AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.3.4.1 MASS TRANSPORT IN ANIMALS

SCORE	PERCENTAGE
/734	%

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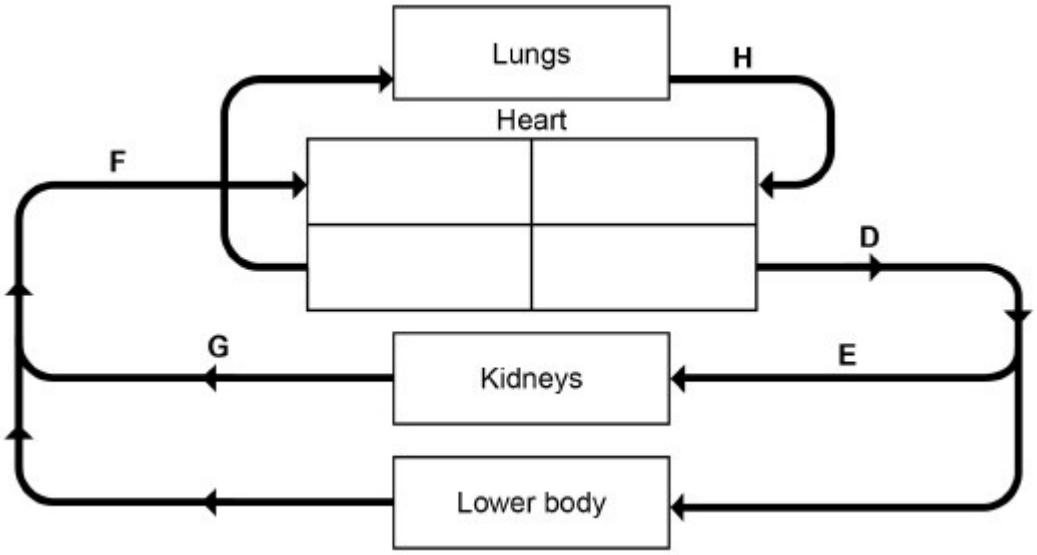
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Q1.

(a) **Figure 1** shows part of the blood circulation in a mammal.

Figure 1



Use **Figure 1** to give the letter that represents each of these blood vessels.

Aorta ☐

Renal vein ☐

Vena cava ☐

(3)

(b) Name the blood vessels that carry blood to the heart **muscle**.

_____

(1)

(c) **Figure 2** shows a photograph of part of a mitochondrion from a mouse liver cell taken using a transmission electron microscope at × 62 800 magnification.

Figure 2



Produce a scientific drawing of the mitochondrion in **Figure 2** in the box below.

Label the following parts of the mitochondrion on your drawing.

- Matrix
- Crista

(4)

(Total 8 marks)

Q2.

(a) Binding of one molecule of oxygen to haemoglobin makes it easier for a second oxygen molecule to bind.

Explain why.

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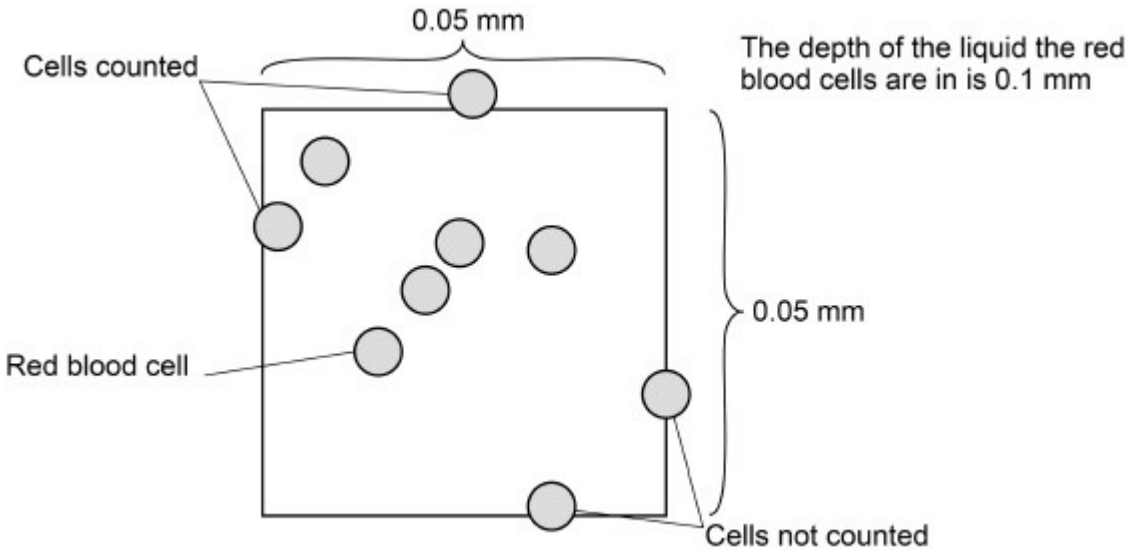
(2)

A haemocytometer is a special microscope slide which can be used to count the numbers of blood cells in a sample of blood.

- The surface of the slide has many small, equal-sized squares marked on it.
- The depth of the liquid under each square is 0.1 mm
- When counting, cells that touch top or left lines are counted but cells that touch right or bottom lines are not counted.

A doctor used a haemocytometer to determine the number of red blood cells per mm^3 in a blood sample. He diluted the original blood sample by a factor of 200 times before putting some on a haemocytometer.

The diagram shows the distribution of cells in a typical small square.



(b) The doctor counted the red blood cells in many small squares.
The **mean** number of red blood cells per small square was 7
The original blood sample was diluted by a factor of 200 times.

Calculate the number of red blood cells per mm^3 in the original blood sample.
Give your answer in standard form.

Answer = _____ red blood cells per mm^3

(2)

(c) When counting, cells that touch top or left lines are counted but cells that touch right or bottom lines **are not** counted.

Suggest **two** reasons for this rule.

1. _____

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2. _____

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(2)

The doctor also wanted to know how many white blood cells per mm^3 there were in a different sample of blood. To do this he first diluted the sample by a factor of 20 times. He then made the white blood cells clearly visible by using a stain that makes nuclei appear dark blue.

(d) When counting white blood cells, the doctor only diluted the blood sample by a factor of 20 times, instead of 200 times when counting red blood cells.

Suggest why he only diluted the sample by a factor of 20 times.

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(1)

(e) Explain how the stain allowed the doctor to count the white blood cells amongst all the red blood cells.

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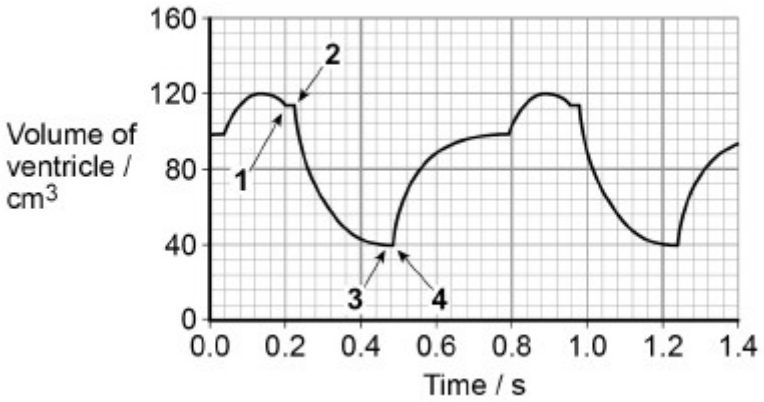
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(1)

(Total 8 marks)

Q3.

The graph shows the volume changes in the left ventricle of a human heart during two cardiac cycles. The numbers **1**, **2**, **3** and **4** represent times when heart valves open or close.



(a) Use information from the graph to complete the table in part (a). Place the number **1**, **2**, **3** or **4** in the appropriate box.

	Valve opens	**Valve closes**
Semi-lunar valve		
Atrioventricular valve		

(2)

(b) Use the diagram above to calculate the volume of blood pumped per minute by the left ventricle.

Answer = _____ $cm^3\ min^{-1}$

(2)

(c) Explain the role of the heart in the formation of tissue fluid.

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(2)

(d) Lymphoedema is a swelling in the legs which may be caused by a blockage in the lymphatic system.

Suggest how a blockage in the lymphatic system could cause lymphoedema.

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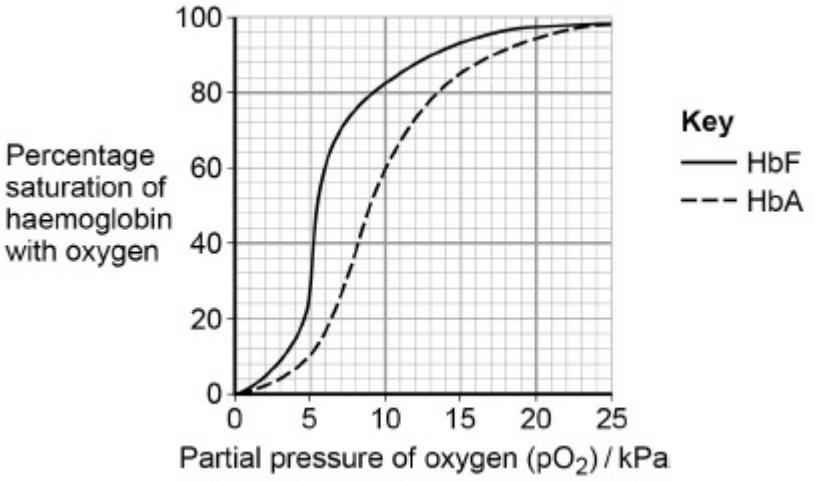
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(1)

(Total 7 marks)

Q4.

The graph shows the oxyhaemoglobin dissociation curves for fetal haemoglobin (HbF) and adult haemoglobin (HbA).



(a) Explain how changes in the shape of haemoglobin result in the S-shaped (sigmoid) oxyhaemoglobin dissociation curve for HbA.

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(2)

(b) At birth 98% of the haemoglobin is HbF. By the age of 6 months, the HbF has usually completely disappeared from the baby's blood and been replaced by HbA.

Use the graph above to explain why this change is an advantage for the baby.

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(2)

(c) Sickle cell disease (SCD) is caused by production of faulty HbA. This results in a reduced ability to transport oxygen to tissues. Scientists investigated the use of a substance called hydroxyurea to treat babies with SCD. Hydroxyurea changes the concentration of HbF in the blood.

The scientists carried out an investigation with 122 babies who had SCD. Each baby was given hydroxyurea for 41 months. The scientists then found the mean change in the concentration of HbF in the babies' blood.

Their results are shown in the table.

Mean concentration of HbF in the babies' blood / arbitrary units	
Before treatment with hydroxyurea (± 1 standard deviation)	**After treatment with hydroxyurea (± 1 standard deviation)**
7.6 (± 4.5)	19.1 (± 6.5)

The scientists concluded that treatment with hydroxyurea would increase the concentration of oxygen in the blood of babies with SCD.

Suggest how the graph and table above support this conclusion.

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(3)

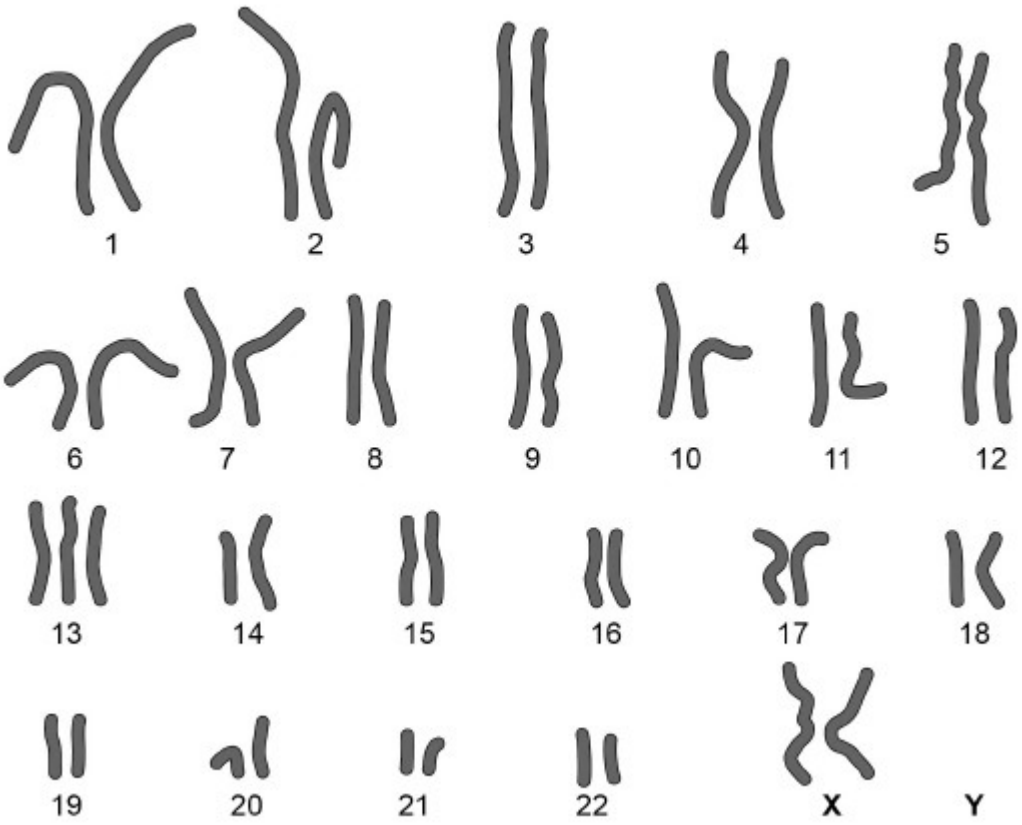
(Total 7 marks)

Q5.

Patau syndrome is a condition caused by a mutation affecting chromosome number. All the cells of the body will have this mutation.

Figure 1 shows the chromosomes from one of the cells of a female who has Patau syndrome.

Figure 1



(a) What is the effect of Patau syndrome on the chromosomes of this female?

_____

_____

(1)

(b) Describe how the change in chromosome number in Patau syndrome was produced.

_____

_____

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(2)

(c) Explain why all the cells of the body will have this mutation.

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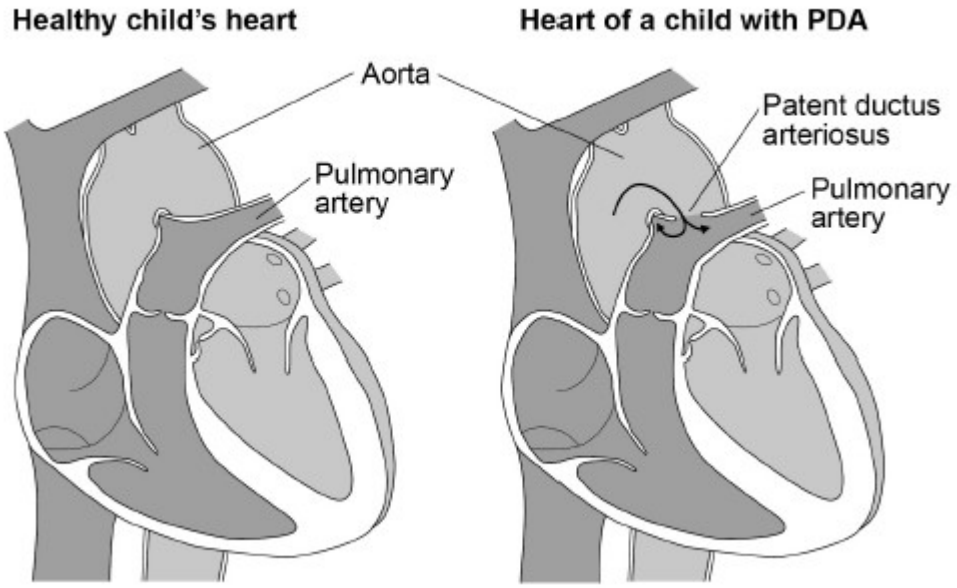
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(2)

(d) Most children born with Patau syndrome die in the first 12 months, often due to defects of circulation of blood.

One of these defects is patent ductus arteriosus (PDA). This can result in some of the blood flowing between the aorta and the pulmonary artery.
Figure 2 shows a healthy child's heart and the heart of a child with PDA.

Figure 2



Suggest how the flow of some of the blood between the aorta and pulmonary artery could cause children to die in the first 12 months.

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(3)

(Total 8 marks)

Q6.

(a) Sodium ions from salt (sodium chloride) are absorbed by cells lining the gut. Some of these cells have membranes with a carrier protein called NHE3.

NHE3 actively transports one sodium ion into the cell in exchange for one proton (hydrogen ion) out of the cell.

Use your knowledge of transport across cell membranes to suggest how NHE3 does this.

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(3)

(b) Scientists investigated the use of a drug called Tenapanor to reduce salt absorption in the gut. Tenapanor inhibits the carrier protein, NHE3.

The scientists fed a diet containing a high concentration of salt to two groups of rats, **A** and **B**.

- The rats in Group **A** were **not** given Tenapanor (0 mg kg^{-1}).
- The rats in Group **B** were given 3 mg kg^{-1} Tenapanor.

One hour after treatment, the scientists removed the gut contents of the rats and immediately weighed them.

Their results are shown in the table.

Concentration of Tenapanor / mg kg^{-1}	**Mean mass of contents of the gut / g**
0	2.0
3	4.1

The scientists carried out a statistical test to see whether the difference in the means was significant. They calculated a P value of less than 0.05.

They concluded that Tenapanor did reduce salt absorption in the gut.

Use all the information provided and your knowledge of water potential to explain how they reached this conclusion.

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(4)

(c) High absorption of salt from the diet can result in a higher than normal concentration of salt in the blood plasma entering capillaries. This can lead to a build-up of tissue fluid.

Explain how.

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(2)

(Total 9 marks)

Q7.

(a) Explain **four** ways in which the structure of the aorta is related to its function.

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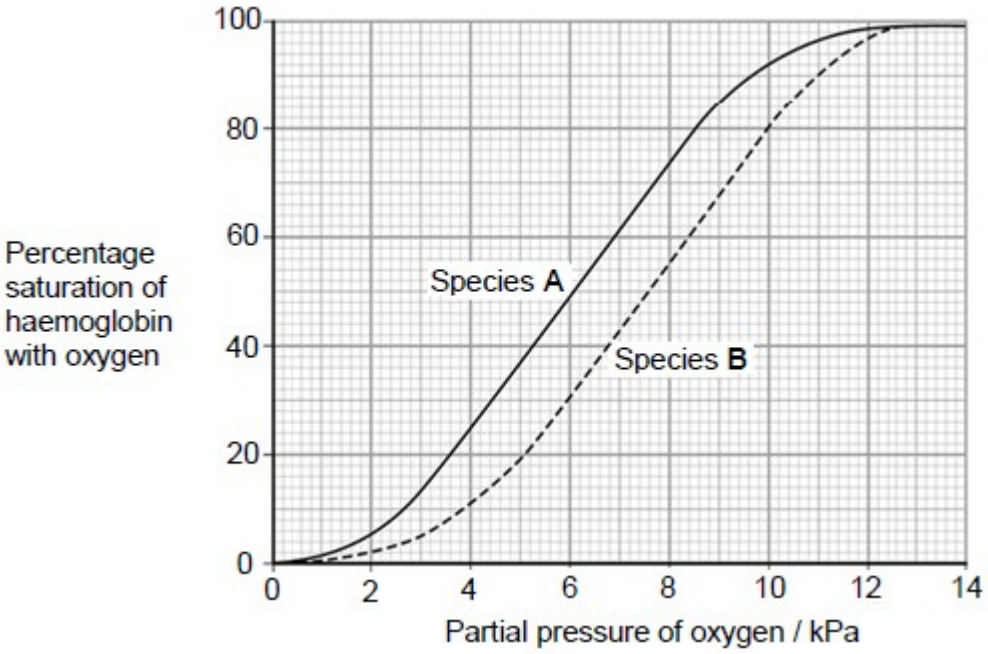
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(4)

Figure 1 shows the oxyhaemoglobin dissociation curves for two different species, **A** and **B**.

Figure 1



(b) Species **B** is more active than species **A**. Use **Figure 1** to explain how the haemoglobin of species **B** allows a greater level of activity.

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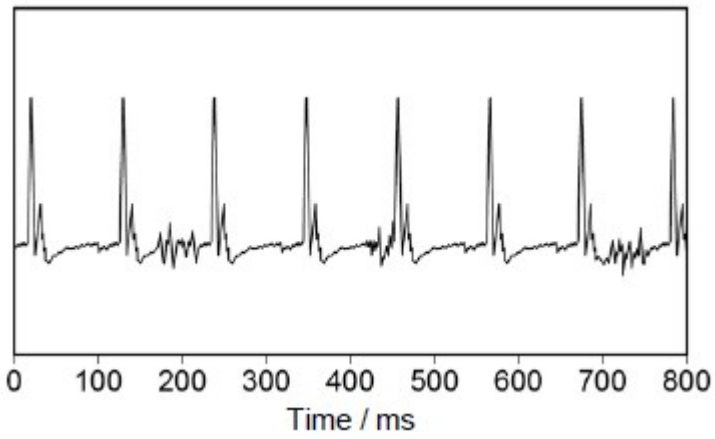
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(4)

(c) An electrocardiogram (ECG) shows the electrical activity of the heart. **Figure 2** shows an ECG for an animal of species **B** at rest. Each large spike represents a contraction of the ventricles.

Figure 2



For species **B**, the mean volume of blood leaving the left ventricle during each contraction is 0.03 cm^3.

Calculate the mean volume of blood leaving the left ventricle per minute.

Volume of blood = _____ cm^3 $minute^{-1}$

(2)

(Total 10 marks)

Q8.

Haemoglobin transports oxygen around the body of many animals.

(a) Haemoglobin is a protein with a quaternary structure.

Explain the meaning of **quaternary structure**.

