Your answer ☐

[1]

26. Adult flies have a very different body structure from that of maggots.

- Flies have complex and well-developed exchange surfaces and transport systems.
- Maggots have only a small number of tracheae and a small volume of tracheal fluid.

Suggest why maggots do not need such well-developed exchange surfaces and transport systems.

---

[3]

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27. Red blood cells contain high concentrations of the enzyme carbonic anhydrase.

(i) A scientist planned to investigate the effect of pH on the activity of carbonic anhydrase.

State **two** factors that the scientist would need to control during this investigation.

1

2

---

[2]

(ii) Human blood is maintained at a pH of 7.4 by reactions that occur in red blood cells.

Use your knowledge of these reactions to explain how a pH of 7.4 is maintained.

---

[3]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1	a		gap(s) between endothelium cells (too) small ; (erythrocytes) too large / cannot change shape (much) ; to, fit / move / pass, between (endothelium) cells **OR** through, gaps / pores / fenestrations;	2 max	**IGNORE** holes in wall **ACCEPT** pores / fenestrations too small Look for idea that they are **too** big not just big **ACCEPT** not small enough **ACCEPT** squeeze **DO NOT CREDIT** diffusion of cells **IGNORE** to pass through capillary wall (it is in question and we want to know how they get through) **Note:** too big to pass through gaps = 2 marks (mp2 and 3) **Examiner's Comments** Candidates were asked why erythrocytes do not enter the tissue fluid. The majority of candidates knew that red blood cells are too large. The better candidates realised that they needed to give a little more detail than simply stating that the cells were too large to 'pass through the capillary wall'. This level of detail is given in the stem of the question. These candidates usually scored the second mark by suggesting that the cells had to pass through pores or gaps between the cells of the capillary wall. Very few candidates used the term endothelium.

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Question			Answer/Indicative content	Marks	Guidance
	b		1 (haemoglobin has) high affinity for oxygen ; 2 oxygen binds to haemoglobin in, lungs / alveoli / high pO_2 ; 3 oxyhaemoglobin ; 4 oxygen released, in tissues / where needed / where pO_2 is low / where respiration is occurring ;	3 max	**ACCEPT** haem group / iron ions for haemoglobin **ACCEPT** high, oxygen tension / concentration **ACCEPT** attaches / combines / loads / associates / becomes more saturated **IGNORE** picks up / oxygenated **DO NOT CREDIT** reacts with **ACCEPT** unloads / dissociates from Hb **Note:** do not give a mark for '***oxygen*** dissociates' as this implies oxygen is forming ions / atoms **ACCEPT** low, oxygen tension / concentration **IGNORE** gives up / drops off **IGNORE** ref to high carbon dioxide concentration **Examiner's Comments** Most candidates scored some marks when asked about the role of haemoglobin in the transport of oxygen. The command word 'describe' requires a reasonable level of detail in the response. Examiners were looking for the idea of either loading or unloading oxygen linked to where this occurred. Good responses made statements such as: 'oxygen combines with haemoglobin in the lungs where the oxygen tension was high'. Again the use of appropriate scientific terms such as 'loading' or 'binding' enabled better candidates to score where others did not. Candidates also need to be specific in their statements – haemoglobin has 'a high affinity for oxygen' rather than just 'an affinity'. Also, oxygen 'dissociates from haemoglobin' rather than just 'dissociates'. The latter implies that the oxygen molecule splits into two smaller particles. Candidates must also be encouraged to read the question carefully, as many responses gave details of the structure of the haemoglobin molecule and how it loads oxygen which were not required.

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Question			Answer/Indicative content	Marks	Guidance
	c	i		3 max	**CREDIT** mark points taken from equations or flow charts e.g. $CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$ this = mp 2 and 4 to award mp 3 and 5 correctly located annotations needed **ACCEPT** correct symbols and formulae throughout (but **NOT** for QWC mark) **CON** If name and formula contradict e.g. hydrogencarbonate ions = H_2CO_3
			1 carbon dioxide, enters / diffuses into, erythrocytes ; 2 (carbon dioxide) combines / reacts, with water ; 3 correct ref to **carbonic anhydrase;** 4 forms **carbonic acid ;** 5 (carbonic acid) **dissociates** to form hydrogencarbonate ions *and*, **hydrogen ions** / **protons** ;		**ACCEPT** red blood cells **Note:** correct context is it catalyses, combination of carbon dioxide and water / formation of carbonic acid **IGNORE** if linked to dissociation of carbonic acid **IGNORE** carbolic / carboxylic **ACCEPT** splits / broken down **ACCEPT** bicarbonate ions **Note:** both products must be ions produced from dissociation of a compound (not dissociation of hydrogencarbonate ions)

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Question			Answer/Indicative content	Marks	Guidance
		i	QWC ;	1	Any two technical terms from the list below used appropriately and spelled correctly : **carbonic acid** **carbonic anhydrase,** **dissociates** (or derivatives of this word) **hydrogen ions / protons** **Examiner's Comments** The best candidates could describe the formation of hydrogencarbonate ions in two or three lines and achieve the QWC mark by the third line. Good responses were clear and succinct – often accompanied by correct symbols and equations. A common misconception was that hydrogen or hydrogen ions reacted with carbon dioxide, or possibly haemoglobin. Another common misconception was that hydrogecarbonate ions dissociate to form hydrogencarbonate ions and hydrogen. This is an area where weaker candidates need further support to fully understand.