_____

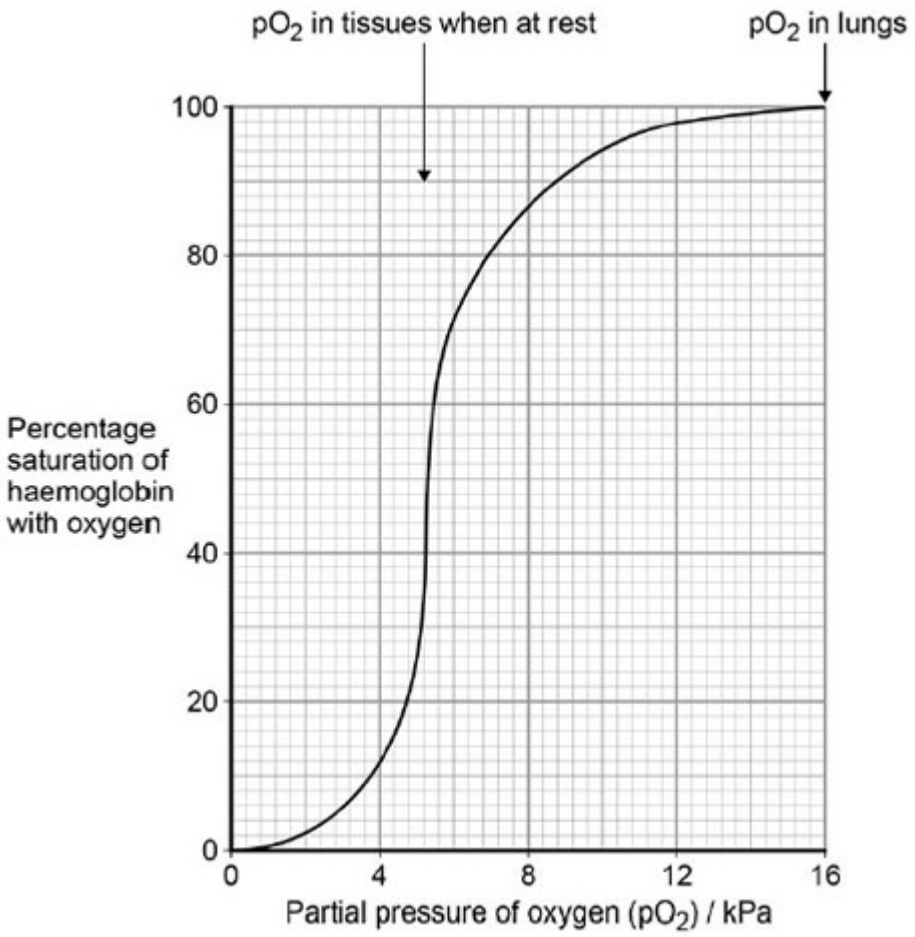
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(1)

(b) When fully saturated, each molecule of haemoglobin is bound to four molecules of oxygen.

The graph shows the percentage saturation of haemoglobin with oxygen at different partial pressures.



Give the formula for calculating the percentage saturation of haemoglobin with oxygen.

Percentage saturation of haemoglobin with oxygen =

(1)

(c) The first molecule of oxygen to bind causes a change in the shape of the haemoglobin molecule.

This change of shape makes it easier for other oxygen molecules to bind to the haemoglobin molecule.

Explain how the graph provides evidence for this.

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_____

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(2)

(d) Suggest **one** advantage of this change in the affinity of haemoglobin for oxygen.

_____

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(1)

(e) Tests on the man whose blood was used to construct the graph gave the following data.

- Concentration of haemoglobin in blood = 150 g dm^{-3}.
- Volume of oxygen carried by fully saturated haemoglobin = 1.35 cm^3 g^{-1}.
- Resting heart rate = 60 beats $minute^{-1}$.
- Volume of blood pumped out of left ventricle each beat = 60 cm^3.

Use these data and information from the graph to calculate the volume of oxygen released to the man's tissues per minute whilst he was at rest.

Show your working.

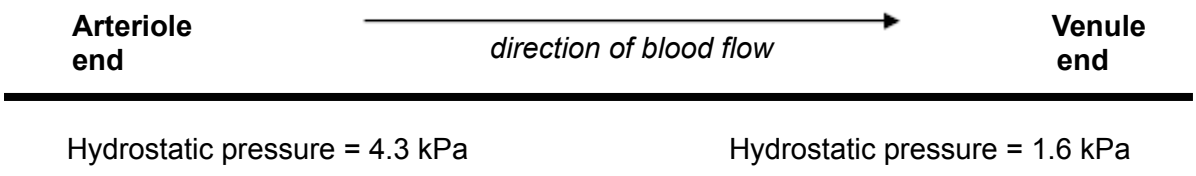
Answer =_____cm^3 $minute^{-1}$

(3)

(Total 8 marks)

Q9.

The figure below represents a capillary surrounded by tissue fluid.
The values of the hydrostatic pressure are shown.



Tissue fluid
Hydrostatic pressure = 1.1 kPa

(a) Use the information in the figure above to explain how tissue fluid is formed.

_____

_____

_____

_____

(2)

(b) The hydrostatic pressure falls from the arteriole end of the capillary to the venule end of the capillary. Explain why.

_____

_____

(1)

(c) High blood pressure leads to an accumulation of tissue fluid. Explain how.

_____

_____

_____

_____

_____

_____

(3)

(d) The water potential of the blood plasma is more negative at the venule end of the capillary than at the arteriole end of the capillary. Explain why.

_____

_____

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_____

(3)

(Total 9 marks)

Q10.

A student investigated the effect of body position on pulse rate.
The table below shows her processed results.

Body position	Pulse rate / beats per minute			
	Reading 1	Reading 2	Reading 3	Mean
Sitting	80	76	76	77
Standing	84	88	92	88
Lying down	68	72	68	69

The way the student recorded her pulse produced pulse rates per minute with even numbers. Other than by chance, suggest why.

_____

_____

_____

(Total 1 mark)

Q11.

A student determined their pulse rate when sitting down. Describe how they could have investigated whether their results were typical of all students of their age.

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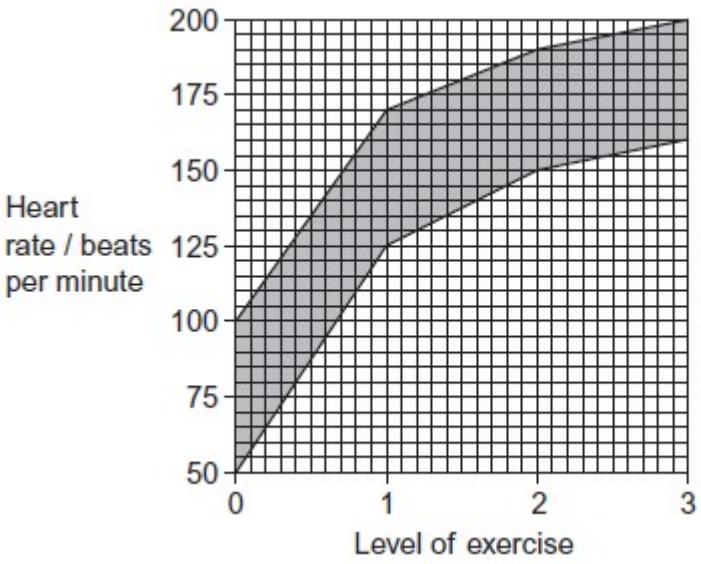
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(Total 3 marks)

Q12.

It is possible to test for signs of heart disease using an exercise test. This involves the patient doing a controlled period of exercise whilst their heart rate is monitored.

Scientists measured the heart rates of 700 healthy adult males aged between 25 and 54 before, during and after an exercise test. The test involved running on a treadmill at different speeds. Their results are shown in the graph below in the form in which they were presented.



(a) Suggest **two** variables the scientists would have controlled during the exercise test.

1 _____

2. _____

(2)

(b) Calculate the ratio of the range of heart rates at exercise level 3 and exercise level 1.

Answer = _____ : 1

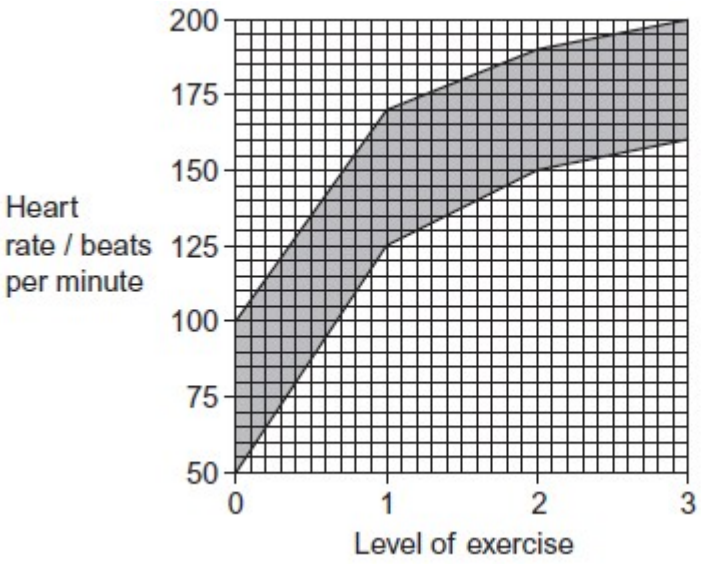
(2)

(Total 4 marks)

Q13.

It is possible to test for signs of heart disease using an exercise test. This involves the patient doing a controlled period of exercise whilst their heart rate is monitored.

Scientists measured the heart rates of 700 healthy adult males aged between 25 and 54 before, during and after an exercise test. The test involved running on a treadmill at different speeds. Their results are shown in the graph below in the form in which they were presented.



The data in the graph above can be used as a reference for doctors when assessing a patient for heart disease.

(a) The data in the graph above do not provide helpful information for all groups of patients.
Give **two** groups of patients to which these data could **not** be applied.

1 _____

_____

2. _____

_____

(1)

(b) The guidelines for using an exercise test for assessment contain the following statements.

1. Ideally, patients should stop taking any medications for a period of time before the test.
2. In reality, most patients will need to continue taking their medications.

Suggest an explanation for each of these statements.

Statement 1 _____

_____

_____

Statement 2 _____

_____

_____

(2)

(Total 3 marks)

Q14.

In a healthy person, blood moves in one direction as it passes through the heart. Give **two** ways in which this is achieved.

1. _____

_____

_____

2. _____

_____

_____

(Total 2 marks)

Q15.

The artery leaving the left ventricle is the aorta. One form of heart disease is aortic valve disease (AVD). In this disease, the valve (the aortic valve) between the left ventricle and the aorta opens normally but only partly closes. This means that when the ventricle relaxes some blood flows back into the ventricle from the aorta.

Severe AVD can be treated by replacing the aortic valve.

A surgeon investigated the effect of this treatment,

- He replaced the aortic valves of 19 patients with valves removed from donors who had recently died.
- The valves from donors were stored in an isotonic antibiotic solution before use.
- He recorded the maximum pressure reached in an artery (as the ventricles contract) and minimum pressure in the artery (as the ventricles relax) in each patient before and after valve replacement surgery.

His results are shown in **Table 1**.

Table 1

	Mean maximum pressure reached in the artery / kPa (± standard deviation)	**Mean minimum pressure reached in the artery / kPa (± standard deviation)**
Before surgery	21.7 (±3.5)	4.8 (±2.5)
After surgery	18.2 (±2.2)	11.0 (±1.1)

This investigation involved 19 patients.

- The mean age was 36 years (standard deviation ±17 years).
- The mean time after surgery that pressure readings were taken was 7 months (standard deviation ±5 months).

Table 2 shows the normal range of values of pressure in this artery in the UK.

Table 2

Pressure	Range of pressures / kPa
Maximum	12.0 to 18.5
Minimum	8.0 to 11.9

Aortic valves removed from donors were stored in isotonic solution containing an antibiotic before being used in valve replacement surgery.

(a) Explain why the valves were stored in an **isotonic** solution.

_____

_____

_____

_____

_____

(2)

(b) Explain why the valves were stored in a solution containing an antibiotic.

_____

_____

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(1)

(c) There was a significant increase in the minimum blood pressure in the artery after valve replacement surgery.
Explain why the valve replacement surgery had this effect.

_____

_____

_____

(1)

(d) The surgeon concluded that there was sufficient evidence for him to continue using this treatment.

How does the information above support his conclusion?

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(3)

(e) How does the information above **not** support his conclusion?

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(2)

(f) From the data in **Table 1** it is **not** possible to determine the highest pressure measured. Explain why.

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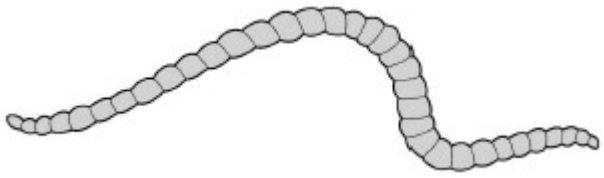
(1)

(Total 10 marks)

Q16.

Tubifex worms are small, thin animals that live in water. They have no specialised gas exchange or circulatory system.

The figure below shows a tubifex worm.



(a) Name the process by which oxygen reaches the cells inside the body of a tubifex worm.

_____

(1)

(b) Using the information provided, explain how **two** features of the body of the tubifex worm allow efficient gas exchange.

1. _____

_____

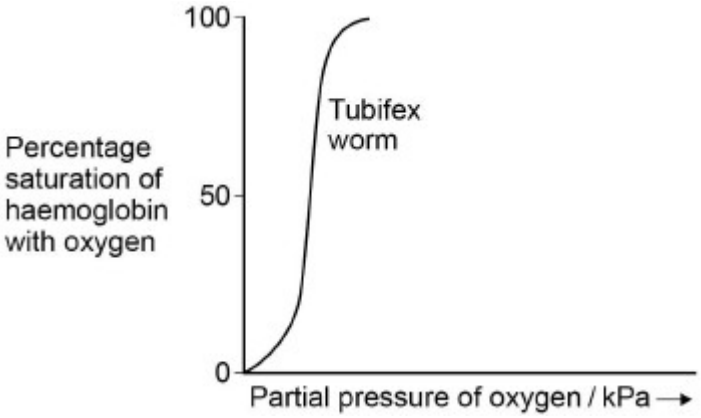
2. _____

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(2)

(c) Most species of tubifex worms live at the bottom of ponds, lakes and rivers where the partial pressure of oxygen is low. Pollution of water by sewage can cause the partial pressure of oxygen to fall below 0.2 kPa.

The graph shows the oxyhaemoglobin dissociation curve for a species of tubifex worm found in a river polluted with sewage.



The species of tubifex worm in the graph has 50% saturation of their haemoglobin with oxygen at 0.08 kPa.

Explain how this enables this species to survive in water polluted with sewage.

_____

_____

_____

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_____

(2)

(d) Species of tubifex worm that live in ponds, lakes and rivers **cannot** survive in seawater.

Use your knowledge of water potential to explain why they cannot survive in seawater.

_____

_____

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_____

(2)

(Total 7 marks)

Q17.

The table shows the volume of blood in a woman's left ventricle at different times during **one** second.

Time / seconds	Volume of blood in left ventricle / cm^3
0.0	112
0.1	120
0.2	95
0.3	65
0.4	50
0.5	55
0.6	82
0.7	90
0.8	100
0.9	112
1.0	120

(a) Use the data in the table to calculate the heart rate in beats per minute.

Tick (✔) **one** box next to the correct answer.

60 ☐

66.7 ☐

75 ☐

85.7 ☐

(1)

(b) The stroke volume is the volume of blood pumped out of the left ventricle during one cardiac cycle.

Use the table above to determine the stroke volume.

Stroke volume = _____ cm^3

(1)

(c) Some people produce a much higher ventricular blood pressure than normal. This can cause tissue fluid to build up outside the blood capillaries of these people.

Explain why.

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(2)

(d) Some drugs used to reduce high ventricular blood pressure cause widening of blood vessels.

Suggest how widening of blood vessels can reduce ventricular blood pressure.

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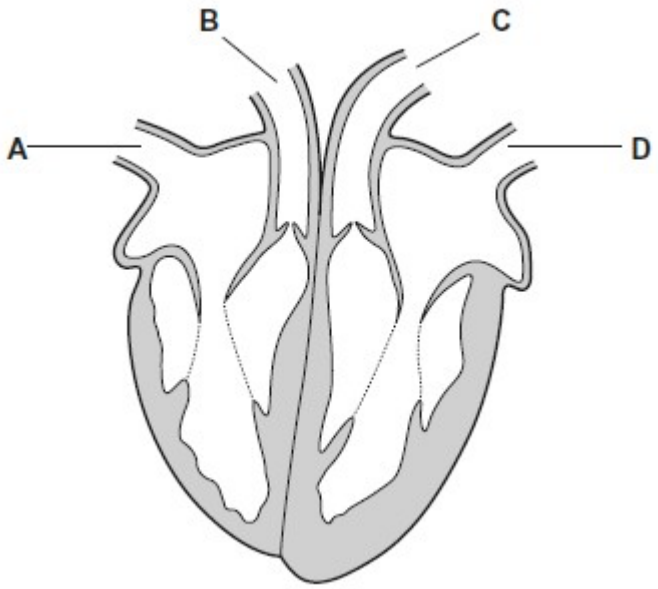
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(2)

(Total 6 marks)

Q18.

The diagram shows a section through the heart. The main blood vessels are labelled **A**, **B**, **C** and **D**.



(a) Write a letter, **A**, **B**, **C** or **D**, in the box to represent the correct blood vessel.

(i) Which blood vessel carries oxygenated blood away from the heart?

(1)

(ii) Which blood vessel carries deoxygenated blood to the heart?

(1)

(b) Explain how the highest blood pressure is produced in the left ventricle.

(1)

(c) Some babies are born with a hole between the right and the left ventricles.

These babies are unable to get enough oxygen to their tissues.
Suggest why.

_____

(2)

(Total 5 marks)

Q19.

Haemoglobin is a protein. It is made of two alpha polypeptides and two beta polypeptides. Each alpha polypeptide has 141 amino acids and each beta polypeptide has 146 amino acids.

(a) What term is used to describe the structure of a protein made of two or more polypeptides?

_____

(1)

(b) Calculate the minimum number of DNA bases needed to code for the number of amino acids in one alpha polypeptide.

Answer = _____

(1)

(c) Describe the role of haemoglobin in supplying oxygen to the tissues of the body.

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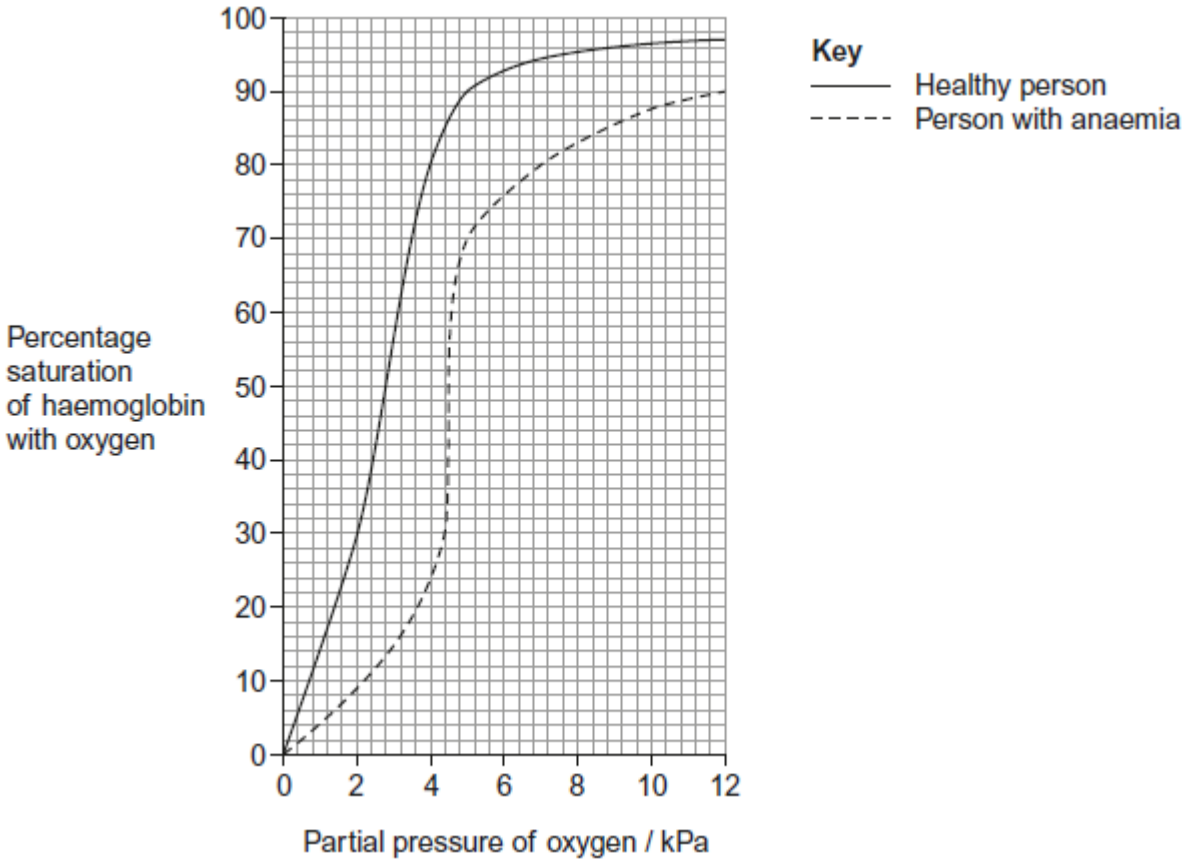
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(2)

Anaemia is a condition in which there is a decrease in the concentration of haemoglobin in blood. In some people with anaemia, substances are produced which change the oxygen dissociation curve of haemoglobin.

The graph shows the effect of these substances on the oxygen dissociation curve of haemoglobin.



(d) (i) Use information in the graph to find the difference in the percentage saturation of haemoglobin with oxygen between a healthy person and a person with anaemia at a partial pressure of oxygen of 4 kPa.

Answer = _____

(1)

(ii) Explain the advantage to a person with anaemia of the change shown in the oxygen dissociation curve.

_____

_____

_____

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(3)

(Total 8 marks)

Q20.

In mammals, the mesenteric artery connects the aorta to blood vessels of the small intestine.

Sport scientists recorded increases in blood flow in the mesenteric artery after different types of meal. The types of meal were:

- carbohydrate only
- fat only
- protein only.

Typical results are shown in the table.

Type of meal	**Maximum percentage increase in blood flow in mesenteric artery**	**Time taken to reach maximum increase in blood flow in mesenteric artery / minutes**
Carbohydrate only	64	15
Fat only	60	30
Protein only	57	45

(a) The sport scientists concluded that the three types of meal had no major effect on maximum percentage increase in blood flow in the mesenteric artery.

What else can be concluded from their results?