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Question			Answer/Indicative content	Marks	Guidance
		ii		3 max	**Maximum 2 marks if effect not named correctly**
			Name 1 Bohr (effect / shift) ;		**ACCEPT** phonetic spelling
			*Explanation (**any 2** of the following marks)* 2 reduces affinity (of Hb) for oxygen ;		**IGNORE** ref to 'curve shifting'
			3 formation of haemoglobinic acid / hydrogen ions interact with haemoglobin ;		**ACCEPT** hydrogen ions, combine / bind, with Hb **ACCEPT** HHb for haemoglobinic acid **ACCEPT** $H^+ + Hb \rightarrow HHb$
			4 prevents, fall in pH / build-up of H^+, in cells **OR** provides buffering effect ;		
			5 alter, structure / shape, of haemoglobin ;		
			6 ***more*** oxygen released where, needed / more respiration / carbon dioxide concentration high ;		**ACCEPT** causes **more** oxygen to leave (oxy)haemoglobin / high**er** levels of oxygen released **IGNORE** ref to oxygen released more quickly or more easily **Note:** do not give a mark for 'more ***oxygen*** dissociates' as this implies oxygen is forming ions / atoms
			7 CO_2 binds to haemoglobin forming carbaminohaemoglobin ;		(as this explains reduced oxygen transport) **Examiner's Comments** Most candidates could name the Bohr effect. Far fewer were able to successfully explain why it occurs. Better candidates started their response where part c) finished, with hydrogen ions having an effect on the haemoglobin. They also related it to part b) by stating that the affinity of the haemoglobin for oxygen is reduced and therefore more oxygen is released where the carbon dioxide concentration is high.
			Total	**12**	

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Question			Answer/Indicative content	Marks	Guidance
2			open (circulatory system) ;	1	**Mark the first answer for each question part.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** This term was well known to the majority of candidates.
			Total	**1**	
3			D	1	
			Total	**1**	
4	a		tunica intima (1) OR endothelium (1)	1	**ALLOW** tunica interna
	b		0.15 ± 0.05 (1) (1) (1)	3	*If incorrect answer given* **ALLOW** 1 mark for calculating artery lumen ÷ vein lumen **ALLOW** 1 mark for correctly calculating artery or vein cross section *Max 2 if answer is given to more than 4 significant figures*
	c		(in arteries) small lumen maintains pressure (1) (in veins) low resistance / friction needed because of, low pressure / slow flow (1) *further detail* *idea that* same flow rate is achieved by having a larger volume / cross sectional area (1) *idea that* large cross section compared to circumference means fewer particles colliding with wall / low friction / less resistance (1)	3	**ALLOW** *idea that* small volume compared to wall surface means molecules in blood more likely to collide with wall
			Total	**7**	
5			A	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
6			B	1	
			Total	**1**	
7			D	1	
			Total	**1**	
8			B	1	
			Total	**1**	
9	a	i	*normal rate* 78.9 bpm (1) *rate for tachycardia* 125 bpm (1) *percentage increase* 58 (%) (1)(1)	4	**ALLOW** 1.3 bps. **ALLOW** 2.1 bps. **ALLOW 2 marks** for percentage increase correctly calculated using candidate's figures for rates and answer given to nearest whole number. **ALLOW 1 mark** for correct working [(125 – 78.9) ÷ 78.9 × 100 or correct use of candidate's figures for rates] **or** a correctly calculated but unrounded answer **DO NOT ALLOW** answers that divide by the rate for tachycardia as a percentage **increase** is asked for.
		ii	*two from* lower (Q)R(S) peak (1) P and T equal in height (1) width of T wave greater (1)	2	
	b		*three from* no distinct, P curve / atrial depolarisation (1) irregular / weak, atrial contraction (1) insufficient blood forced into ventricles (1) although ventricles contract there is less blood forced from the heart (1)	3	
			Total	**9**	

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Question			Answer/Indicative content	Marks	Guidance
10			(ventricular) tachycardia (1)	1	
			Total	**1**	
11	a	i		4	**IGNORE** references to T waves
		i	*(in X)* *idea of* no defined P phase (1) atrial fibrillation (1) *idea of* rapid or frequent electrical impulses in atria (1) *idea of* electrical impulses not only from SAN (1) *idea of* smaller gaps between QRS phases (1) **ORA** *idea of* heart rate set by SAN is faster (1) **ORA**	**ALLOW** Y has a defined P phase **ALLOW** Y does not show atrial fibrillation **ALLOW** *idea of* regular bursts of electrical impulses through atria in Y **ALLOW** electrical impulses only from SAN in Y
		ii	4570 (1)(1) $cm^3\ min^{-1}$ (1)	3	**Apply ECF** **ALLOW** 4571 to 4572 **ALLOW 1 mark for** heart rate of 57.14 (allow 57.0 to 57.2) bpm (4 full cycles in 4.2 seconds) **if no other mark awarded**
	b		three cardiac cycles drawn (1) second cardiac cycle closer to the first cycle than the third cycle (1) abnormal QRS in second cycle (e.g. extended peak or lack of T phase) (1)	2	e.g. 2 marks for 
			Total	**9**	

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Question			Answer/Indicative content	Marks	Guidance
12	a		**Level 3 (5–6 marks)** Describes differences and similarities of llama and camel haemoglobin at all four levels of protein structure with correct reference to bonding. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Describes differences and similarities of llama and camel haemoglobin in some levels of protein structure with some reference to bonding. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Describes a difference or similarity of llama and camel haemoglobin at a level of protein structure. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	6	**Indicative scientific points include:** • difference in primary structure • different amino acid / polypeptide sequence • one amino acid changed. • amino acid change could cause change to secondary structure • initial coiling or folding of polypeptide chain • α-helix • β-pleated sheet • hydrogen bonding. • amino acid change could cause change to tertiary structure • further coiling of secondary structure • ionic bonding • disulphide bonds • hydrophilic / hydrophobic bonds • 3D shape. • amino acid change has not changed quaternary structure • alpha and beta subunits still able to form haemoglobin in both camel and llama.
	b	i	2.8 (kPa)	1	**ALLOW** answer in the range of 2.8–3.0 kPa
		ii	(llama) haemoglobin needs higher affinity for oxygen (1) (so) can pick up oxygen at lower partial pressure (of oxygen) (1)	2	
			Total	**9**	

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>13</td><td>a</td><td>i</td><td>(branches of) coronary artery (1)</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>ii</td><td>(cardiac / heart) muscle (1)</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>iii</td><td><table><tr><th>Feature</th><th>Visible</th></tr><tr><td>AV valve</td><td>☐</td></tr><tr><td>bundle of His</td><td>X</td></tr><tr><td>left ventricular wall</td><td>☐</td></tr><tr><td>Pulmonary vein</td><td>X</td></tr><tr><td>Purkyne fibres</td><td>X</td></tr><tr><td>SA node</td><td>X</td></tr><tr><td>semi-lunar valve</td><td>☐</td></tr><tr><td>septum</td><td>☐</td></tr></table></td><td>3</td><td>4 correct ticks = 3 marks
3 correct ticks (and no more than 1 incorrect) = 2 marks
2 correct ticks (and no more than 2 incorrect) = 1 mark</td></tr>
<tr><td></td><td>b</td><td>i</td><td>line clearly rises and falls at the same time as the left ventricle line (1)
peak between 2 and 15 kPa (1)</td><td>2</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
		ii	For answers marked by levels of response: Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, **best** describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme. Once the level is located, award the higher or lower mark. **The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met. **The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing. **In summary:** • **The science content determines the level.** • **The communication statement determines the mark within a level.**		

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Question			Answer/Indicative content	Marks	Guidance
		ii	**Level 3 (5–6 marks)** Describes fully the behaviour of the chambers **and** valves at **W**, **X**, **Y** and **Z**, **and** relates these behaviours to changes in pressure, at all of points **W**-**Z**. *There is a well-developed connection between the events and causes at all four points, which is clear and logically structured and uses scientific terminology at an appropriate level.* **Level 2 (3–4 marks)** Describes the behaviour of the chambers or valves, **and** relates some of these behaviours to changes in pressure, at all of the points **W**-**Z**. *There is a developed connection between the events and causes discussed, which is clear and logically structured and uses scientific terminology at an appropriate level.* **Level 1 (1–2 marks)** Describes the behaviour of the chambers or valves, **or** describes the pressure changes, at some of points **W**-**Z**. *The description provided is clear and unambiguous and uses scientific terminology at an appropriate level.* **0 marks** No response or no response worthy of credit.	6	**Indicative scientific points may include…** *Chambers* • ventricles begin to contract at **Y** • ventricles are relaxing between **W** and **Y** • atria relaxed at **W**, **X**, **Y** and **Z** • atrial contraction completed before **Y**. *Valves* • A-V / bicuspid, valve closes at **Y** and opens at **X** • semilunar / aortic, valve opens at **Z** and closes at **W**. *Pressure* • At **W** ventricular pressure falls below aortic pressure • At **X** ventricular pressure falls below atrial pressure • At **Y** ventricular pressure rises above atrial pressure • At **Z** ventricular pressure rises above aortic pressure.
	c	i	-14 ± 1 % (1) (1) (1)	3	**ALLOW** 3 marks for correct answer Max 2 if no negative sign If answer is incorrect award 1 mark for 64.5 ± 1 (bpm)
		ii	only one (full) cardiac cycle / heartbeat, shown (1) could be anomalous / atypical (1) *idea that* measurement of cycle from different points gives different values (1) mean (of several cycles) would be better (1)	3	

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Question			Answer/Indicative content	Marks	Guidance
		iii	longer T-wave or broader R wave (1)	1	
			Total	**20**	

Question			Answer/Indicative content	Marks	Guidance
14			***Please refer to the marking instruction point 10 for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1, Level 2*** *or* ***Level 3****, best describes the overall quality of the answer.* *Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* • *award the higher mark where the Communication Statement has been met.* • *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.***		