_____

_____

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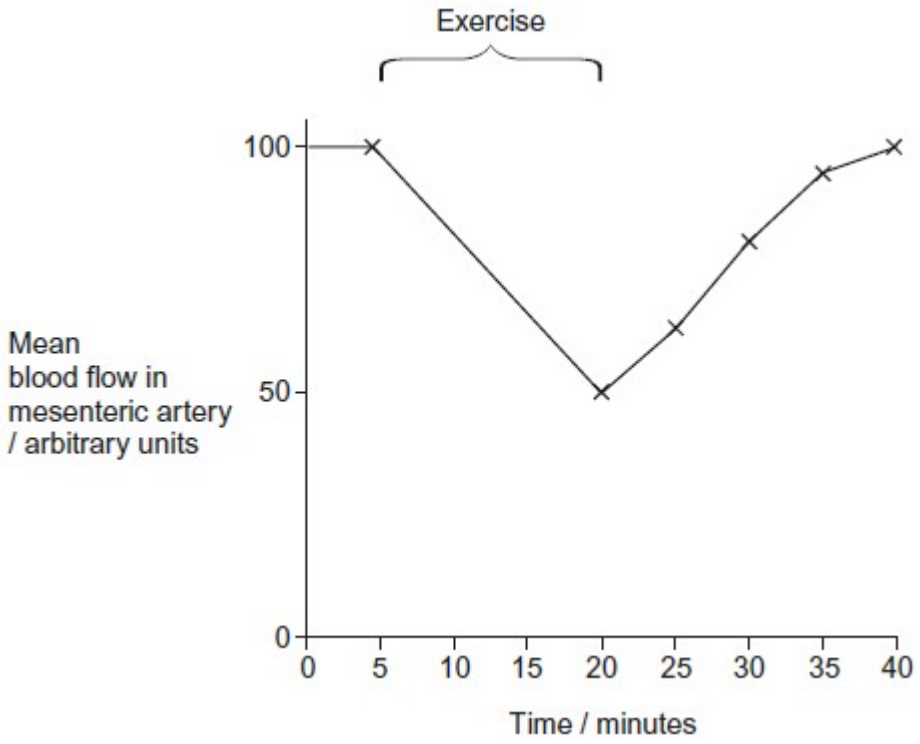
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(2)

In another investigation, the sport scientists recorded blood flow in the mesenteric artery before and after vigorous exercise.

The graph shows their results for a large group of volunteers.



(b) Suggest the advantage of the change in blood flow in the mesenteric artery during exercise.

(3)

(c) The sport scientists concluded people should **not** do vigorous exercise after a meal. Does the information from the table and the graph support this conclusion?

_____

_____

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(4)

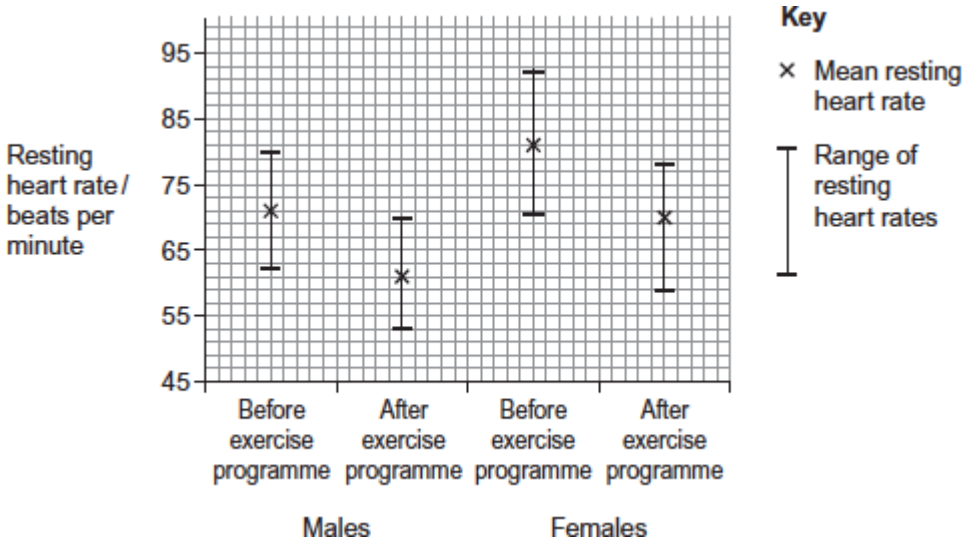
(Total 9 marks)

Q21.

Scientists investigated the effect of a 6-week exercise programme on the resting heart rate of males and females.

The scientists recruited a large group of male volunteers and a large group of female volunteers. They measured the resting heart rate of each volunteer before the exercise programme. Both groups took part in the same exercise programme. The scientists measured the resting heart rate of each volunteer after the exercise programme.

The scientists determined the mean resting heart rate and the range of resting heart rates for each group before and after the exercise programme. The graph shows their results.



(a) What was the range of the resting heart rates in males after the exercise programme?

_____

(1)

(b) Calculate the percentage decrease in the mean resting heart rate of females after the exercise programme. Show your working.

Answer = _____ %

(2)

(c) The scientists used the percentage change in the mean resting heart rate after the exercise programme to compare the results for males and females.

Explain why they used percentage change in the resting heart rate.

_____

_____

_____

_____

_____

(2)

(d) The scientists calculated the cardiac output of the volunteers before and after the exercise programme. In some volunteers, their cardiac output stayed the same, even though their resting heart rate decreased.

Explain how their cardiac output could stay the same even when their resting heart rate had decreased.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q22.

(a) What is the function of the coronary arteries?

_____

_____

_____

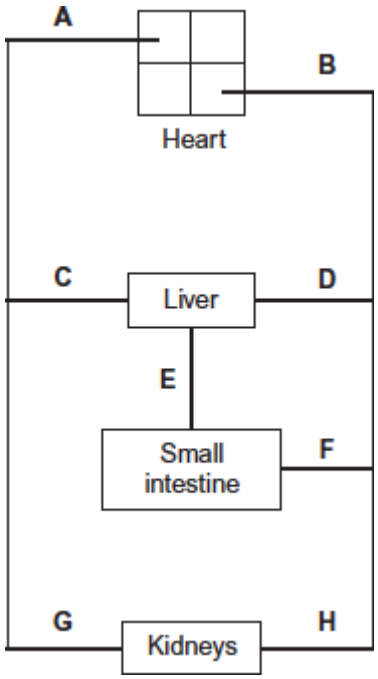
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(2)

(b) **Figure 1** shows some of the large blood vessels in a mammal.

Figure 1



(i) Which of the blood vessels **A** to **H** is the vena cava?

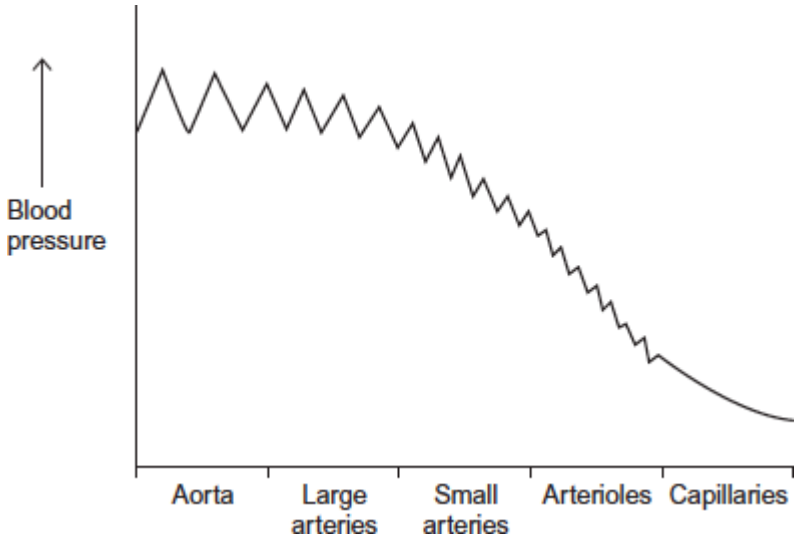
(1)

(ii) Which of the blood vessels **A** to **H** is the renal artery?

(1)

(c) **Figure 2** shows how the blood pressure changes as blood travels from the aorta to the capillaries.

Figure 2



The rise and fall in blood pressure in the aorta is greater than in the small arteries.Suggest why.

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q23.

The mean internal diameter and the mean speed of blood flow for different human blood vessels are shown below in the table.

Blood vessel	**Mean internal diameter / mm**	**Mean speed of blood flow / mm s^{-1}**
Aorta	35	470
Coronary artery	4	380
Arteriole	0.03	110
Capillary	0.001	15
Vena cava	20	270

(a) Although the speed of blood flow in an arteriole is greater than speed of blood flow in a capillary, blood does **not** accumulate in the arterioles.

Explain why.

_____

_____

_____

(1)

(b) Other than causing slow blood flow, explain **one** advantage of capillaries being narrow.

_____

_____

_____

_____

(2)

(c) What factor limits the minimum internal diameter of the lumen of a capillary?

_____

_____

_____

(1)

(d) The volume of blood leaving the capillary network into the veins is less than the volume of blood entering from the arteries.

Explain why.

_____

_____

_____

(1)

(Total 5 marks)

Q24.

A principle of homeostasis is the maintenance of a constant internal environment. An increase in the concentration of carbon dioxide would change the internal environment and blood pH.
Explain the importance of maintaining a constant blood pH.

_____

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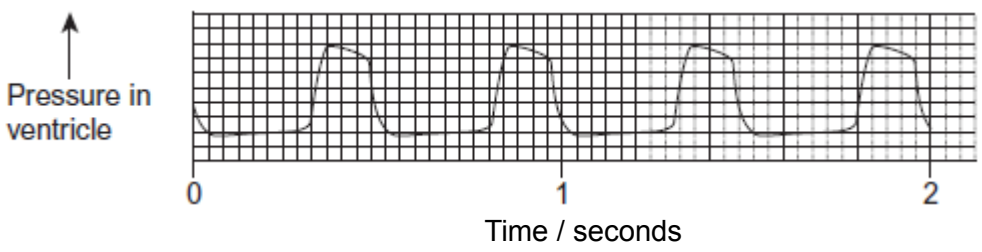
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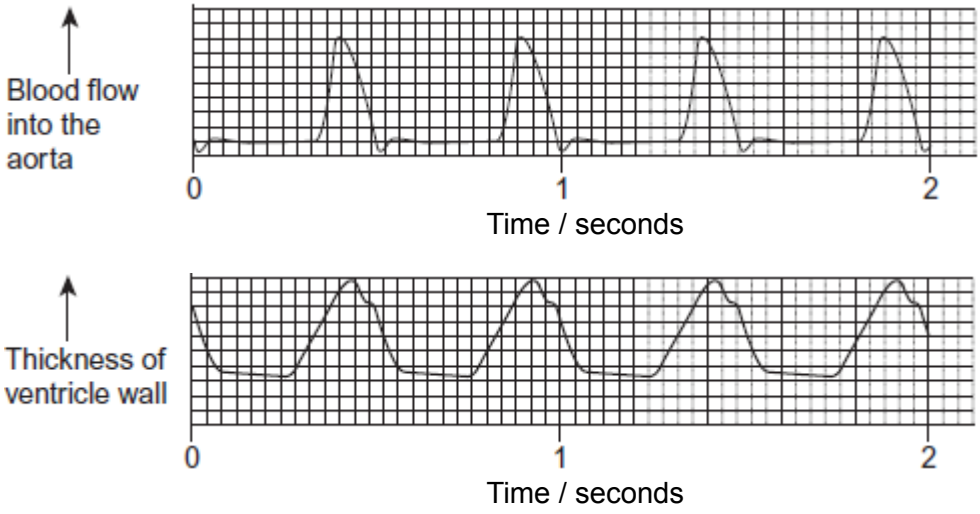
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(Total 3 marks)

Q25.

The figure below shows recordings made from the heart of a dog.





(a) Use information from the figure to explain how the pressure in the dog's ventricle is related to blood flow into the aorta.

_____

_____

_____

_____

(2)

(b) Use information from the figure to explain how the pressure in the dog's ventricle is related to the thickness of the ventricle wall.

_____

_____

_____

_____

(2)

(c) Use the figure to calculate the heart rate of the dog in beats per minute.
Show your working.

Heart rate _____ beats per minute

(2)

(Total 6 marks)

Q26.

(a) The oxygen dissociation curve for haemoglobin shifts to the right during vigorous exercise. Explain the advantage of this shift.

_____

_____

_____

_____

_____

_____

(3)

(b) Weddell seals are diving mammals that live in cold environments. A Weddell seal is shown in **Figure 1**.

Figure 1



By Jerzystrzelecki (own work)
[CC BY 3.0] via Wikimedia Commons

(i) Explain how the body shape of a Weddell seal is an adaptation to living in a cold environment.

_____

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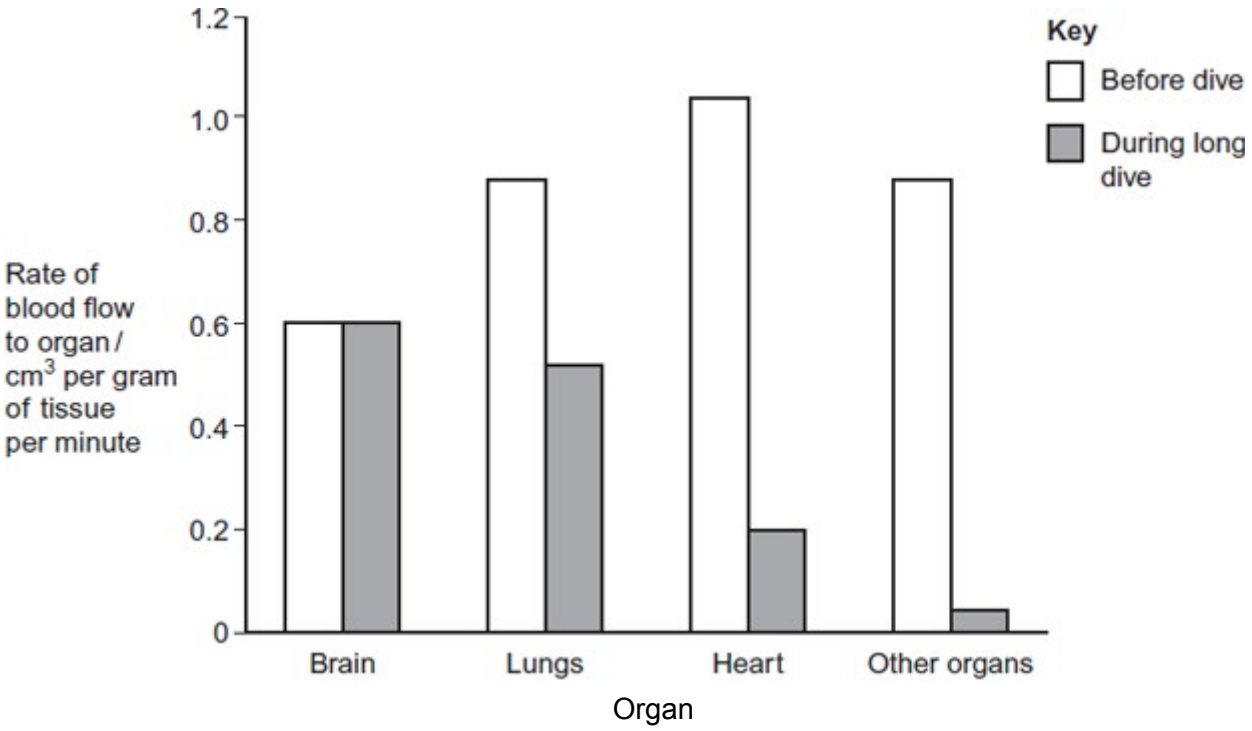
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(2)

(ii) Weddell seals can remain underwater for long periods of time. **Figure 2** shows the rate of blood flow to different organs of a Weddell seal before a dive and during a long dive.

Figure 2



Describe and explain the changes in the rate of blood flow to the different organs during a long dive.

_____

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(3)

(Total 8 marks)

Q27.

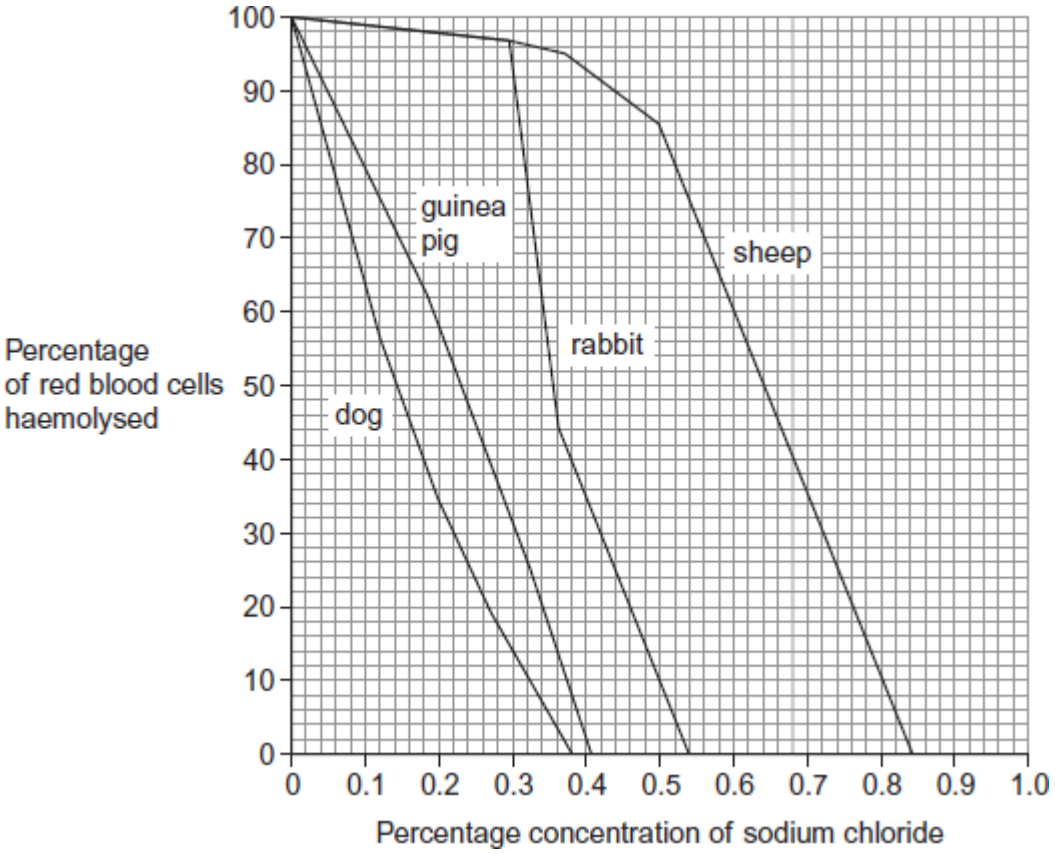
If red blood cells are placed in pure water, water enters the cells by osmosis and they burst. This is called haemolysis. As red blood cells burst they release pigment.

Scientists placed samples of red blood cells in different concentrations of sodium chloride solution for the same period of time. They used red blood cells from four different mammals: dog, guinea pig, rabbit and sheep.

If haemolysis had taken place, the solution turned red. The scientists measured the intensity of the red colour using a colorimeter. The more intense the red colour, the greater the amount of haemolysis.

The scientists calculated the percentage of red blood cells that were haemolysed in each sodium chloride solution.

The following figure shows the scientists' results.



(a) Use the figure to give **two** differences between the results for dog and sheep.

Difference 1 _____

_____

Difference 2 _____

_____

(2)

(b) Calculate the difference in the percentage of haemolysed cells between sheep and rabbit at a sodium chloride concentration of 0.5%.

_____

(1)

(c) Explain the relationship between the depth of the red colour of the solution and how much haemolysis has taken place.

_____

_____

_____

_____

_____

(2)

(d) During treatment in a veterinary surgery, any of the mammals in the figure above may be given an infusion of sodium chloride solution directly into a vein. The concentration of sodium chloride solution used is 0.9%, rather than 0.5%, regardless of the species of mammal.

Explain the advantage to the vet of using this concentration.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q28.

(a) Describe how a heartbeat is initiated and coordinated.

_____

_____

_____

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_____

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_____

(5)

(b) Explain how the heart muscle and the heart valves maintain a one-way flow of blood from the left atrium to the aorta.

_____

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(5)

(Total 10 marks)

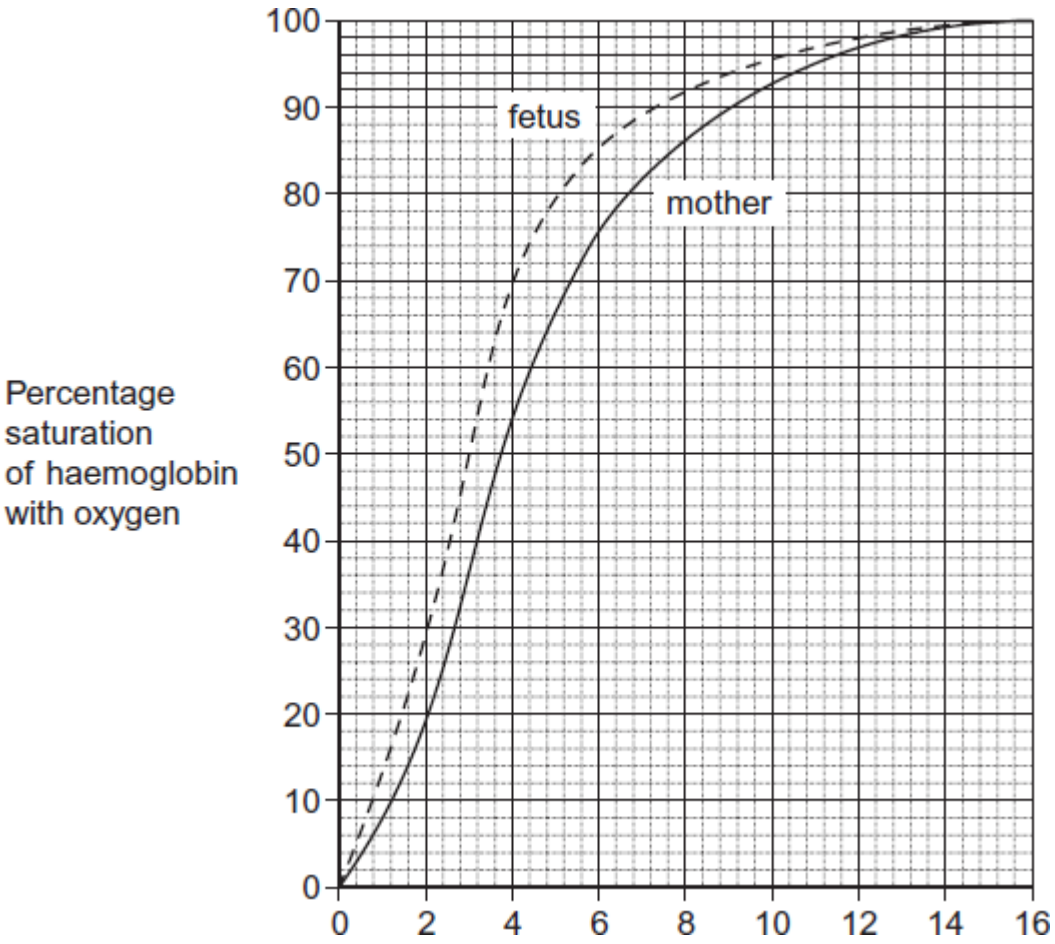
Q29.