Question			Answer/Indicative content	Marks	Guidance
			Level 3 (5–6 marks) A clear description how the non-specific defences cause all or nearly all of the observed responses (making reference to clotting and scab formation, inflammation **and** swelling of lymph node). All observations are clearly explained in full and with a clear link between each observation and each explanation. *There is a logical thread linking each observation in the correct time line as the immune system comes into action. Specialist terms are used throughout.* **Level 2 (3–4 marks)** A clear description of the non-specific responses that cause some of the observed responses (making reference to clotting and scab formation, one to do with inflammation of the cut **and / or** swelling of lymph node). Some explanations are provided but these may not link clearly to the observation or may not be complete explanations. *The information is clear and concise using a number of scientific terms appropriately.* **Level 1 (1–2 marks)** A limited description of the non-specific responses covering at least one of the observations (to do with clotting and scab formation, inflammation of the cut or swelling of the lymph node). Explanations are given for the observation but the explanations are not clear and there is no clear link between the observation and the explanation. *There is a logical structure to the answer. The explanation, though basic, is clear.* **0 marks** No response or no response worthy of credit.	6	**Indicative scientific points may include:** **bleeding stops:** • exposure (of blood / platelets) to collagen in damaged, blood vessel / tissue causes clotting response • many factors involved in clotting process • soluble fibrinogen converted to insoluble fibres • mesh of fibres traps cells and platelets • clot prevents bleeding • clot dries out to produce scab • scab protects against entry of pathogens **swelling / redness / tenderness**: • infection by pathogen • detection by mast cells • release of, histamine / cell signals, cause response • arterioles dilate allowing more blood to area causing redness • more tissue fluid forms causing swelling (oedema) • phagocytes attracted to area • phagocytosis of pathogens **discomfort in armpits:** • excess tissue fluid drained to lymph vessels • pathogens in tissue fluid enter lymph fluidz • transported along lymph system to lymph nodes • activity of phagocytes (and lymphocytes) causes, swelling of lymph nodes / discomfort in armpit
			Total	**6**	

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Question			Answer/Indicative content	Marks	Guidance
15			B	1	**Examiner's Comments** This was well understood by many candidates, correctly interpreting the graph to determine the period of ventricular systole and then choosing the correct time period. C and A were common incorrect suggestions.
			Total	**1**	
16			C	1	**Examiner's Comments** This question required candidates to draw on their knowledge of the various parts of the circulatory system in a way in which they may not have done previously. The most common error was to think that the blood in the vena cava was under high pressure.
			Total	**1**	
17			B	1	**Examiner's Comments** This question required basic mathematical skills, as required in the specification, to select the correct answer. A significant proportion of candidates were unable to perform the calculations correctly.
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
18	a		6 600 □□	2	**Correct answer** = **2 marks** If answer is incorrect, **ALLOW** 1 mark for seeing 20.1 – 0.3 = 19.8 **or** (20.1 – 0.3) ÷ *x* **or** 19.8 ÷ *x* where *x* = any number **Examiner's Comments** This was a challenging question with no more than a third of candidates knowing how to carry out the percentage change calculation correctly. A large proportion of candidates failed to work out the difference as the first step (so missed the calculation mark) and if they did calculate it, candidates then offered this as the % difference, without the division and ×100 part of the calculation. This mathematical skill should be specifically practised.
	b	i	1005 □□	2	**Correct answer = 2 marks** If answer is incorrect then **ALLOW** 1 mark for any ref to 201 × 5 (e.g. 2.01 × 5 or 2.01 × 50 or 0.201 × 0.5 etc) **Examiner's Comments** Many candidates understood the need to multiply 5 × 20.1 and gained one working mark for this or a variation of it, but many were clearly struggling with the conversion into different units of different magnitude and the correct answer was only gained by a few.

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Question			Answer/Indicative content	Marks	Guidance
		ii	1 arteries / arterioles, have thick wall **or** capillary wall is, thin / one cell thick / only endothelium ☐ 2 no diffusion (through artery wall) **or** diffusion distance (too) large for artery **or** diffusion occurs (through capillary wall) **or** short diffusion distance for capillary ☐	2	1 **ACCEPT** artery walls have, elastic fibres / muscle / collagen / (more) layers **IGNORE** ref to veins / venules **DO NOT CREDIT** ref to cell wall **Note:** 'artery walls too thick for diffusion to take place' **= 2 marks** **Examiner's Comments** Many candidates made reference to elastic tissue and muscle tissue in arteries and arterioles but did not gain credit because they failed to specify the wall. Some candidates just referred to 'blood vessels' as stated in the question, without naming them. A significant number referred to cell walls of the different vessels. The majority of candidates referred to capillaries as being one cell thick, with no reference to their walls. Most candidates gained credit for diffusion in connection with capillaries.
	c	i	Bohr (effect / shift) ☐	1	**Correct spelling only** **ACCEPT** bohr / Bohr's / bohr's **Examiner's Comments** The vast majority of candidates answered (and spelled) Bohr effect/shift correctly.

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Question			Answer/Indicative content	Marks	Guidance
		ii	*in actively respiring tissues* 1 more / high levels of, carbon dioxide (produced) **or** high pCO_2 ☐ 2 lowered affinity of haemoglobin for oxygen☐ 3 (CO_2 results in) dissociation of carbonic acid / increase of H^+, leading to the release of oxygen ☐ 4 more oxygen released at same pO_2 / suitable data quote from graph ☐	max 2	*If symbols used must be correct e.g.* *CO_2* ***not*** *CO^2* 1 **ACCEPT** ORA for resting tissue 2 **ACCEPT** 'Hb' for haemoglobin **ACCEPT** weaker affinity 4 (at, T / 3.2 kPa O_2) drops from 40% to 24% saturation / 16% reduction **Examiner's Comments** Most candidates described the actively respiring cells' 'need' for oxygen and that it is released because the tissues require it. They also stated that actively respiring tissues have a low partial pressure of oxygen (as they use up oxygen), but failed to make the link to more CO_2 being produced. A worrying number of candidates thought that resting tissues did not respire or need any oxygen at all, and some thought that respiring tissues themselves have a higher affinity for oxygen. The more able candidates described the effect of increased carbon dioxide in terms of H^+ from carbonic acid causing dissociation of oxygen from haemoglobin.
			Total	**9**	

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Question			Answer/Indicative content	Marks	Guidance
19	a	i	closed ☐	1	**DO NOT CREDIT incorrect additional answers** **Examiner's Comments** Most candidates answered this correctly.
		ii	the fish has a single (circulation) **and** the mammal has a double (circulation) ☐	1	**ACCEPT** descriptions of the circulations, but **both** must be described to be awarded the mark. e.g. deoxygenated and oxygenated blood passes separately through the mammalian heart but only deoxygenated blood through the fish heart in a circuit of the body the blood passes through the heart twice in mammals but once in fish **ACCEPT** single (fish circulatory system) versus a double (mammalian circulatory system) **DO NOT CREDIT** double versus single **Examiner's Comments** This question was quite well answered, although those candidates who chose to describe the circulations (rather than stating single for the fish and double for the mammal) frequently only described one. It was interesting to note that a significant number of candidates referred to 'pumps' rather than hearts, although some stated that the fish did not have a heart.

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Question			Answer/Indicative content	Marks	Guidance
	b		**Level 3 (5–6 marks)** • Describes both frog and mammalian circulations • Gives some detail on the relative effectiveness of the two systems. *There is a well-developed line of reasoning which is clear and logically structured, relates to Figs 5.1 and 5.2 and uses scientific terminology at an appropriate level.* *All the information presented is relevant and forms a continuousnarrative.* Awarding at this Level = L3 & 5 ticks □ □ □ □ □ Communication = □ or □ **Level 2 (3–4 marks)** • Describes the mammalian or frog circulation. • Attempts a description of the circulation of the other organism. • Comments on the effectiveness of the two systems. *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* Awarding at this Level = L2 & 3 ticks □ □ □ Communication = □ **or** □ –	6	***In summary:*** *Read through the whole answer. (**Be prepared to recognise and credit unexpected approaches where they show relevance.**) Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, **Level 1**, **Level 2** or **Level 3**, **best describes the overall quality of the answer**.* *Then, award the higher or lower mark within the level, according to the **Communication Statement** (shown in italics):* • *award the higher mark where the Communication Statement has been met.* • *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.*** **Use the green dot in the margin to indicate places where good scientific points are made about the 2 circulations.** **Use a highlight square in the margin to indicate places where good scientific points are made about the relative effectiveness.** **Indicative scientific points may include but are not limited to:** *circulations* **19** both are double circulations **20** blood from mammalian heart transported separately to lungs and body **21** oxygenated and deoxygenated blood never mix

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Question	Answer/Indicative content	Marks	Guidance
	Level 1 (1–2 marks) • **either** Describes the mammalian **or** frog circulation. **or** Comments on the effectiveness of the two circulatory systems. *The information is communicated with some structure but may include a small amount of irrelevant material and some inappropriate use of scientific language.* Awarding at this Level = L1 & 1 tick ☐ Communication = ☐ **or** ☐ – **0 marks** No response or no response worthy of credit.		**22** blood from frog heart transported to lungs and body together **23** blood going to the body in the frog is, partially oxygenated / mixed **24** oxygenated blood only separate when returning from lungs **25** reference to the spiral valve partly separating oxygenated and deoxygenated blood **26** flow of blood through the hearts described **27** ref to differences between structure of frog and mammalian hearts *effectiveness of circulation* **28** both can be considered to be effective **29** frog could be considered to be less effective **30** frog has less oxygen available for the body cells **31** circulation is effective enough for the frog's needs **32** frog has lower metabolic rate **33** frog maintains body temperature by other means **34** frog heart may beat faster (to compensate) **35** frog oxygenates blood at skin / mouth **36** frog circulation may limit its size **37** frog circulation developed from that of tadpole **38** mammalian body cells get maximum available O_2 **39** mammal has higher metabolic rate **40** mammal (uses metabolism to) maintain body temperature **Examiner's Comments** This was a Level of Response question which was challenging as it dealt with some unfamiliar material and produced a wide spread of marks. The candidates often did well with part or full descriptions of the frog and mammalian circulatory systems but responses often lacked effective accounts of comparative efficiency. The vast majority of candidates recognised that blood is 'mixed' in

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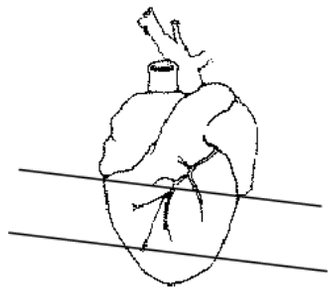
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Question			Answer/Indicative content	Marks	Guidance
					amphibians but not in mammals. There were some good descriptions of the mammalian circulation, which at times also went on to describe amphibian circulation well. Some thought that the frog has an open circulatory system or sometimes a triple one. Many candidates attempted to explain why the mammalian circulation is effective in terms of the separation of oxygenated and deoxygenated blood and some linked this to the oxygen concentration gradient in respiring tissues. A few linked this to differences in the metabolic rates of the two organisms. A minority of candidates discussed the relative carbon dioxide concentration gradients in the lungs or respiring tissues. Some candidates wrote about pressure differences - blood can be under higher pressure in the mammalian systemic circulation so can travel faster around body. Some references to maintaining body temperature were seen, but candidates often used simple non-scientific terms such as cold blooded. Some gained full marks by discussing the relative effectiveness of mammalian and amphibian circulation.
			Total	**8**	

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Question			Answer/Indicative content	Marks	Guidance
20	a		**F;** **A;** **B** or **D;** **E;**	4	**Examiner's Comments** Most candidates did well here. The most frequent incorrect response was to write B (the pressure is very high) to explain why small arteries have muscular walls (first row).
	b	i	a line drawn across the ventricles;	1	**ACCEPT** any line between those shown below  **Examiner's Comments** Less than half of all candidates gained the mark. There were a significant number who failed to respond but most drew either a horizontal line that passed through the atria or drew a vertical line through the atria and ventricles. Better candidates realised that the thickness of the walls drawn in Fig. 6.2 meant that the chambers had to be the ventricles.