(a) The table shows three statements about some biological molecules. Complete the table with a tick in each box if the statement is true for haemoglobin, cellulose or starch.

Statement	Haemoglobin	Cellulose	Starch
Has a quaternary structure			
Formed by condensation reactions			
Contains nitrogen			

(3)

The graph shows oxygen dissociation curves for the haemoglobin of a mother and her fetus.



(b) What is the difference in percentage saturation between the haemoglobin of the mother and her fetus at a partial pressure of oxygen (pO_2) of 4 kPa?

(1)

(c) The oxygen dissociation curve of the fetus is to the left of that for its mother. Explain the advantage of this for the fetus.

(2)

(d) After birth, fetal haemoglobin is replaced with adult haemoglobin. Use the graph to suggest the advantage of this to the baby.

_____

_____

_____

_____

_____

_____

(2)

(e) Hereditary persistence of fetal haemoglobin (HPFH) is a condition in which production of fetal haemoglobin continues into adulthood. Adult haemoglobin is also produced.

People with HPFH do not usually show symptoms. Suggest why.

_____

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_____

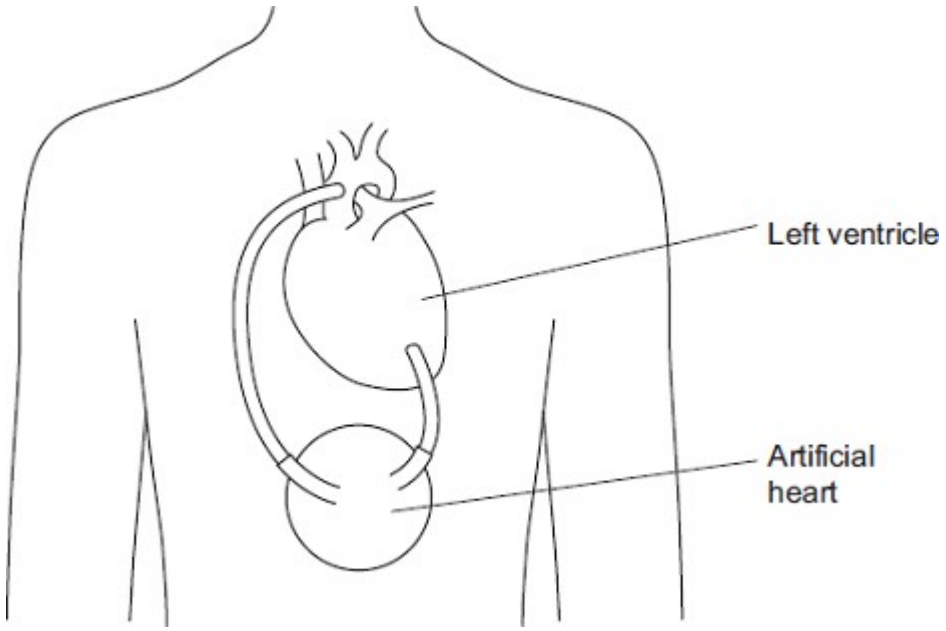
(1)

(Total 9 marks)

Q30.

Some people have a form of *heart failure* where their heart is not pumping blood as well as it used to. Some people with heart failure are given an artificial heart to improve circulation of blood from the left ventricle.
Figure 1 shows where this type of artificial heart is connected.

Figure 1



(a) Name the blood vessel to which the artificial heart is connected.

_____

(1)

(b) In these patients, the right ventricle still produces sufficient blood flow to keep the patient alive.

Suggest why the left ventricle requires the help of the artificial heart but the right ventricle does not.

_____

_____

_____

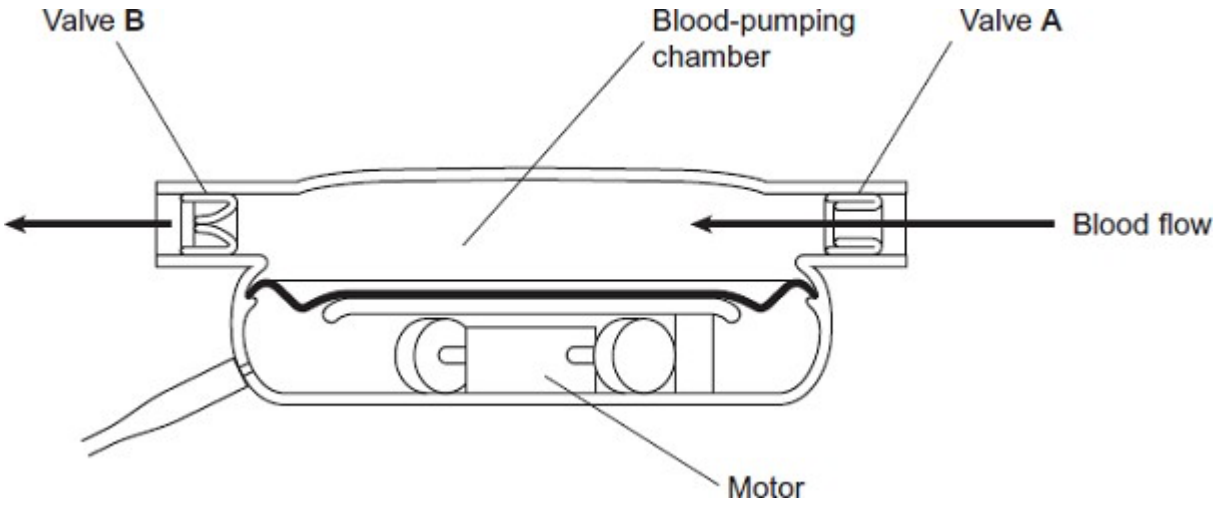
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(2)

(c) **Figure 2** shows the internal structure of this type of artificial heart.

Figure 2



Valves **A** and **B** have the same functions as heart valves involved in the cardiac cycle. Name the heart valve that has the same function as:

valve **A** _____

valve **B** _____

(2)

(d) There are different designs of artificial heart. Doctors compared results for patients who received two different types of artificial heart, **X** and **Y.**

They recorded information 2 years after the artificial hearts were implanted. Their results are **shown in Figure 3**.

Figure 3

	Information recorded 2 years after artificial heart implanted		
Type of artificial heart	**Number of patients surviving without replacement of artificial heart**	**Number of patients surviving but who required repair or replacement of artificial heart**	**Number of patients who died**
X (119 patients)	62	13	44
Y (58 patients)	7	24	27

Which type of artificial heart was the more successful? Use calculations to support your answer.

_____

_____

_____

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_____

_____

_____

(3)

(Total 8 marks)

Q31.

Some people have a condition called *white-coat hypertension*. People with this condition develop a higher than normal heart rate and blood pressure when they are in a doctor's surgery. High heart rate is correlated with high blood pressure.

Doctors investigated differences in heart rate between men *with white-coat hypertension* and those without the condition. They measured the men's mean heart rates:

- in the doctor's surgery, by recording the pulse in the wrist for 1 minute, when the men were lying down
- at home, using a portable heart rate monitor when the men were walking around
- at home, using a portable heart rate monitor when the men were sleeping.

(a) The groups of men selected for this investigation were matched.

Other than being men, suggest **one** factor for which they should have been matched.

_____

(1)

(b) Explain why the pulse recordings in the doctor's surgery were taken when the men were lying down.

_____

_____

_____

(1)

(c) The pulse felt in the artery in the wrist can be recorded and used to measure heart rate.

Suggest why the pulse felt can be used to measure heart rate.

_____

_____

_____

_____

_____

(2)

(d) The portable heart rate monitor recorded the men's heart rates continuously. This gave more reliable mean heart rates than those obtained by recording the pulse in the wrist for 1 minute.

Suggest why it is more reliable.

_____

_____

_____

_____

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(2)

(e) The table shows the doctors' results.

Where and how heart rate was measured	**Mean heart rate / beats per minute**	
	Men with white-coat hypertension	**Men without white-coat hypertension**
Doctor's surgery, recording	67	63

pulse when lying down		
At home, walking around, using heart monitor	76	73
At home, sleeping, using heart monitor	63	60

A journalist, who saw these results, stated that they showed there is no such thing as *white-coat hypertension*.

Do these data support this statement? Give reasons for your answer.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q32.

Some substances can cross the cell-surface membrane of a cell by simple diffusion through the phospholipid bilayer. Describe other ways by which substances cross this membrane.

_____

_____

_____

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_____

_____

(Total 5 marks)

Q33.

(a) (i) An arteriole is described as an organ. Explain why.

_____

_____

_____

(1)

(ii) An arteriole contains muscle fibres. Explain how these muscle fibres reduce blood flow to capillaries.

_____

_____

_____

_____

_____

(2)

(b) (i) A capillary has a thin wall. This leads to rapid exchange of substances between the blood and tissue fluid. Explain why.

_____

_____

_____

(1)

(ii) Blood flow in capillaries is slow. Give the advantage of this.

_____

_____

_____

(1)

(c) Kwashiorkor is a disease caused by a lack of protein in the blood. This leads to a swollen abdomen due to a build up of tissue fluid.

Explain why a lack of protein in the blood causes a build up of tissue fluid.

_____

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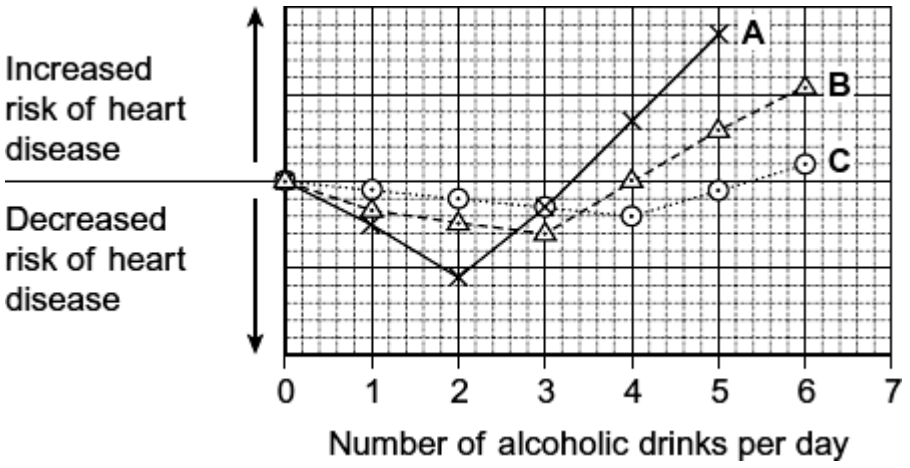
(3)

(Total 8 marks)

Q34.

Scientists compared the results of three investigations, **A**, **B** and **C**. These investigations were into the effect of drinking different amounts of alcohol on the risk of developing heart disease.

The graph shows the results of these investigations.



(a) Describe the relationship between increasing the number of alcoholic drinks per day and the risk of heart disease in investigation **A**.

_____

_____

_____

_____

_____

(2)

(b) All the volunteers who took part in investigation **C** were aged between 40 and 50 years old. Explain how choosing volunteers of a similar age improved this investigation.

_____

_____

_____

(1)

(c) A newspaper headline used the information in the graph to claim 'Alcohol is good for you.' Evaluate this claim.

_____

_____

_____

_____

_____

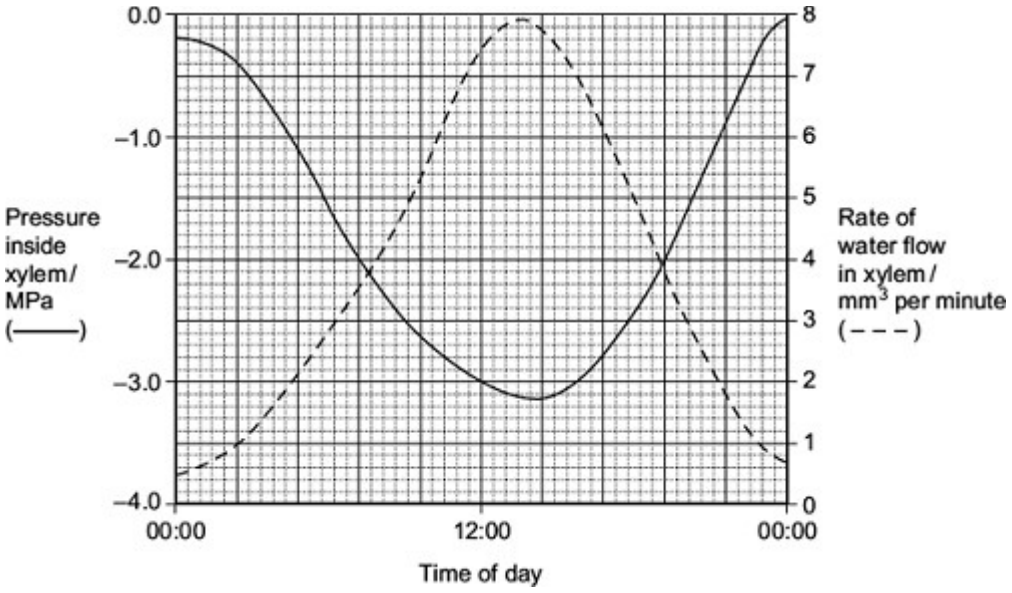
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(3)

(Total 6 marks)

Q35.

(a) Scientists measured the rate of water flow and the pressure in the xylem in a small branch. Their results are shown in the graph.



(i) Use your knowledge of transpiration to explain the changes in the rate of flow in the xylem shown in the graph.

_____

_____

_____

_____

_____

_____

(3)

(ii) Explain why the values for the pressure in the xylem are negative.

_____

_____

_____

(1)

(b) Doctors measured the thickness of the walls of three blood vessels in a large group

of people. Their results are given in the table.

Name of vessel	Mean wall thickness /mm (± standard deviation)
Aorta	5.7 ± 1.2
Pulmonary artery	1.0 ± 0.2
Pulmonary vein	0.5 ± 0.2

(i) Explain the difference in thickness between the pulmonary artery and the pulmonary vein.

_____

_____

_____

(1)

(ii) The thickness of the aorta wall changes all the time during each cardiac cycle. Explain why

_____

_____

_____

_____

_____

_____

(3)

(iii) Which of the three blood vessels shows the greatest variation in wall thickness?
Explain your answer.

_____

_____

_____

(1)

(c) Describe how tissue fluid is formed **and** how it is returned to the circulatory system.

_____

_____

_____

(6)

(Total 15 marks)

Q36.

An electrocardiogram is made by attaching recording electrodes to a person's chest. It shows the electrical changes that take place in a person's heart each time it beats. A sports physiologist produced electrocardiograms for a fit adult male.

Chart **X** shows an electrocardiogram from this man after 10 minutes of complete rest. A cardiac cycle consists of the filling time and the contraction time. The filling time and the contraction time for one cardiac cycle are shown on this chart.

Chart **X**

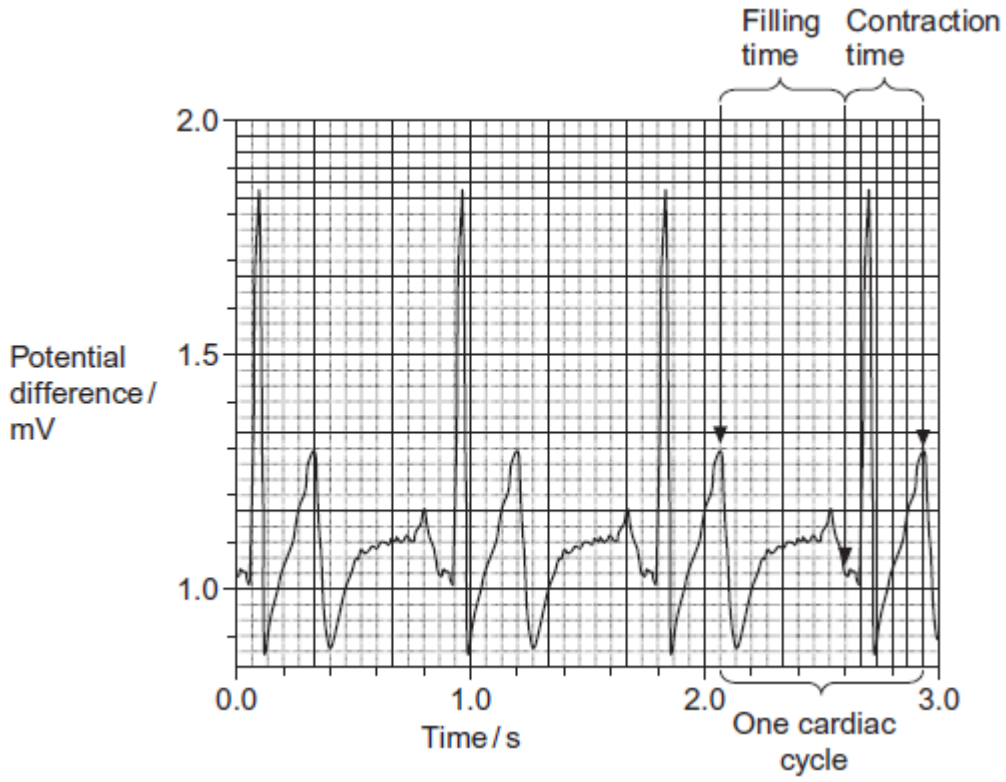
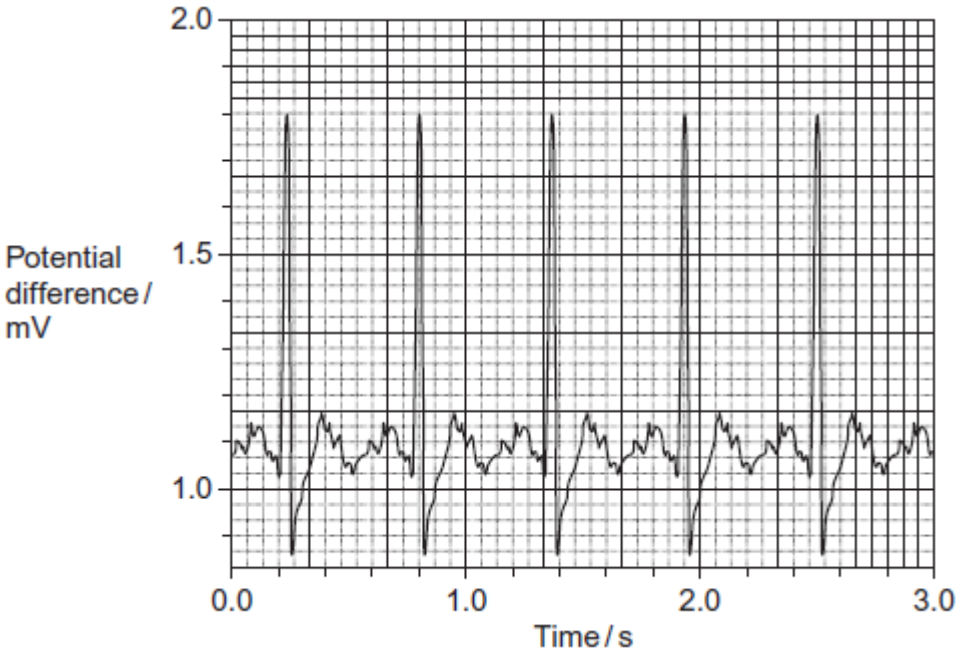


Chart **Y** shows an electrocardiogram from the same man immediately after a period of

exercise.

Chart **Y**



(a) Give **one** way in which an electrocardiogram could have produced more reliable results than counting the pulse.

_____

_____

_____

(1)

(b) (i) Chart **X** shows that the man's resting heart rate was 67 beats per minute. What was his pulse rate? Explain your answer.

_____

_____

_____

(2)

(ii) Use chart **Y** to calculate the man's heart rate after the period of exercise. Show your working.

Answer _____ beats per minute

(2)

(c) Use charts **X** and **Y** to describe how exercise affected filling time.

_____

_____

_____

_____

_____

(2)

(d) The physiologist used electrocardiograms to investigate the effect of increasing heart rate on filling time.
Describe how she could have modified the method of exercising you used to produce a range of increases in heart rate.

_____

_____

_____

_____

_____

(2)

(Total 9 marks)

Q37.

Ivabradine is a drug that slows heart rate. It is taken as a pill. Doctors investigated its value in reducing the resting heart rate of patients with coronary heart disease.

- They described their investigation as a large-scale, controlled trial. It was also carried out on people living in different areas.
- The results of the trial showed that ivabradine slowed heart rate.
- Angina is a pain in the chest. It results when insufficient oxygen is brought to the heart muscle during exercise. The doctors found that ivabradine reduced angina.

(a) The results of the ivabradine trial were reliable.

(i) Explain the importance of the ivabradine investigation being a large-scale trial.

_____

_____

_____

(1)

(ii) Explain the importance of the ivabradine investigation being carried out on people living in different areas.

_____

_____

_____

(1)

(b) The ivabradine investigation was a controlled trial. Suggest how the control group would have been treated.

_____

_____

_____

_____

_____

(2)

(c) An electrocardiogram is made by attaching recording electrodes to a person's chest. It shows the electrical changes that take place in a person's heart each time it beats. A sports physiologist produced electrocardiograms for a fit adult male.

Chart **X** shows an electrocardiogram from this man after 10 minutes of complete rest.
A cardiac cycle consists of the filling time and the contraction time. The filling time and the contraction time for one cardiac cycle are shown on this chart.

Chart **X**

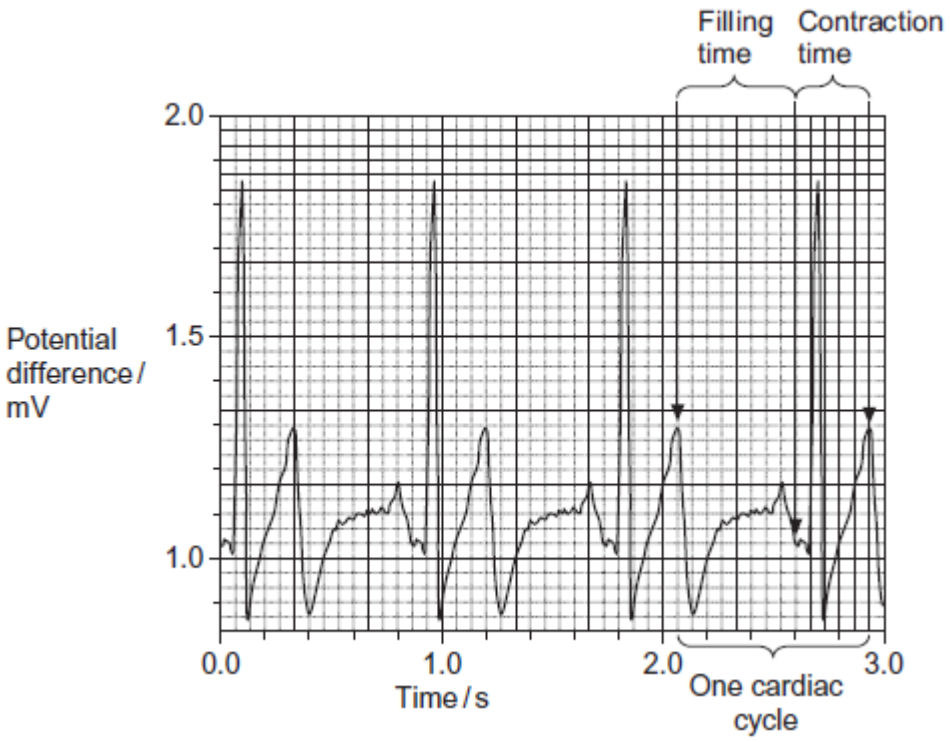
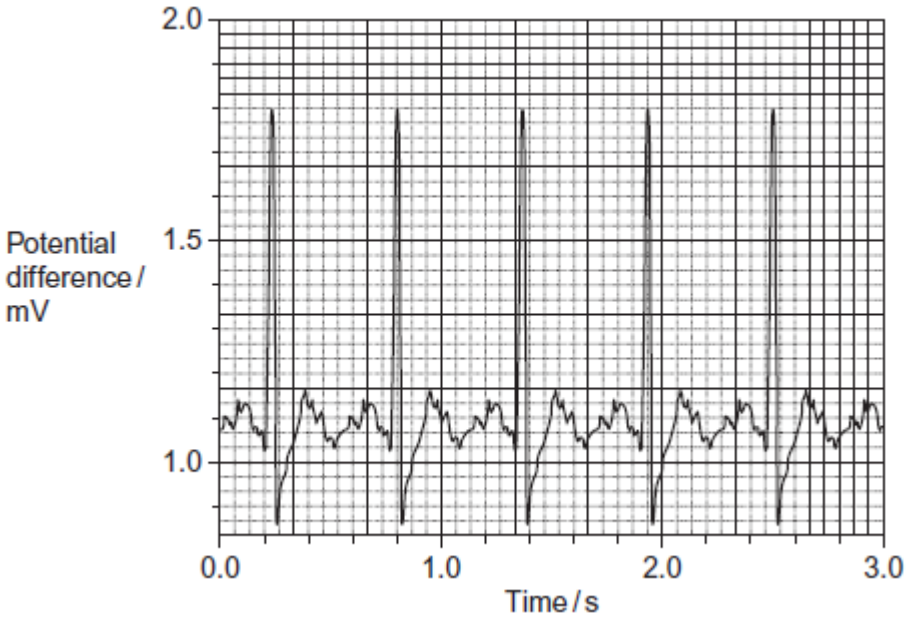


Chart **Y** shows an electrocardiogram from the same man immediately after a period of exercise.

Chart **Y**



Ivabradine slows heart rate.

(i) Use information from the charts above to explain why ivabradine increases the volume of blood entering the heart during a cardiac cycle.

_____

_____

(1)

(ii) Ivabradine reduces angina. Suggest how an increase in the volume of blood entering the heart reduces angina.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q38.

(a) (i) The human heart has four chambers.
In which **one** of the four chambers of the human heart does pressure reach the highest value?

_____

(1)

(ii) Explain how the structure of this chamber causes this high pressure.

_____

_____

_____

(1)

The table shows the volume of blood in a man's right ventricle at different times during one cardiac cycle.

Time / s	Volume of blood / cm^3
0.0	125
0.1	148
0.2	103
0.3	70
0.4	56
0.5	55
0.6	98
0.7	125

(b) (i) Use the data in the table to calculate the man's heart rate.

Heart rate = _____ beats per minute

(ii) Use the data in the table and your answer to part (b) (i) to calculate the man's cardiac output. Show your working.

Cardiac output = _____ cm^3 per minute

(3)

(c) Use information from the table to complete the table below to show whether the valves are **open** or **closed** at each of the times shown. Write open or closed in the appropriate boxes.

Time / s	Valve between right atrium and right ventricle	Valve between right ventricle and pulmonary artery
0.2		
0.6		

(2)

(Total 7 marks)

Q39.

Read the following passage.

Aspirin is a very useful drug. One of its uses is to reduce fever and inflammation. Aspirin does this by preventing cells from producing substances called prostaglandins. Prostaglandins are produced by an enzyme-controlled pathway. Aspirin works by inhibiting one of the enzymes in this pathway. Aspirin attaches permanently to a chemical group on one of the monomers that make up the active site of this enzyme.

The enzyme that is involved in the pathway leading to the production of prostaglandins is also involved in the pathway leading to the production of thromboxane. This is a substance that promotes blood clotting. A small daily dose of aspirin may reduce the risk of myocardial infarction (heart attack).

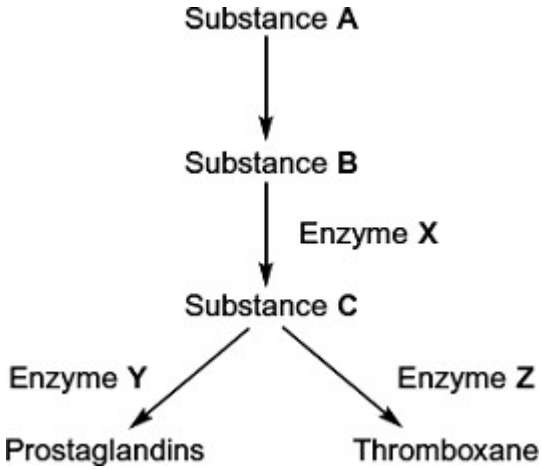
Use information from the passage and your own knowledge to answer the following questions.

(a) Name the monomers that make up the active site of the enzyme (lines 6 – 7).

_____

(1)

(b) The diagram shows the pathways by which prostaglandins and thromboxane are formed.



(i) Aspirin only affects one of the enzymes in this pathway. Use information in lines 5 - 7 to explain why aspirin does **not** affect the other enzymes.

_____

_____

_____

_____

_____

(2)

(ii) Which enzyme, **X**, **Y** or **Z**, is inhibited by aspirin? Explain the evidence from the passage that supports your answer.

Enzyme _____

Explanation _____

_____

_____

(2)

(c) Aspirin is an enzyme inhibitor. Explain how aspirin prevents substrate molecules being converted to product molecules.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q40.

(a) Explain how oxygen is loaded, transported and unloaded in the blood.

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(6)

Midges are very small insects. The early stages of the life cycle of midges are called

larvae. Midge larvae live in water. A biologist investigated the uptake of oxygen by the larvae of two species of midge. He measured the rate of uptake of oxygen by the larvae in water containing different concentrations of oxygen. The table shows his results.

Concentration of oxygen in water /cm^3 dm^{-3}	**Mean rate of oxygen uptake / cm^3 g^{-1} h^{-1}**	
	Chironomus longistylus	*Tanytarsus brunnipes*
1	220	141
2	285	246
3	304	342
4	313	362
5	320	367
6	318	430
7	320	469

(b) The larvae in this investigation were kept at a temperature of 17 °C. Why was it important that the larvae of both species were kept at the same temperature?

_____

_____

_____

_____

_____

(2)

(c) Describe the effect of an increase in oxygen concentration on the mean rate of oxygen uptake in *Chironomus longistylus*.

_____

_____

_____

_____

_____

(2)

(d) *Chironomus longistylus* lives in still water whereas *Tanytarsus brunnipes* lives in fast running streams. The water in fast running streams has a higher concentration of oxygen than in still water. Use the table in part (a) to suggest how *Chironomus longistylus* is better adapted than *Tanytarsus brunnipes* to living in still water.

_____

_____

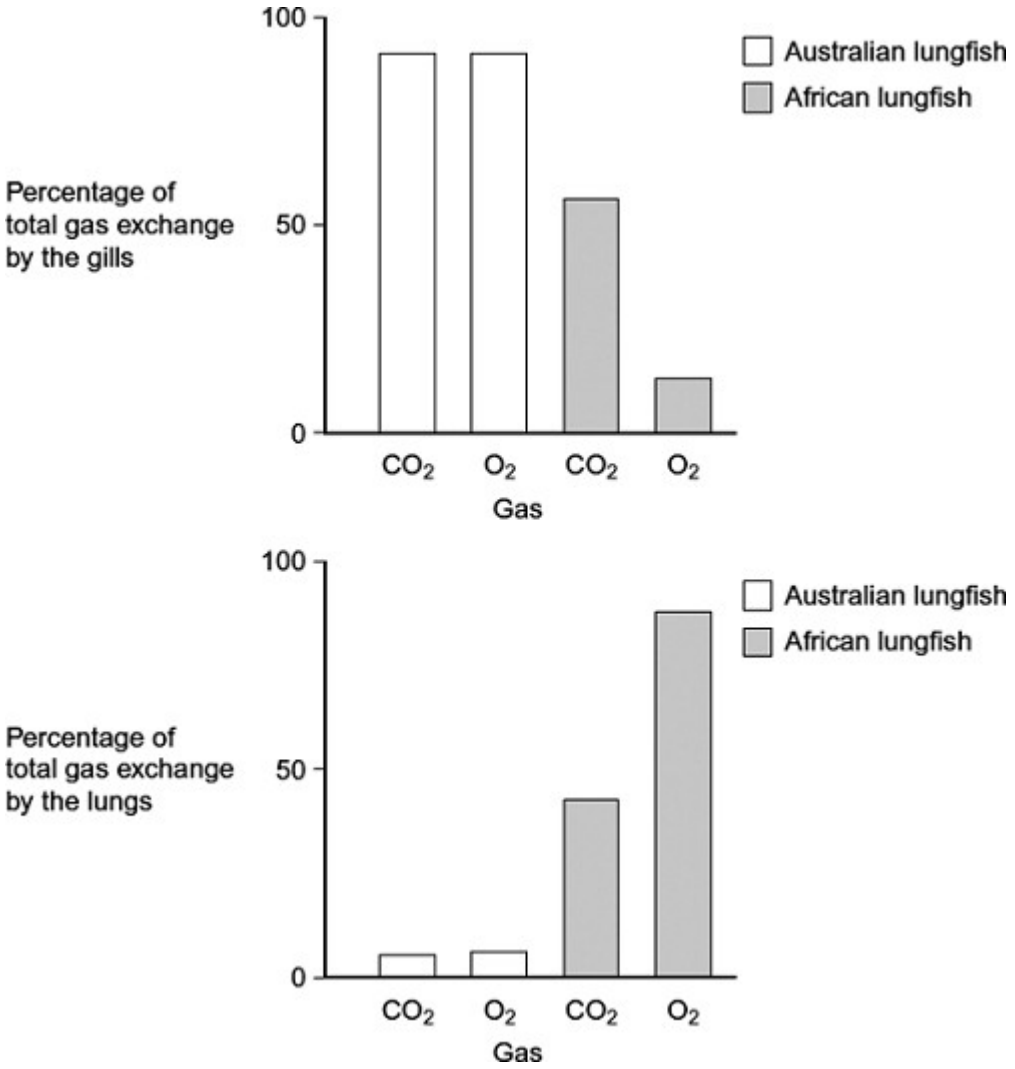
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(2)

(e) Lungfish are freshwater fish which have gills and lungs. Scientists investigated how Australian and African lungfish use their lungs and gills for gas exchange. The graphs show the results of this investigation.



(i) Describe the difference in the way carbon dioxide is lost from the body of an Australian lungfish and an African lungfish.

_____

_____

_____

(1)

(ii) African lungfish are likely to survive for longer than Australian lungfish when living in pools that dry up. Explain why.

_____

_____

_____

_____

_____

(2)

(Total 15 marks)

Q41.

The table shows pressure changes in the left side of the heart during one cardiac cycle.

	Blood pressure / k Pa	
Time / s	**Left atrium**	**Left ventricle**
0.0	0.7	0.3
0.1	1.0	2.0
0.2	0.2	12.5
0.3	0.2	15.3
0.4	1.0	4.5
0.5	0.5	1.0
0.6	0.6	0.3
0.7	0.7	0.3

(a) Between which times is the valve between the atrium and the ventricle closed?

Explain your answer.

Times _____ s and _____ s

Explanation _____

_____

_____

_____

(2)

(b) The maximum pressure in the ventricle is much higher than that in the atrium.

Explain what causes this.

_____

_____

_____

_____

(2)

(c) Use the information in the table to calculate the heart rate in beats per minute.

Answer _____ beats per minute

(1)

(Total 5 marks)

Q42.

Read the following passage.

Chlamydia is a bacterium. Scientists have shown that infection with chlamydia can cause heart disease in humans. Infection with the bacterium can stimulate the formation of atheroma. This can lead to a heart attack.

Other scientists have been working with mice. These scientists have suggested that chlamydia may cause heart disease in a different way. They have found a protein on the surface of chlamydia cells which is similar to a protein in the heart muscle of mice. After an infection with chlamydia, cells of the immune system of the mice may attack their heart muscle cells and cause heart disease.

Use the information in the passage and your own knowledge to answer the following questions.

(a) (i) Using information from the passage, explain what is meant by an antigen.

_____

_____

_____

_____

(2)

(ii) After an infection with chlamydia, cells of the immune system of the mice may attack the heart muscle cells (lines 7-8). Explain why.

_____

_____

_____

_____

_____

(2)

(b) Some scientists have suggested that people should be vaccinated to prevent infection by chlamydia. Evaluate this suggestion.

_____

_____

_____

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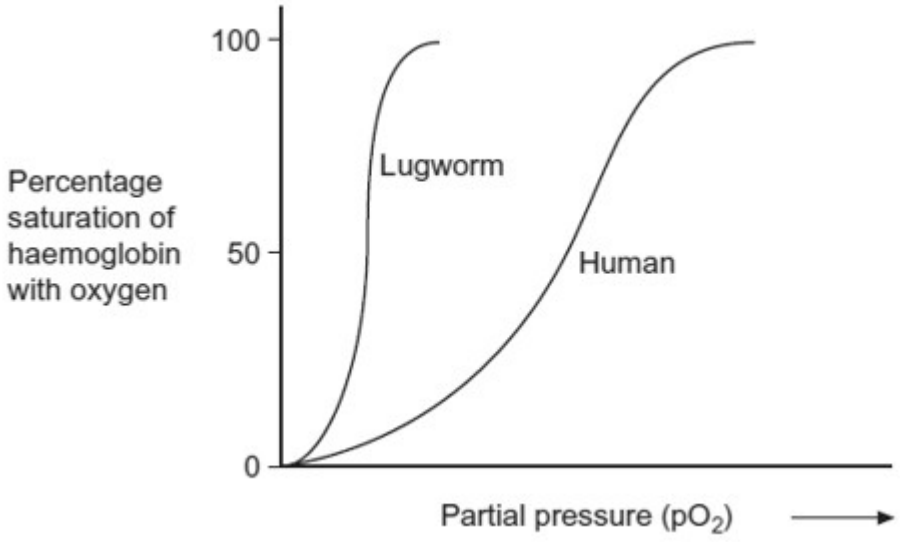
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(3)

(Total 7 marks)

Q43.

Lugworms live in mud where the partial pressure of oxygen is low. The graph shows oxygen dissociation curves for a lugworm and for a human.



(a) Explain the advantage to the lugworm of having haemoglobin with a dissociation curve in the position shown.

_____

_____

_____

_____

(2)

(b) In humans, substances move out of the capillaries to form tissue fluid. Describe how this tissue fluid is returned to the circulatory system.

_____

_____

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_____

_____

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(3)

(Total 5 marks)

Q44.

Erythropoietin (EPO) is a substance produced in the body. It increases the production of red blood cells. Synthetic EPO is made artificially. It is used to treat patients who have a form of anaemia in which there is a reduced number of red blood cells. Scientists investigated the effect of synthetic EPO on volunteers with this form of anaemia.

- The scientists injected synthetic EPO in a salt solution into patients in the experimental groups. They also set up control groups.
- They gave the different experimental groups different doses of synthetic EPO and different lengths of treatment.
- At the beginning and end of the treatment, the scientists measured each patient's haemoglobin concentration. From these measurements, they calculated the mean increase in haemoglobin concentration.

Some of the results are shown in the table.

Number of volunteers	Length of treatment / weeks	Dose of synthetic EPO / units per kilogram per week	Mean increase in haemoglobin concentration / arbitrary units
58	8	85	19.0
18	8	170	26.0
40	12	150	12.5
82	12	450	34.2
46	24	120	23.0
53	24	240	31.0

(a) Explain why treatment with synthetic EPO affects the haemoglobin concentration in these volunteers.

_____

_____

_____

_____

_____

(2)

(b) Suggest how the control groups should have been treated in this investigation.

_____

_____

_____

_____

_____

(2)

(c) The scientists measured the dose of synthetic EPO per kilogram per week.

Explain why they measured the dose per unit mass and per unit time.

_____

_____

_____

_____

_____

(2)

(d) Explain how the information that the scientists collected might be useful in treating patients with anaemia.

_____

_____

_____

_____

_____

(2)

(e) Some athletes have used synthetic EPO as a performance enhancer. Explain how synthetic EPO may improve performance in long-distance events.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(f) Athletes may be tested to see if the concentration of EPO in their blood is above normal. Suggest how scientists determine the normal concentration of EPO in blood.

_____

_____

_____

_____

_____

(2)

(g) Synthetic EPO can increase blood pressure. Suggest why.

_____

_____

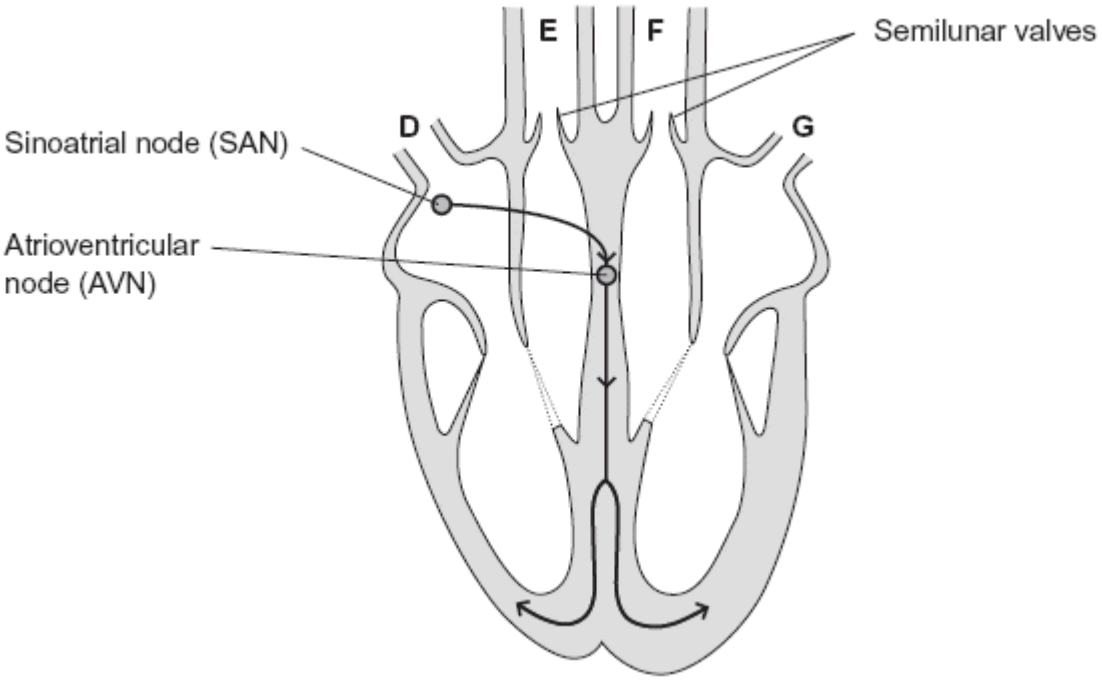
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(1)

(Total 15 marks)

Q45.

The diagram shows a human heart as seen from the front. The main blood vessels are labelled **D** to **G**. The arrows show the pathways taken by the electrical activity involved in coordinating the heartbeat in the cardiac cycle.



(a) Which of the blood vessels, **D** to **G**

(i) carries oxygenated blood to the heart

☐

(1)

(ii) carries deoxygenated blood to the lungs?

☐

(1)

(b) Explain, in terms of pressure, why the semilunar valves open.

_____

_____

_____

(1)

(c) When a wave of electrical activity reaches the AVN, there is a short delay before a new wave leaves the AVN. Explain the importance of this short delay.

_____

_____

_____

_____

_____

(2)

(d) The table shows the cardiac output and resting heart rate of an athlete before and after completing a training programme.

	Before training	**After training**
Cardiac out/cm^3	5000	5000
Resisting heart rate/beats per minute	70	55

(i) Calculate the athlete's stroke volume after training. Show your working.

_____ cm^3

(2)

(ii) Use information from the table to explain how training has caused the resting heart rate of this athlete to be lower.

_____

_____

_____

_____

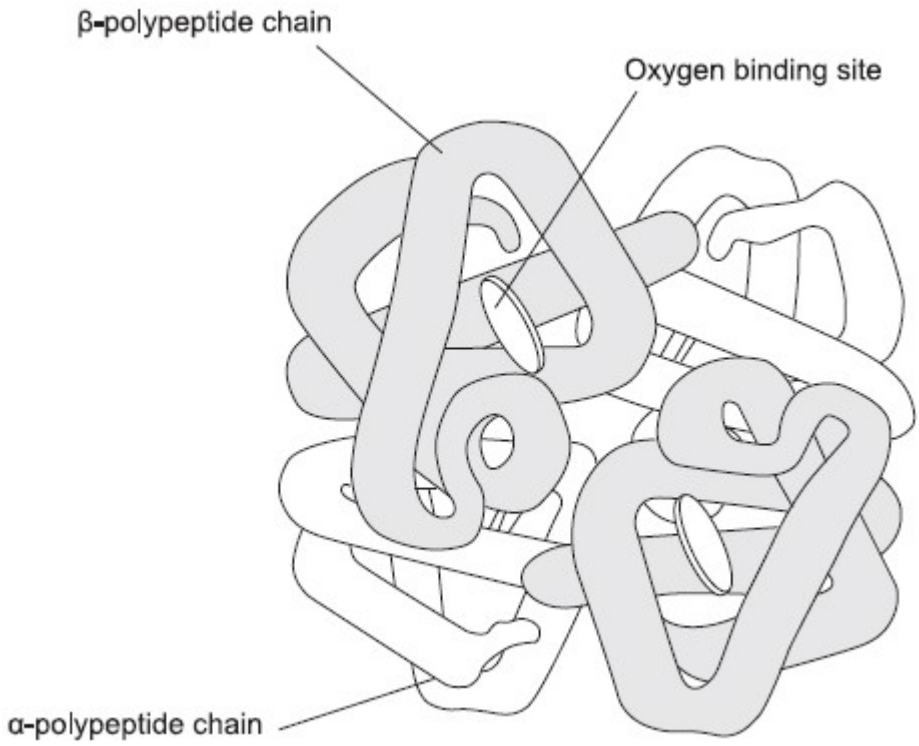
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(2)

(Total 9 marks)

Q46.