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Question			Answer/Indicative content	Marks	Guidance
		ii	K = right ventricle; L = (interventricular) septum; M = (left) ventricle wall / cardiac muscle / myocardium;	3	 **ACCEPT** septem **IGNORE** ventricle **Examiner's Comments** Part (ii) elicited a wide variety of responses, many dependent upon how the candidate had interpreted (i). Thus many candidates labelled K as the atrium. However, many candidates did well and were able to distinguish between the ventricle (K) and the ventricle wall (M).
			Total	**8**	

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Question			Answer/Indicative content	Marks	Guidance
21		i	False / F True / T True / T;;	2	**All 3 answers correct = 2 marks** **Any 2 answers correct = 1 mark** **1 or 0 answers correct = 0 marks** **Mark incorrect cells first** **1 □ = 1 max** **2 □ = 0 marks** **Examiner's Comments** Candidates frequently scored 1 mark for this question. The most common error was to decide that the final statement was false.
		ii	1 *idea that* (hormonal) stimulation of individual muscle cells would result in uncoordinated response **or** (hormonal) stimulation of SAN results in coordinated action of the cardiac muscle; 2 *idea that* (hormonal) stimulation of individual muscle cells will not result in a change in heart rate **or** (hormonal) stimulation of SAN results in a change in heart rate; 3 (as) (hormone) receptors only present on the SAN / individual cells do not have (hormone) receptors;	2 max	hormone binds to / hormone acts on = stimulation e.g. coordinated action = both atria contract together **Examiner's Comments** Candidates who simply described the role of the SAN in coordinating and regulating the rate of heart beat did not score as this did not answer the question. Answers needed to link this to the effect that hormones would have on either the SAN or individual cardiac muscle cells.

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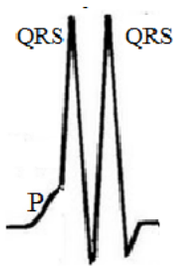
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Question			Answer/Indicative content	Marks	Guidance
		iii	1 adrenaline / first messenger / it, binds to receptor(s) on cell **surface** membrane (of SAN cell(s)); 2 activates adenyl(yl) cyclase; 3 ATP converted to, cyclic AMP / cAMP **or** cyclic AMP / cAMP / second messenger, synthesised; 4 results in depolarisation (of SAN cell membrane);	2 max	**IGNORE** ref to synthesis of glucose 1 **CREDIT** 'plasma membrane' or 'plasmalemma' for 'cell surface membrane' 2 **CREDIT** ref to adenylate cyclase 3 **DO NOT CREDIT** in context of 'wave of depolarisation' **Examiner's Comments** Many knew this well, but a lack of precision in expression meant that marks were not awarded. They were expected to refer to receptors on the cell surface membrane, activation of adenylyl cyclase and the formation of cAMP. The terms 'activation', 'production' and 'synthesis' seemed to be used interchangeably, so not always appropriately.
			Total	**6**	

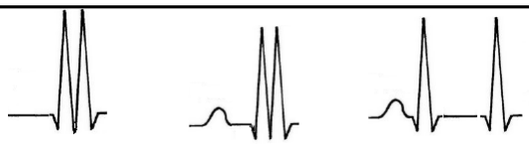
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Question			Answer/Indicative content	Marks	Guidance
22	a		**C;** **E;** **A;** **B;**	4	**Examiner's Comments** This proved to be the most discriminating question on the paper. This question received a good spread of marks – many candidates achieved full credit but a range of 1 and 2 mark responses was also seen. However, no clear pattern of alternative responses could be identified.
	b	i	P wave combined with larger peak before QRS complex;  	1	**Note:** - **look for additional QRS peak between P and original QRS peak** - **new peak may be merged with P but there must still be evidence of P** **IGNORE** relative size and width of two QRS peaks **IGNORE** anything drawn after second QRS **IGNORE** small gap / 'bump' between two QRS peaks **ACCEPT** two QRS peaks drawn immediately after P peak if no delay between P and first QRS **IGNORE** relative size and width of two QRS peaks **IGNORE** anything drawn after second QRS **IGNORE** small gap / bump between two QRS peaks  **DO NOT CREDIT** two QRS with no sign of a P peak trace with gap between P and first QRS

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Question			Answer/Indicative content	Marks	Guidance
					 **Examiner's Comments** The majority of candidates appreciated that supraventricular tachycardia would cause two QRS peaks to show on the ECG. Some responses were very carefully drawn while others were quick sketches. However, most candidates drew a second QRS peak after the normal peak leaving a gap between the P wave and the first QRS peak. Only a relatively small number realised that the additional QRS peak would occur immediately after the P wave and that there should be no gap between the P and the first QRS. In fact the P and the first QRS complex tend to merge into one.

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Question			Answer/Indicative content	Marks	Guidance
		ii	lower output / less blood leaves heart (for each ventricular contraction); *idea of:* ventricles do not have time to fill (before contracting); OR ventricle contraction inefficient because first contraction is downwards	2	**ACCEPT** less goes around body **CREDIT** 'heart pumps less blood' 'blood flow reduced' e.g. ventricle(s) not full before contracting e.g. atria unable to, contract / empty, before ventricles contract **IGNORE** ref to change in pressure & rate of flow (question asks about blood flow) **Examiner's Comments** This proved to be another challenging question in which more than half the candidates incorrectly stated that blood flow or blood pressure would increase due to a double ventricular systole. Candidates needed a very secure understanding of the cardiac cycle to appreciate that if the ventricle contracts too soon it will not have allowed time for the atria to empty into the ventricles, therefore the volume of blood in the ventricle would be lower than normal. Examiners were very pleased to see that the best candidates fully appreciated that not only would the ventricles not fill properly but the first contraction would start at the top of the ventricles pushing blood down away from the major arteries. Many candidates wrote about pressure and/or rate of flow or suggested that the flow would be more irregular. A typical incorrect answer would be "It may increase the blood pressure as ventricular systole occurs twice, for every atrial systole. This would pump blood faster around the body".

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Question			Answer/Indicative content	Marks	Guidance
	c	i	lungs not, functioning / filled with air; blood / haemoglobin, is, not oxygenated in the lungs / oxygenated in placenta (therefore) pulmonary circuit / lungs, bypassed;	2 max	**ACCEPT** fetus not breathing **ACCEPT** ref to 'single circulation' **ACCEPT** little blood goes to, lungs / pulmonary circuit **DO NOT ACCEPT** no blood goes to lungs **Examiner's Comments** Examiners were looking for definite statements about the flow of blood in the fetus such as 'less blood flows to the lungs' or 'the pulmonary circuit is by-passed'. Many candidates were rather vague making statements such as 'no need for blood to flow to the lungs' or 'the fetus gets oxygen from its mother' without mention of haemoglobin or the placenta. Other common mistakes included references to mother and fetus sharing blood, or that 'the fetus doesn't respire so there is no deoxygenated blood'! Many candidates answered this question carelessly because they did not recognise that the placenta is the only source of oxygen for the fetus. A large number of candidates did not discuss the lungs at all in their response, not appreciating that the fetus cannot breathe in utero. Instead they made statements such as 'the heart is not developed enough to pump blood' or more worryingly 'the mother pumps blood around their body so they don't have to'.

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Question			Answer/Indicative content	Marks	Guidance
		ii	**EITHER** *Difference:* (fetal haemoglobin) higher affinity for oxygen /described/ **ORA**; *Reason:* (fetal haemoglobin) must be able to bind to oxygen, in low(er) partial pressure / in placenta/ when adult oxyhaemoglobin dissociates / when adult haemoglobin dissociates from oxygen; **OR** *Difference:* (fetal haemoglobin) contains gamma sub-units; *Reason:* creates high(er) affinity for oxygen;	2	**ACCEPT** able to become more saturated than adult haemoglobin at low pO_2 **IGNORE** gets more saturated at low pO_2 (ie no comparison to adult haemoglobin) **IGNORE** ref to saturation curve **CREDIT** 'associate with / combine with / loads' for bind **IGNORE** pick up / take up / gains / absorbs / attracts / attaches / saturates **DO NOT CREDIT** oxygen dissociates or haemoglobin dissociates **Examiner's Comments** The majority of candidates knew that fetal haemoglobin has a higher affinity for oxygen than adult haemoglobin. Those who did not achieve this mark stated that fetal haemoglobin had 'a high affinity' or failed to make it clear that it was the affinity for oxygen. Fewer candidates achieved the second mark where examiners were looking for a clear explanation of the reason for this difference using correct technical terminology.
			Total	**11**	

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Question			Answer/Indicative content	Marks	Guidance
23				6 max	***N** marking points*
			N1 nicotine;		**N1 DO NOT CREDIT** if any **N** mark is associated with a chemical other than nicotine
			N2 increases stickiness of platelets;		**N2 ACCEPT** makes platelets sticky
			N3 thrombosis / formation of blood clot; **N4** causes release of adrenaline;		**N3 ACCEPT** thrombus formation
			N5 causes constriction of, <u>arterioles</u> / small arteries;		**N5 IGNORE** narrowing of lumen
			N6 reduced, blood flow / oxygen supply, <u>to (named) extremities</u>;		***C** marking points*
			C7 carbon monoxide / CO;		**C7 DO NOT CREDIT** if any **C** mark is associated with a chemical other than carbon monoxide
			C8 combines (permanently) with haemoglobin / forms carboxyhaemoglobin;		**C8 IGNORE** carbamino
			C9 reduced oxygen carrying capacity of blood;		**C9 ACCEPT** reduced amount of oxygen in blood **C9 IGNORE** 'less oxygenated blood is delivered to tissues' as this could imply reduced cardiac output
			10 increased, heart rate / blood pressure;		**10 IGNORE** heart must work harder
			11 damage to, lining / endothelium, (of blood vessels);		**11 ACCEPT** epithelium
			12 <u>atherosclerosis / atheroma</u>;		**12 IGNORE** plaques
			13 coronary heart disease / CHD / heart attack / stroke / myocardial infarction / MI / angina;		**13 IGNORE** conary / chronic / part of heart dying / cardiac arrest / heart failure