The diagram shows a molecule of haemoglobin.



(a) What is the evidence from the diagram that haemoglobin has a quaternary structure?

_____

_____

(1)

(b) (i) A gene codes for the α-polypeptide chain. There are 423 bases in this gene that code for amino acids. How many amino acids are there in the α-polypeptide chain?

☐

(1)

(ii) The total number of bases in the DNA of the α-polypeptide gene is more than 423.

Give **two** reasons why there are more than 423 bases.

1. _____

_____

2. _____

_____

(2)

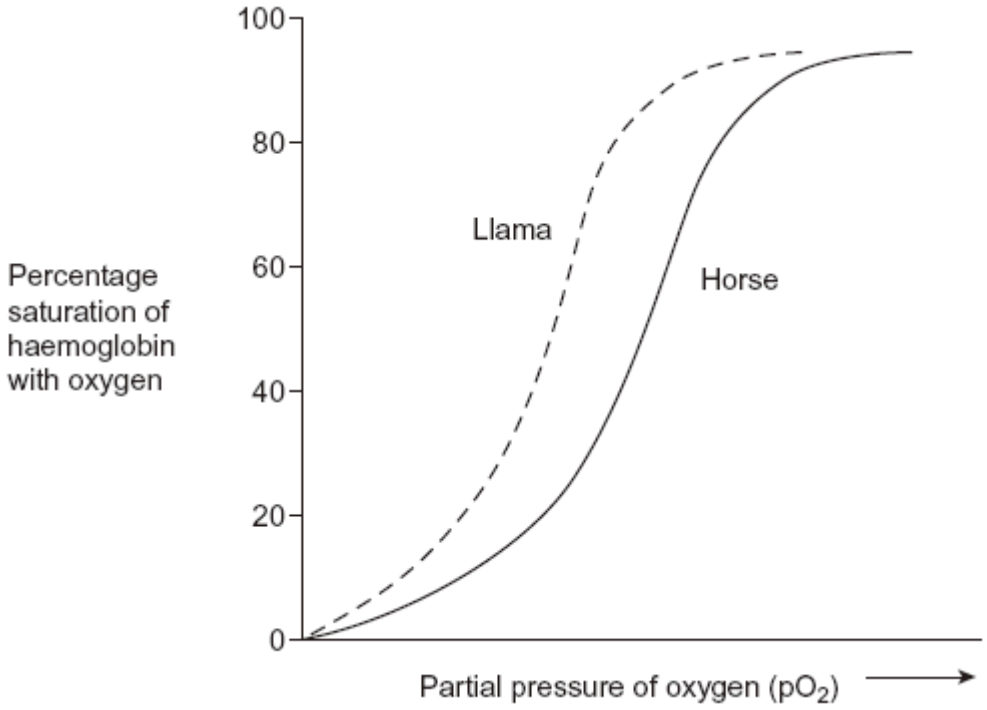
(c) The haemoglobin in one organism may have a different chemical structure from the haemoglobin in another organism. Describe how.

_____

_____

(1)

(d) The graph shows oxygen dissociation curves for horse haemoglobin and for llama haemoglobin. Horses are adapted to live at sea level and llamas are adapted to live in high mountains.



Use the graph to explain why llamas are better adapted to live in high mountains than horses.

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(3)

(Total 8 marks)

Q47.

(a) Students measured the rate of transpiration of a plant growing in a pot under different environmental conditions. Their results are shown in the table.

Conditions	Transpiration rate / g h^{-1}

A	Still air 15°	1.2
B	Moving air 15°	1.7
C	Still air 25°	2.3

During transpiration, water diffuses from cells to the air surrounding a leaf.

(i) Suggest an explanation for the difference in transpiration rate between conditions **A** and **B**.

_____

_____

_____

_____

_____

(2)

(ii) Suggest an explanation for the difference in transpiration rate between conditions **A** and **C**.

_____

_____

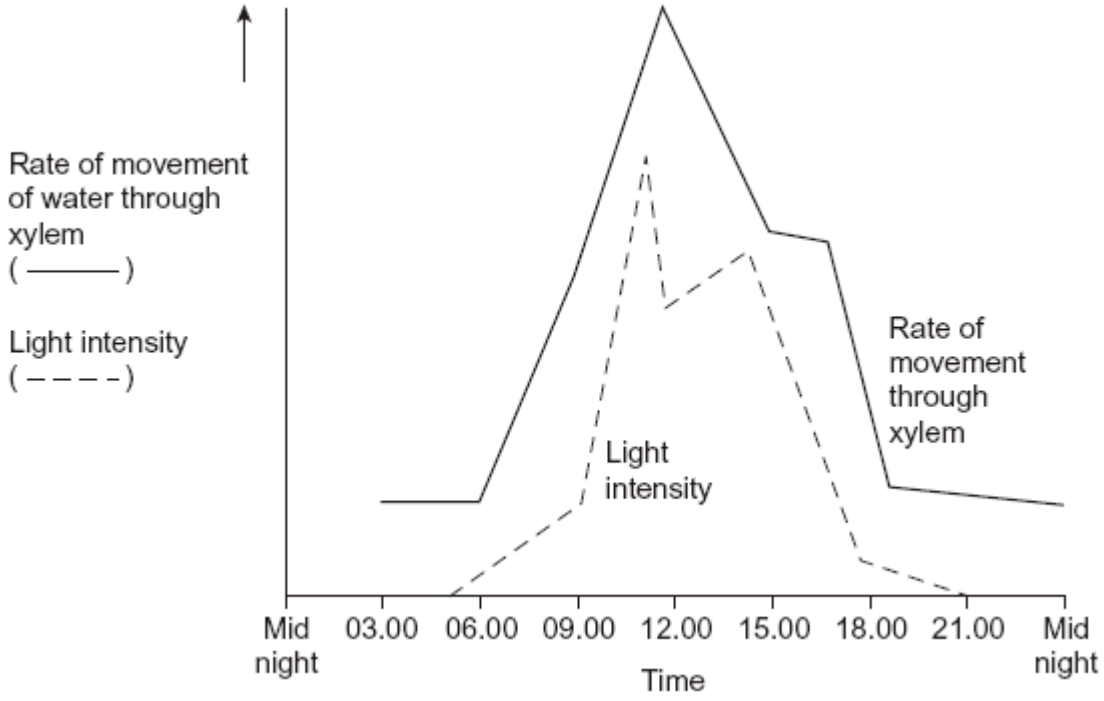
_____

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(2)

(b) Scientists investigated the rate of water movement through the xylem of a twig from a tree over 24 hours. The graph shows their results. It also shows the light intensity for the same period of time.



(i) Describe the relationship between the rate of water movement through the xylem and the light intensity.

_____

_____

_____

(1)

(ii) Explain the change in the rate of water movement through the xylem between 06.00 and 12.00 hours.

_____

_____

_____

_____

_____

(2)

(iii) The scientists also measured the diameter of the trunk of the tree on which the twig had been growing. The diameter was less at 12.00 than it was at 03.00 hours.

Explain why the diameter was less at 12.00 hours.

_____

_____

_____

_____

_____

(2)

(c) Arteries and arterioles take blood away from the heart.

Explain how the structures of the walls of arteries and arterioles are related to their functions.

_____

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_____

(6)

(Total 15 marks)

Q48.

Read the following passage.

Some foods contain substances called flavenoids. Flavenoids lower blood cholesterol concentration and reduce the risk of developing coronary heart disease.

Some types of dark chocolate have a high concentration of flavenoids. One group of scientists investigated the effect of eating dark chocolate on the risk of developing coronary heart disease.

The scientists randomly divided healthy volunteers into two groups. Every day one group was given dark chocolate containing flavenoids to eat. The other group acted as a control.

The scientists measured the diameter of the lumen of the main artery in the arms of the volunteers every week. At the end of a month, the diameter of the lumen of the main artery in the arm of the volunteers who had eaten

dark chocolate containing flavenoids had increased.

Use information from the passage and your own knowledge to answer the questions.

(a) (i) The scientists used healthy volunteers in this investigation (line 7). Why was it important that the volunteers were healthy?

_____

_____

_____

(1)

(ii) The scientists randomly divided the volunteers into two groups (line 7). Explain why they divided them randomly.

_____

_____

(1)

(b) (i) Describe how the control group should have been treated.

_____

_____

_____

_____

(2)

(ii) Why was it important to have a control group in this investigation?

_____

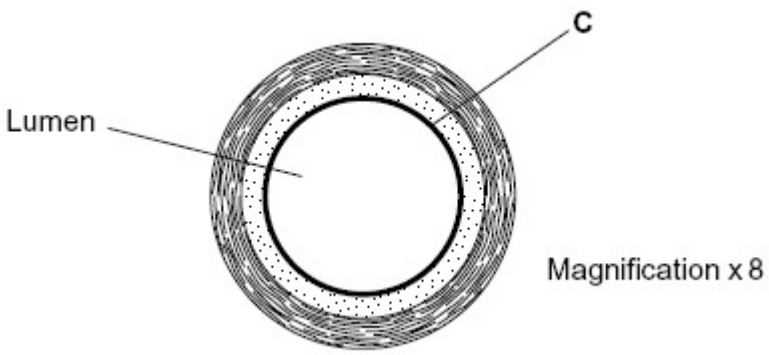
_____

(1)

(Total 5 marks)

Q49.

The diagram shows a cross-section of a blood vessel.



(a) Name layer **C**.

_____

(1)

(b) Calculate the actual diameter of the lumen of this blood vessel in millimetres. Show your working.

Answer _____ mm

(2)

(c) The aorta has many elastic fibres in its wall. An arteriole has many muscle fibres in its wall.

(i) Explain the importance of elastic fibres in the wall of the aorta.

_____

_____

_____

_____

(2)

(ii) Explain the importance of muscle fibres in the wall of an arteriole.

_____

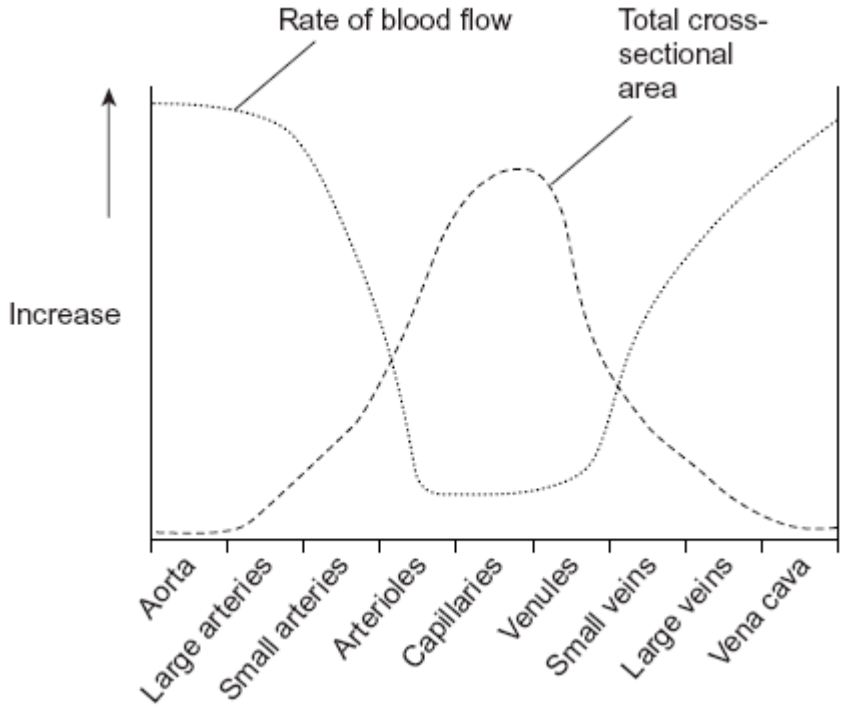
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_____

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(2)

(d) The graph shows the rate of blood flow in different blood vessels. It also shows the total cross-sectional area of these blood vessels.



(i) The rate of blood flow decreases from the aorta to the capillaries. Use information from the graph to explain why.

_____

_____

_____

(1)

(ii) Efficient exchange of substances in the capillaries is linked to the rate of blood flow. Explain how.

_____

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_____

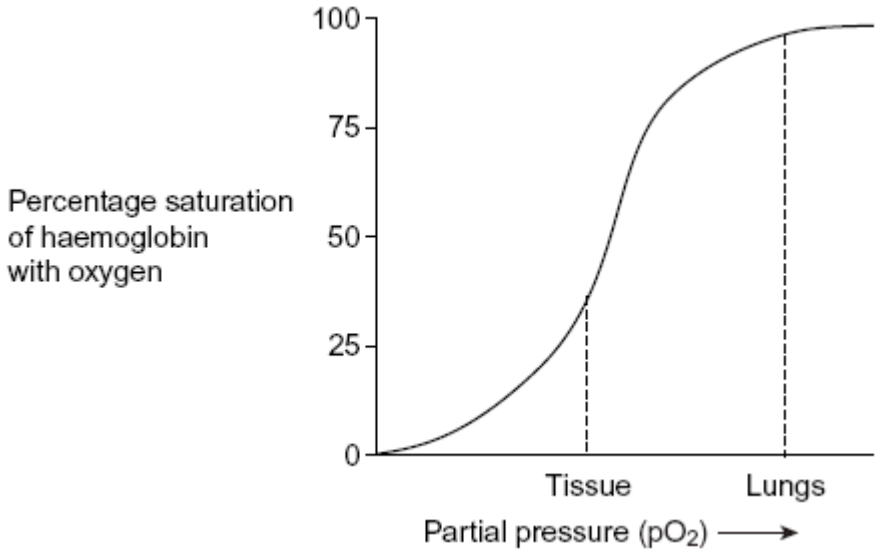
(1)

(Total 9 marks)

Q50.

(a) **Figure 1** shows the oxygen dissociation curve for human haemoglobin.

Figure 1



Use **Figure 1** to describe how haemoglobin loads and unloads oxygen in the body.

_____

_____

_____

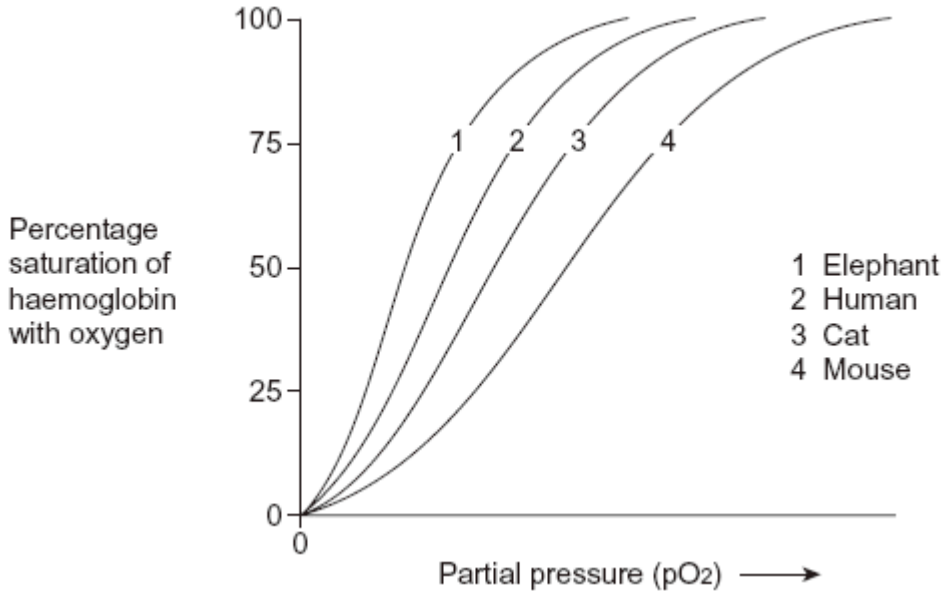
_____

_____

(3)

(b) **Figure 2** shows oxygen dissociation curves from mammals of different size.

Figure 2



(i) Describe the relationship between the size of mammals and the oxygen dissociation curves of their haemoglobins.

_____

_____

(1)

(ii) Heat from respiration helps mammals to maintain a constant body temperature.

Use this information to explain the relationship between the surface area to volume ratio of mammals and the oxygen dissociation curves of their haemoglobins.

_____

_____

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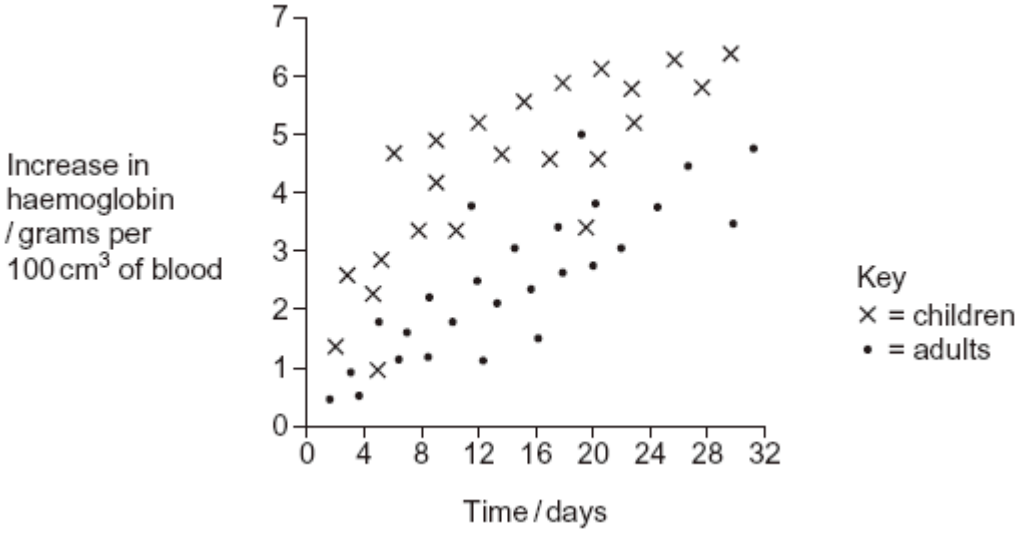
(4)

(Total 8 marks)

Q51.

(a) Haemoglobin contains iron. One type of anaemia is caused by a lack of iron. This type of anaemia can be treated by taking tablets containing iron. A number of patients were given a daily dose of 120 mg of iron. **Figure 1** shows the effect of this treatment on the increase in the concentration of haemoglobin in their red blood cells.

Figure 1



(i) Give **one** difference in the response of adults and children to this treatment.

_____

_____

(1)

(ii) You could use the graph to predict the effect of this treatment on the increase in haemoglobin content of an adult after 40 days. Explain how.

_____

_____

_____

_____

(2)

(iii) Haemoglobin has a quaternary structure. Explain what is meant by a quaternary structure.

_____

_____

(1)

(b) (i) Pernicious anaemia is another type of anaemia. One method of identifying pernicious anaemia is to measure the diameter of the red blood cells in a sample of blood that has been diluted with an isotonic salt solution. Explain why an isotonic salt solution is used to dilute the blood sample.

_____

_____

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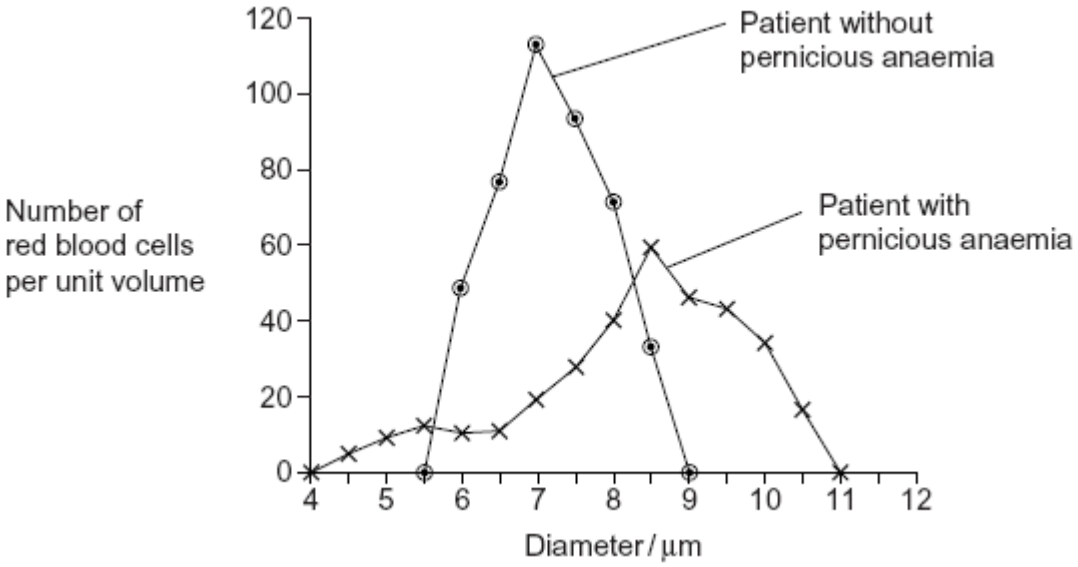
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(3)

(ii) A technician compared the red blood cells in two blood samples of equal volume. One sample was from a patient with pernicious anaemia, the other was from a patient who did not have pernicious anaemia. **Figure 2** shows some of the results she obtained.

Figure 2



Describe **two** differences between the blood samples.

1. _____

_____

2. _____

_____

(2)

(Total 9 marks)

Q52.

Scientists fed different diets to three groups of monkeys of different ages. They fed half the monkeys in each age group a diet in which all the triglycerides were saturated and half on a diet in which all the triglycerides were unsaturated. All other aspects of the diets and living conditions were kept as similar as possible. The scientists measured the plasma cholesterol concentration of the monkeys. The table below shows their results.

Age group / months	Type of triglyceride in diet	Number of monkeys in group	Mean plasma cholesterol concentration /mmol dm^{-3} (± standard deviation)
16	Saturated	10	8.45 (± 1.96)
32	Saturated	8	9.75 (± 2.60)
60	Saturated	12	10.42 (± 4.12)
16	Unsaturated	9	6.59 (± 1.56)
32	Unsaturated	8	7.24 (± 2.60)
60	Unsaturated	11	8.84 (± 2.32)

(a) The scientists concluded that a diet high in saturated triglyceride raises the concentration of blood plasma cholesterol. Evaluate their conclusion.

_____

_____

_____

_____

_____

_____

(3)

(b) The monkeys in this investigation were all of the same sex.
Explain how selecting monkeys of the same sex would help the scientists to draw reliable conclusions.

_____

_____

_____

_____

_____

(2)

(c) Is the research described relevant to human health? Explain your answer.

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q53.

The cardiac cycle is controlled by the sinoatrial node (SAN) and the atrioventricular node (AVN).

Describe how.

_____

_____

_____

_____

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_____

(Total 5 marks)

Q54.

(a) An increase in respiration in the tissues of a mammal affects the oxygen dissociation curve of haemoglobin. Describe and explain how.

_____

_____

_____

_____

(2)

(b) There is less oxygen at high altitudes than at sea level.

(i) People living at high altitudes have more red blood cells than people living at sea level. Explain the advantage of this to people living at high altitude.

_____

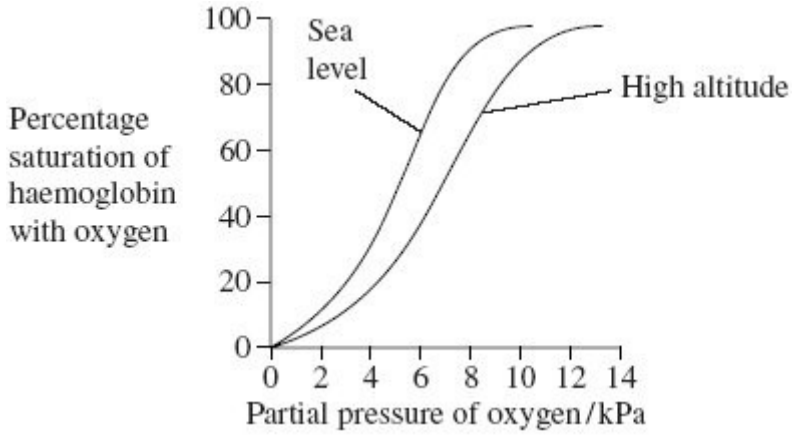
_____

_____

_____

(2)

(ii) The graph shows oxygen dissociation curves for people living at high altitude and for people living at sea level.



Explain the advantage to people living at high altitude of having the oxygen dissociation curve shown in the graph.

_____

_____

_____

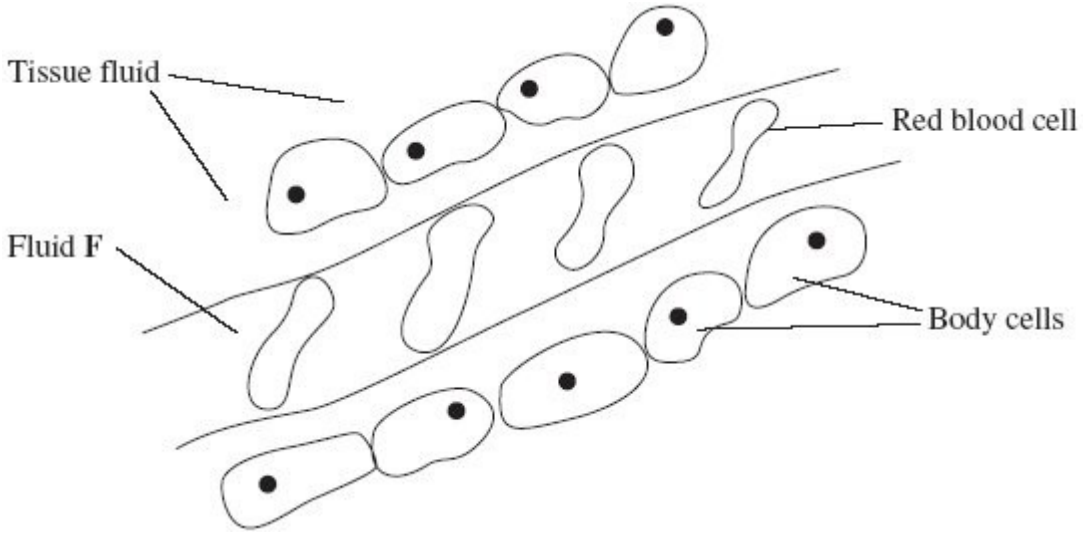
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(2)

(Total 6 marks)

Q55.

The diagram shows tissue fluid and cells surrounding a capillary.



(a) Name fluid **F**.

_____

(1)

(b) Give **one** way in which fluid **F** is different from tissue fluid.

_____

(1)

(c) (i) The blood pressure is high at the start of the capillary. Explain how the left ventricle causes the blood to be at high pressure.

_____

_____

(1)

(ii) The blood pressure decreases along the length of the capillary. What causes this decrease in pressure?

_____

_____

(1)

(d) In children, some diets may result in a low concentration of protein in fluid **F**. This can cause the accumulation of tissue fluid. Explain the link between a low concentration of protein in fluid **F** and the accumulation of tissue fluid.

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q56.

(a) The sinoatrial node (SAN) is in the right atrium of the heart. Describe the role of the sinoatrial node.

_____

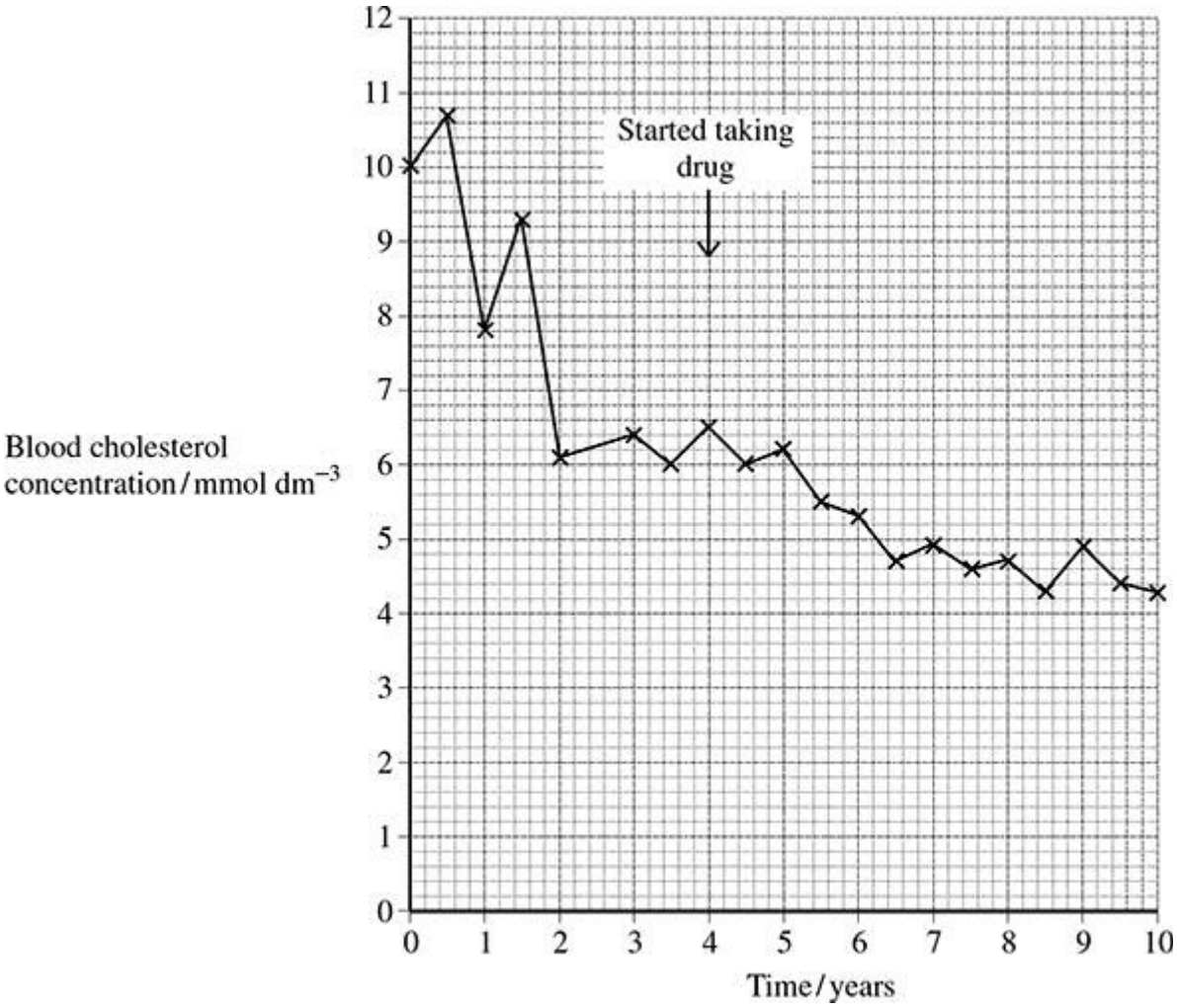
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(2)

Ten years ago, a woman was found to have a high concentration of cholesterol in her blood. As a result, she was put on a special diet. She has been on this diet ever since. Four years after starting the diet, she started taking a drug to lower her blood cholesterol. The graph shows the concentration of cholesterol in her blood over the ten-year period.



(b) Describe how the concentration of cholesterol in her blood changed over the ten-year period.

_____

_____

_____

_____

_____

(2)

(c) Explain the overall change in cholesterol concentration in the blood in the first two years.

_____

_____

_____

_____

_____

(2)

(d) Use the graph to evaluate the success of the special diet and of the drug in reducing the risk of coronary heart disease.

_____

_____

_____

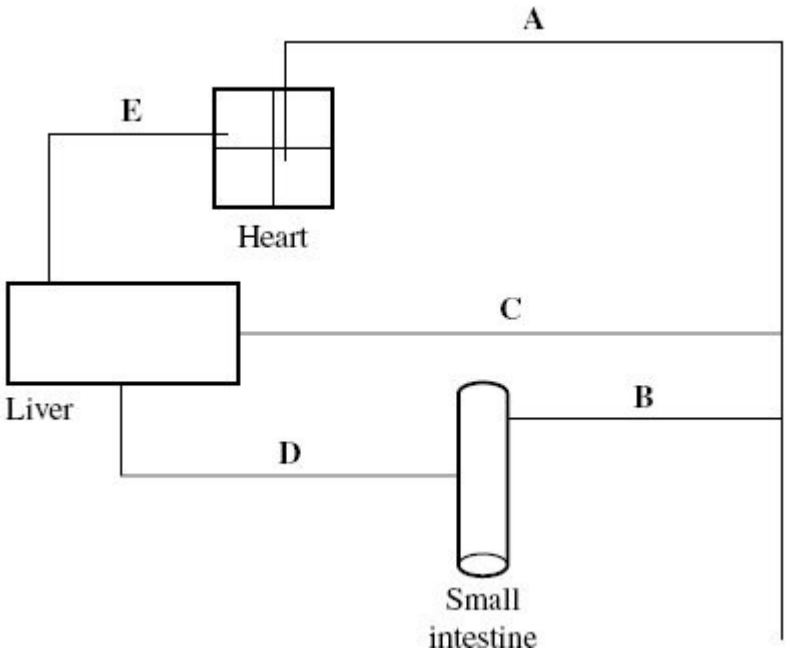
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(2)

(Total 8 marks)

Q57.

The diagram shows some of the large blood vessels in a mammal.



(a) Add arrows to the diagram to show the direction of blood flow in each of the blood vessels **A** to **E**.

(1)

(b) Which of blood vessels **A** to **E** contains blood at the lowest pressure?

☐

(1)

(c) Complete the table to show **two** differences between the structure of vessel **C** and the structure of vessel **E**.

Structural feature	Vessel C	Vessel E

(2)

(d) Blood vessel **B** contains smooth muscle in its walls. Explain how this muscle may reduce the blood flow to the small intestine.

_____

_____

_____

_____

(2)

(e) Elastic tissue in the walls of blood vessel **A** helps to even out the pressure of blood through this vessel. Explain how.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q58.

(a) A fish uses its gills to absorb oxygen from water. Explain how the gills of a fish are adapted for efficient gas exchange.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

Mackerel live in the surface waters of the sea. Toadfish live on the seabed in deep water.

(b) The concentration of oxygen is higher in the surface waters than it is in water close to the seabed. Suggest why.

_____

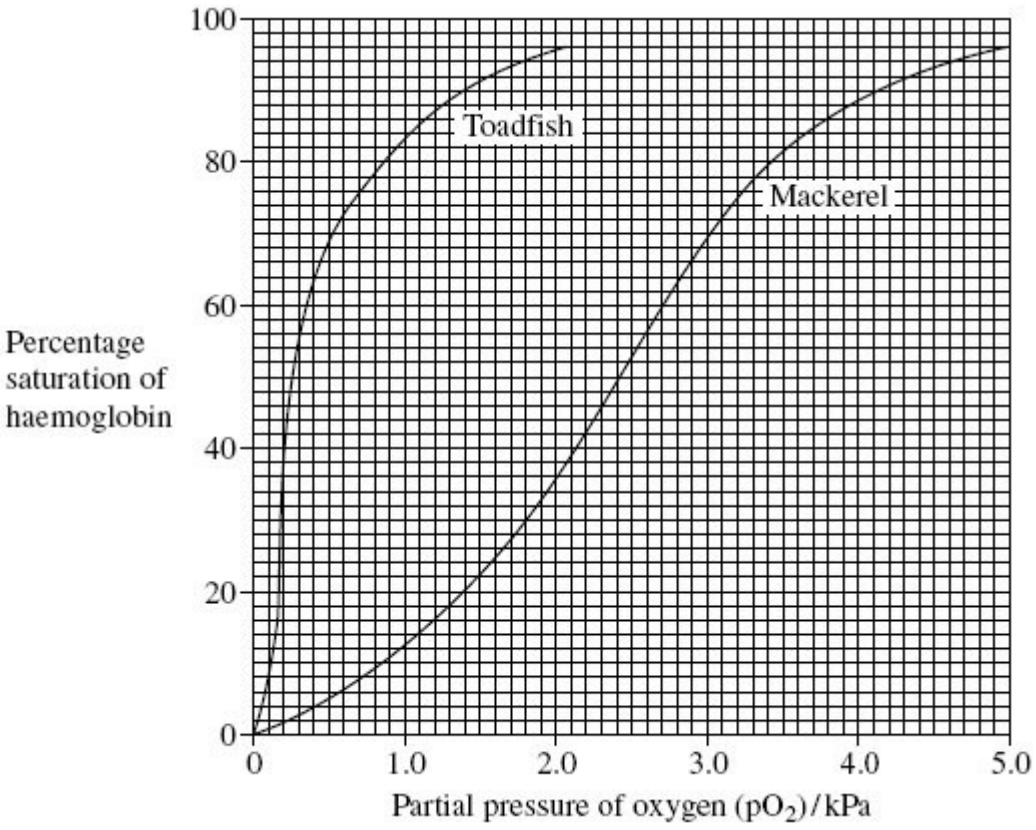
_____

_____

_____

(2)

(c) The graph shows oxygen dissociation curves for toadfish haemoglobin and for mackerel haemoglobin.



Explain how the shape of the curve for toadfish haemoglobin is related to where the toadfish is normally found.

_____

_____

_____

_____

(2)

(d) Scientists analysed the sequence of amino acids in one polypeptide chain in the haemoglobin of four different species of ape. The only difference they found affected the amino acids at three positions in the polypeptide chain. Their results are shown in the table. The letters are abbreviations for particular amino acids.

Species	Position 87	Position 104	Position 125
Chimpanzee	T	R	P
Bonobo	T	R	P
Gorilla	T	K	P
Orang utan	K	R	Q

What information do the data in the table suggest about the relationships between the chimpanzee, the bonobo and the gorilla? Explain your answer.

_____

_____

_____

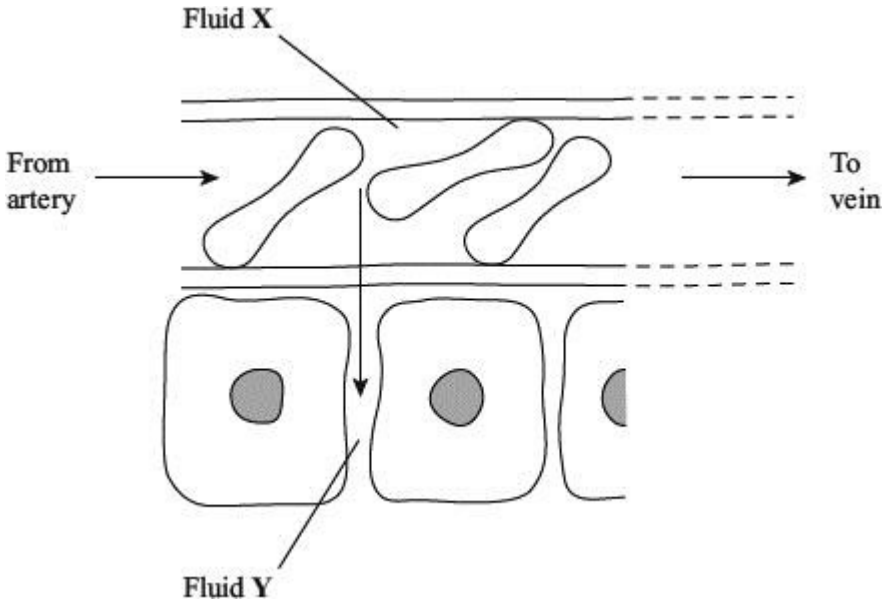
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(2)

(Total 12 marks)

Q59.

The diagram shows part of a capillary and some of the cells surrounding it.



(a) Name

(i) fluid **X**,

_____

(1)

(ii) fluid **Y**

_____

(1)

(b) Describe and explain **one** way in which the composition of fluid **Y** differs from that of fluid **X**.

_____

_____

_____

_____

(2)

(c) Explain how fluid leaves the capillary at the arterial end.

_____

_____

_____

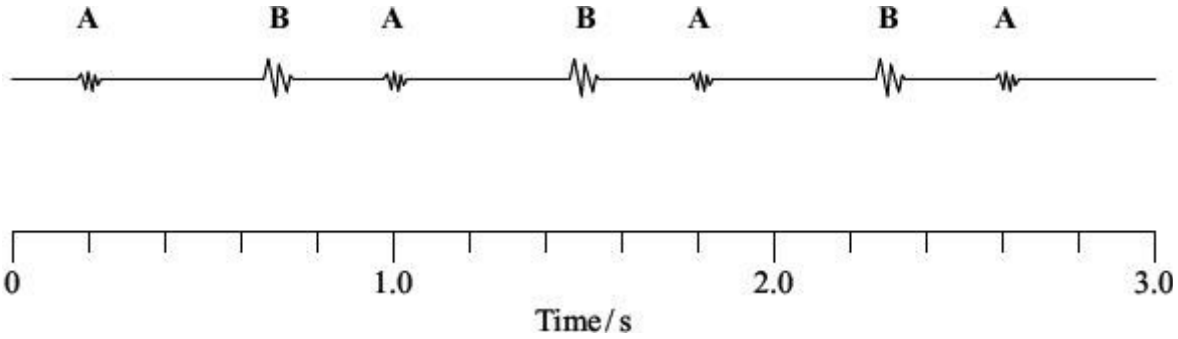
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(2)

(Total 6 marks)

Q60.

When a stethoscope is placed on the chest wall, sounds are heard as the heart beats. These heart sounds are caused by valves shutting. The diagram shows the heart sounds from a resting person.



(a) (i) The sounds labelled **A** on the diagram are made by the closing of the valves at the entrance to the arteries. What makes the sounds labelled **B**?

_____

_____

(1)

(ii) Explain what causes the valve to shut when sound **A** is heard.

_____

_____

(1)

(b) In this person, the stroke volume is 70 cm^3. Calculate the cardiac output. Show your working.

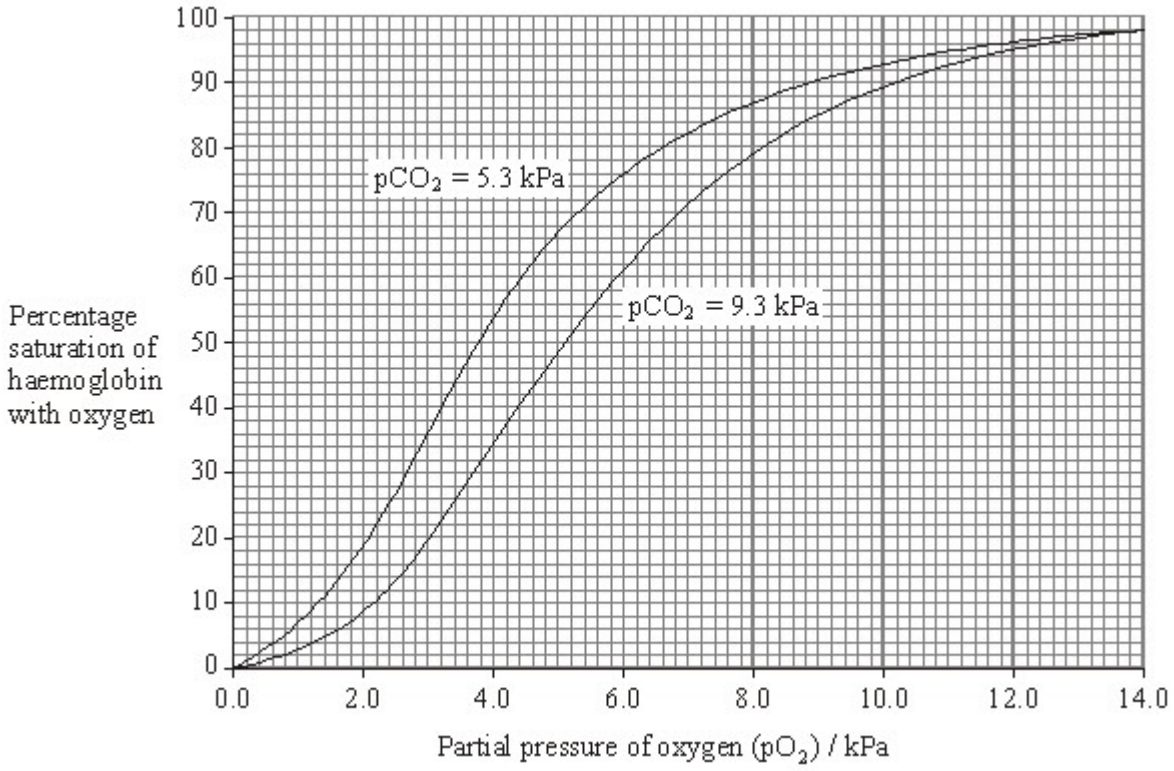
Cardiac output _____ cm^3 per minute

(3)

(Total 5 marks)

Q61.