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Question			Answer/Indicative content	Marks	Guidance
			QWC - N1 and C7 plus another **N** mark or **C** mark **and no** discussion of tar	1	**DO NOT AWARD** QWC if candidate discusses a lung disease or any non-cardiovascular effects **DO NOT AWARD** QWC tar is *discussed* at all **IGNORE** nicotine is addictive **IGNORE** 'tar' if it appears as a list of chemicals **Examiner's Comments** Most candidates were very comfortable with the topic and wrote lengthy answers which often gained 6 of the 7 available marks. Responses that discussed nicotine and carbon monoxide in the context of only the cardiovascular system often got full marks. The QWC mark was frequently not awarded because candidates discussed effects on the respiratory system.
			Total	**7**	

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Question			Answer/Indicative content	Marks	Guidance
24		i	*increased blood pressure* **B1** (small) blood vessels / capillaries, burst / break; **B2** bleeding causes (localised) build up of pressure (leading to cell death) **or** blood / oxygen, supply, reduced / stopped; **B3** cells cannot <u>respire</u> (leading to cell death); *thrombosis* **T1** thrombus / clot, interrupts / reduces, blood flow; **T2** (cells) deprived of, oxygen / glucose; **T3** cells cannot <u>respire</u> (leading to cell death);	4 max	**B1 CREDIT** haemorrhage / aneurism / arterioles / arteries **B1 IGNORE** veins / venules **B1 IGNORE** destroys / damages blood vessels **B2** e.g. bleeding leads to cell compression **B2 ACCEPT** brain deprived of, oxygen / glucose **B3 DO NOT ACCEPT** <u>respire</u> less 'Clot results in less oxygenated blood to cells' = **T1** and **T2** **T2 ACCEPT** brain deprived of, oxygen / glucose **T3 DO NOT ACCEPT** <u>respire</u> less **Examiner's Comments** This question was generally well answered by candidates, with the effects of thrombosis being best understood. A number of candidates did not link high blood pressure to a burst blood vessel in the brain, yet some of these were still able to gain marks by discussing atherosclerosis. Candidates most often lost marks by not including each logical step in their explanations (e.g. for thrombosis: blood clot – lack of blood flow – lack of oxygen – no respiration). Thrombosis (a process) was also incorrectly substituted for a thrombus / clot (a noun). Unusually in this question candidates could state the same things in both parts of the question and get maximum marks.

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Question			Answer/Indicative content	Marks	Guidance
		ii	*idea that* (if the stroke has been caused by a bleed) then the drug will, increase the bleeding / be ineffective as a treatment (to prevent bleeding);	1	e.g. 'the drug makes the problem worse' **DO NOT CREDIT** 'not effective in reduction of blood pressure' **Examiner's Comments** Few candidates were able to explain that the drug for counteracting thrombosis would increase bleeding or would be ineffective in treating the cause of the stroke. Many confused answers were seen describing the drug thinning the blood, with this being linked to an increase in blood pressure.

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Question			Answer/Indicative content	Marks	Guidance
		iii	*idea of* disruption of, oxygen / glucose, supply (to brain cells) for <u>aerobic respiration</u>; *lack of oxygen / glucose / blood / damage to* <u>cerebellum</u> resulting in problems with coordination / movement; <u>cerebrum</u> / <u>cerebral</u> <u>hemisphere(s)</u> / <u>cerebral</u> <u>cortex</u>, resulting in loss of, memory / speech; <u>medulla</u> (oblongata) / <u>cerebrum</u> / <u>cerebellum</u>, resulting in paralysis (of body below the neck);	4	**Can be awarded at any point in the answer**. **Effect must be correctly linked to the part of the brain responsible.** **ACCEPT** Broca's / Wernicke's, area / hippocampus **ACCEPT** cerebral hemisphere(s) / cerebral cortex / corpus callosum **Examiner's Comments** Many candidates were able to correctly describe the functions of different parts of the brain and understand the consequence of damage to each of these areas. However, several candidates simply stated these functions, and struggled to write an answer that was in the correct context. Cerebrum and cerebellum were sometimes confused. Both candidates and teachers need to focus their study of the brain on those anatomical structures named in the OCR specification. Attempts at detailed answers sometimes achieved no marks as smaller structures were named (e.g. frontal lobe, association area) with no link to the correct named parts. By far the majority of candidates focussed their answers on named parts of the brain and did not give the overview required by marking point 1.
			Total	**9**	
25			A □	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
26			maggots are smaller so have greater <u>surface area to volume ratio</u> (than adult flies) ☐ shorter diffusion distance ☐ *idea that* maggots less active so lower metabolic demand for O_2 ☐ no (hard) exoskeleton so can absorb oxygen by diffusion through, skin / cuticle ☐	3	**ALLOW** ORA throughout **ALLOW** SA:V ratio
			Total	**3**	
27		i	temperature ☐ enzyme concentration ☐ substrate / carbon dioxide, concentration ☐	2 max	
		ii	idea of H^+ reacts with haemoglobin to form haemoglobinic acid, which lowers pH (back to 7.4)☐ idea of H^+ reacts with HCO_3^- to form H_2CO_3, which lowers pH (back to 7.4)☐ *idea of* H_2CO_3 dissociates to form H^+ and HCO_3^-, which raises pH (back to 7.4)☐	3	
			Total	**5**	

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