The graph shows the oxyhaemoglobin dissociation curve at two different partial pressures of carbon dioxide (pCO_2).



(a) During vigorous exercise, the blood entering a leg muscle had a pO_2 of 4 kPa and a pCO_2 of 5.3 kPa. The blood leaving the muscle had a pO_2 of 2.8 kPa and a pCO_2 of 9.3 kPa. Each dm^3 of blood leaving the lungs contained 200 cm^3 oxygen and was 98% saturated with oxygen.

Use this information and information from the graph to calculate the volume of oxygen released to the muscle from 1 dm^3 of blood. Show your working.

Answer _____ cm^3 oxygen

(2)

(b) The blood leaving a muscle has a lower pH than the blood entering it. During vigorous exercise, the fall in pH is even greater. Explain what causes this greater fall in pH.

_____

_____

_____

_____

_____

_____

(3)

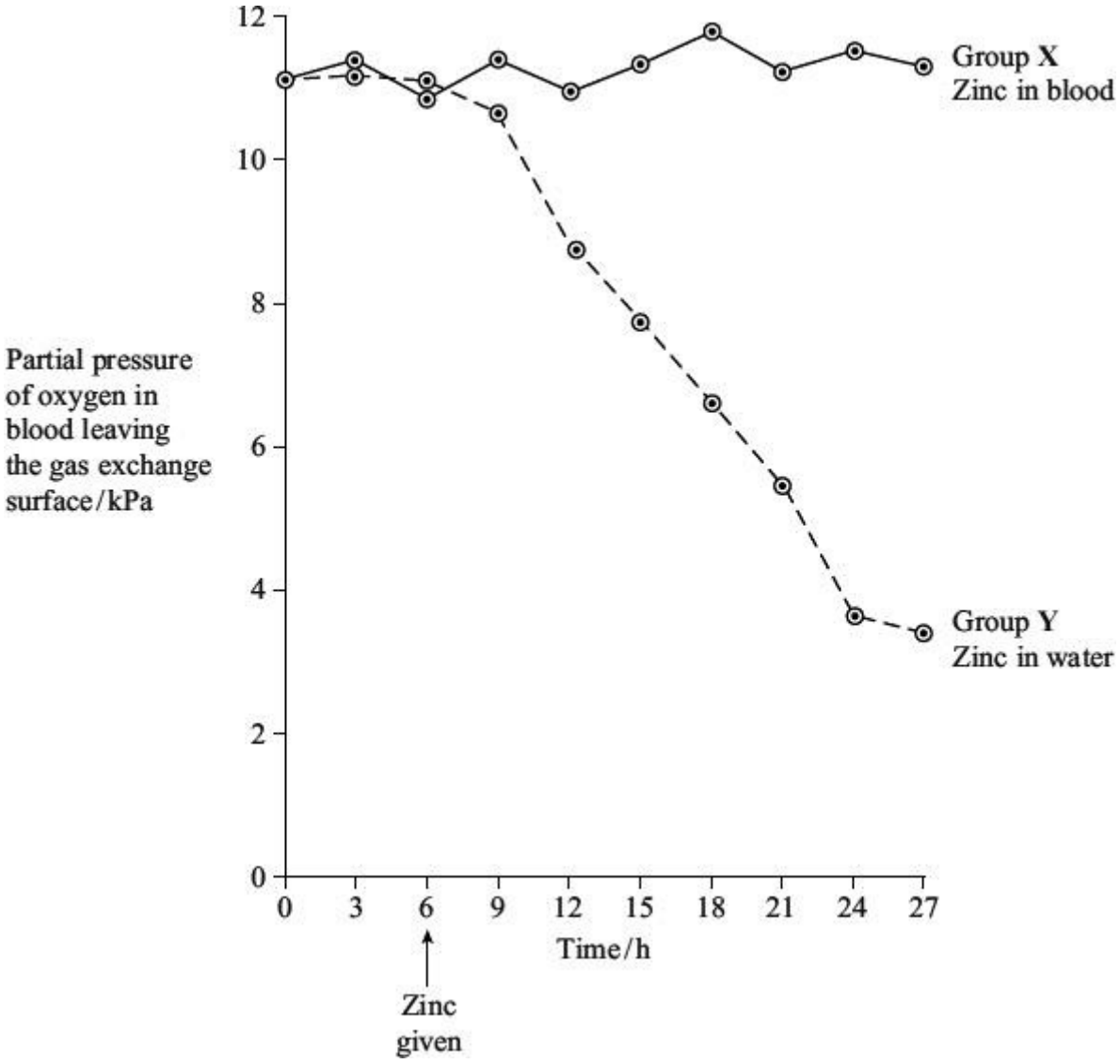
(Total 5 marks)

Q62.

Ions of metals such as zinc often pollute rivers. The effect of zinc ions on gas exchange and respiration in fish was investigated. Fish were kept in tanks of water in a laboratory.

The fish in one group (**X**) had a solution of a zinc compound injected directly into their blood and were then put in a tank of zinc-free water. A second group (**Y**) was not injected but had the solution of the zinc compound added to the water in the tank.

The partial pressure of oxygen in the blood of both groups of fish was then monitored. The results are shown in the graph.



(a) During this investigation, the water temperature in the tanks was kept constant. Explain why changes in the water temperature might lead to the results of the investigation being unreliable.

_____

_____

(1)

(b) The results from the two groups were compared using a statistical test.

(i) Suggest a null hypothesis that could be tested.

_____

(1)

(ii) Explain why it is important to use a statistical test in analysing the results of this investigation.

_____

_____

_____

_____

(2)

(c) Two suggestions were made to explain the results shown in the graph.

A Zinc ions reduce the rate at which oxygen is taken up from the water and passes into the blood.

B Zinc ions reduce the ability of haemoglobin to transport oxygen.

Which of these suggestions is the more likely? Explain the evidence from the graph that supports your answer.

_____

_____

_____

_____

(2)

(d) During the investigation, the pH of the blood was also monitored. It decreased in group **Y**. Suggest an explanation for this decrease in pH.

_____

_____

_____

_____

_____

_____

(3)

(e) Leaves were collected from sycamore trees growing in a polluted wood and the concentration of some metal ions in samples of these leaves was measured. Woodlice were then fed with the leaves. After 20 weeks, the concentration of the ions in the bodies of the woodlice was measured. Some of the results are shown in the table.

	Concentration of ions / μg g^{-1}			
	Copper	Cadmium	Zinc	Lead
Leaves	52	26	1430	908
Woodlice	1130	525	1370	132

(i) Which of the elements shown in the table is concentrated most by the woodlice? Use suitable calculations to support your answer.

(2)

(ii) Suggest what happens to most of the lead ions in the leaves eaten by the woodlice.

_____

_____

(1)

(iii) Explain the difference in the copper ion concentration between the leaves and the woodlice.

_____

_____

_____

_____

(2)

(f) Yorkshire fog is a species of grass. Two varieties of Yorkshire fog were studied. One variety was tolerant to arsenic, while the other variety was not. In a series of investigations, it was found that

- Arsenic-tolerant plants grow in soil which contains a high concentration of arsenic.
- Arsenic-tolerant plants growing in soil containing high concentrations of arsenic and phosphorus-containing compounds have very low concentrations of arsenic in their cells. They also have low concentrations of phosphates in their cells. Arsenic and phosphorus are chemically similar.
- Plants that are not tolerant to arsenic grow poorly on soil which has a high concentration of both arsenic and phosphorus-containing compounds.
- Tolerance to arsenic in Yorkshire fog is caused by a single gene with the allele, **a**, for tolerance recessive to the allele, **A**, for non-tolerance.

(i) What caused the allele for tolerance to first arise?

_____

_____

(1)

(ii) Give **two** functions of phosphates in plant cells.

1. _____

_____

2. _____

_____

(2)

(iii) Arsenic-tolerant Yorkshire fog plants are very rare in areas with low concentrations of arsenic in the soil, even where the soil has a high concentration of phosphate. Explain why they are unable to compete in these conditions with plants that are not tolerant to arsenic.

_____

_____

_____

_____

_____

_____

(3)

(Total 20 marks)

Q63.

Seals are mammals. They spend much of the time in water but have lungs and breathe air. When a seal is resting at the surface of the water, the blood flow to each gram of swimming muscles is 0.21 cm^3 per minute. When it is swimming under water, the blood flow to different organs changes. The flow to the swimming muscles is then 0.05 cm^3 per gram per minute.

(a) Describe the part played by arterioles in redistributing blood to different organs.

_____

_____

_____

_____

(2)

(b) (i) Describe how the change in blood flow to the muscles of a seal differs from the change in blood flow to human muscles as activity increases.

_____

_____

(1)

(ii) Suggest the advantage to the seal of the change in blood flow to the muscles.

_____

_____

_____

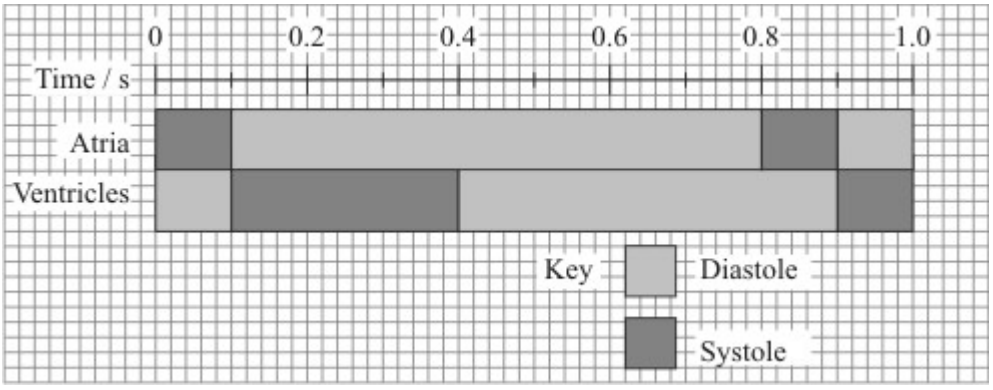
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(2)

(Total 5 marks)

Q64.

Relaxation of heart muscle is called diastole. Contraction is called systole. The diagram shows the periods of diastole and systole when the heart is beating.



(a) At what time is the volume of blood in the ventricle at a maximum?

_____

(1)

(b) Calculate the heart rate in beats per minute. Show your working.

Heart rate = _____ beats per minute

(2)

(c) The valves between the atria and the ventricles are closed between 0.1 s and 0.4 s.

(i) Explain how pressure causes these valves to be shut.

_____

_____

(1)

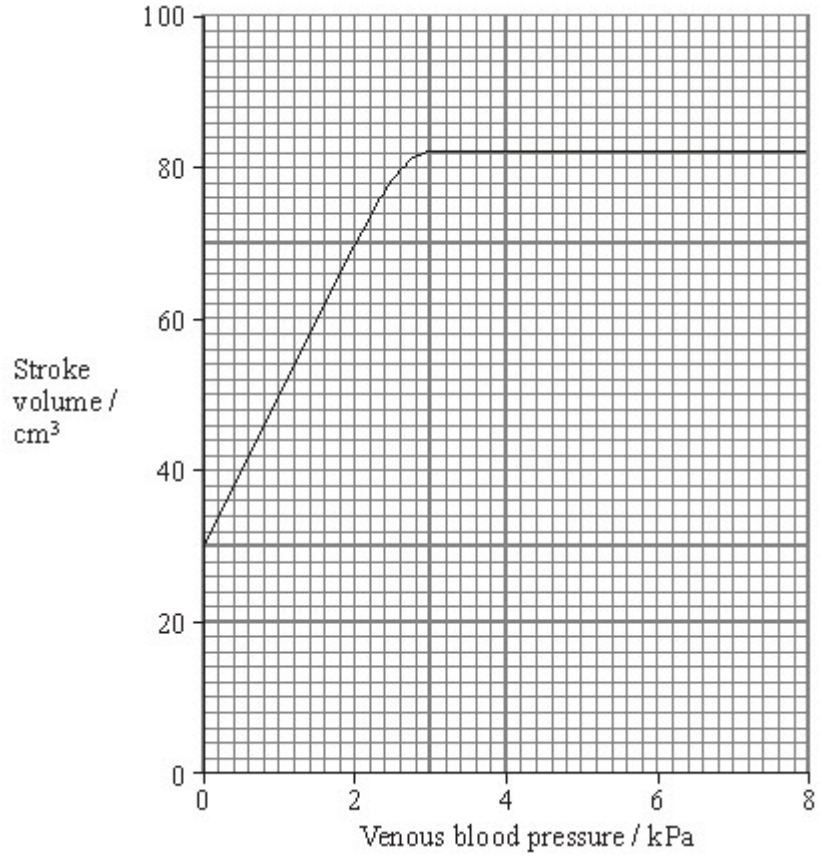
(ii) Explain how closure of these valves is essential to the functioning of the heart.

_____

_____

(1)

The graph shows the effect of the pressure of blood in the veins on the stroke volume of the heart.



(d) Describe how venous blood pressure affects stroke volume.

_____

_____

_____

_____

(2)

(e) At a venous pressure of 2 kPa, the cardiac output is 5600 cm^3 per minute. Calculate the number of times the ventricle contracts in one minute. Show your working.

Answer _____

(2)

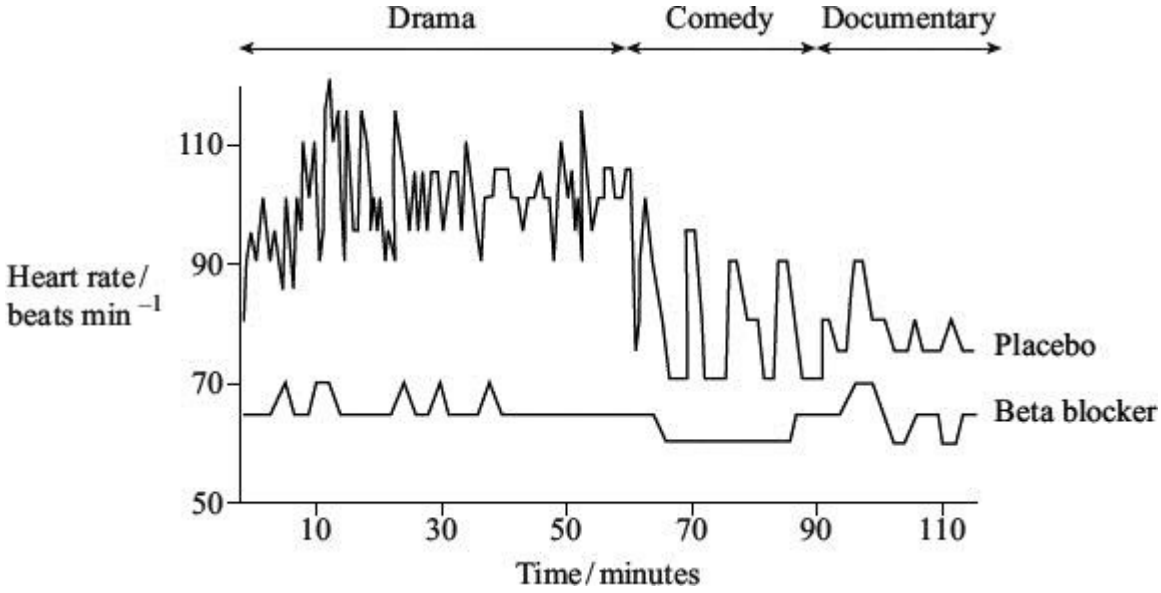
(f) Explain how blood in a vein in the leg is returned to the heart.

(6)

(Total 15 marks)

Q65.

(a) The graph shows the heart rates of two men with hypertension. They were watching television. One of the men had taken a beta blocker and the other had taken a placebo (dummy pill).



(i) Use the graph to describe the effects of the beta blocker on heart rate.

_____

_____

_____

_____

(2)

(ii) In this investigation, it was important that neither man knew which type of pill he had taken. Suggest why.

_____

_____

(1)

(b) The table shows the results of an investigation into the effects of prescribing beta blockers to patients who had suffered a myocardial infarction.

Patient age at time of myocardial infarction / years	Under 60	60 – 69
Percentage reduction in mortality within the next 2 years compared with groups who had taken a placebo	19	33

(i) Give **one** conclusion which may be drawn from these data.

_____

_____

(1)

(ii) Explain how the percentage reduction in mortality would have been calculated.

_____

_____

_____

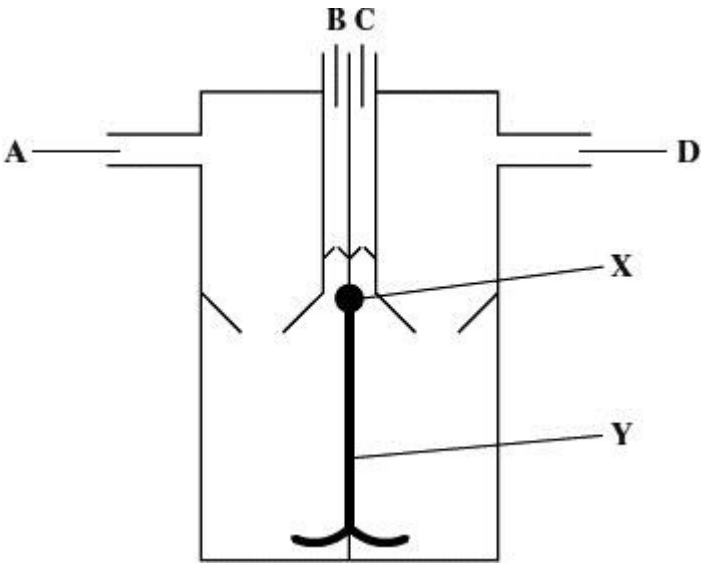
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(2)

(Total 6 marks)

Q66.

This diagram shows a human heart seen from the front.



(a) (i) Which **one or more** of vessels **A** to **D** contains oxygenated blood?

_____

(1)

(ii) During a cardiac cycle, the pressure of the blood in vessel **C** is higher than the pressure of the blood in vessel **B**. Explain what causes this difference in pressure.

_____

_____

(1)

(b) What does the diagram suggest about the pressure in the atria compared to the pressure in the ventricles at the stage in the cardiac cycle represented in the diagram? Explain your answer.

_____

_____

_____

_____

(2)

(c) The wave of electrical activity which coordinates the heart beat is delayed slightly at part **X**. It then passes along part **Y** to the base of the ventricles.

Explain the importance of

(i) the slight delay at part **X**;

_____

_____

_____

_____

(2)

(ii) the electrical activity being passed to the base of the ventricles.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q67.

The table shows the relative thickness of layers in the walls of an artery and a vein.

Layer in wall	Thickness / μm	
	Artery	**Vein**
Endothelium	20	20
Smooth muscle	490	240
Elastic tissue	370	240
Connective tissue	120	120

(a) Explain why a vein may be described as an organ.

_____

_____

(1)

(b) (i) Use information from the table to suggest the thickness of a capillary wall. Give the reason for your answer.

_____

_____

(1)

(ii) The diameter of the artery was 4 mm. Calculate the diameter of the lumen of this artery. Show your working.

Answer _____

(2)

(c) Explain how the elastic tissue in the wall helps to even out the pressure of blood flowing through the artery.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q68.

(a) The table shows some data for a shrew and an elephant.

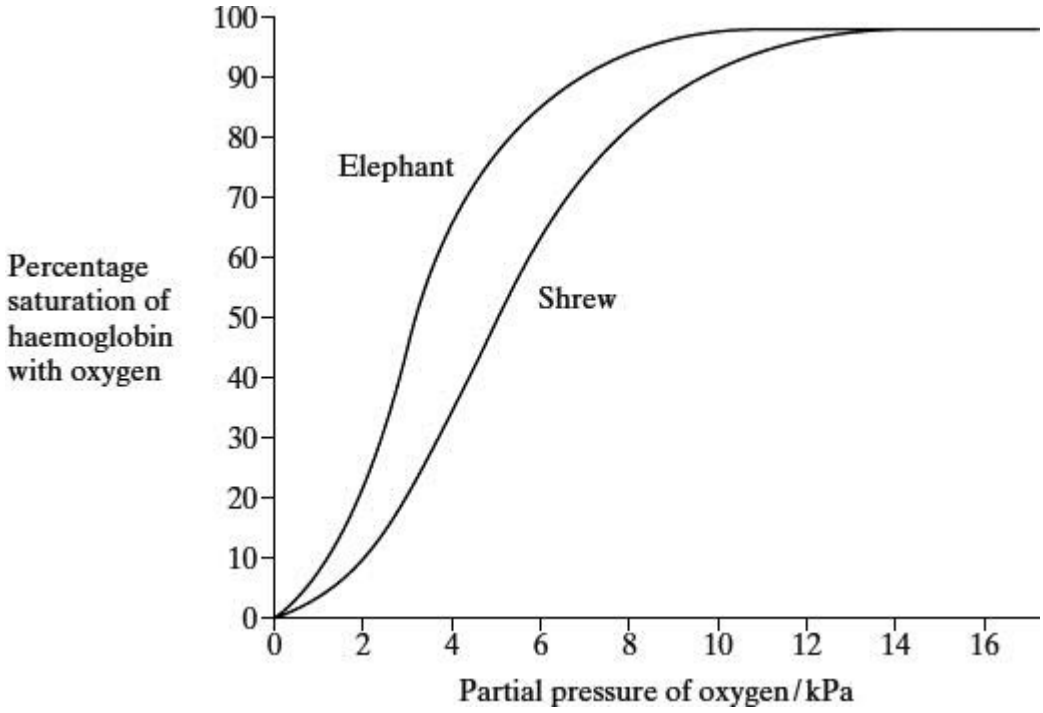
	Shrew	**Elephant**
Body mass	10 g	5000 kg
Volume of oxygen taken up per hour	20 cm^3	52.5 dm^3

The rate of oxygen uptake for the shrew is 2 $cm^3g^{-1}h^{-1}$. Calculate the volume of oxygen taken up per gram of body tissue per hour in the elephant.
Show your working.

Answer _____ $cm^3g^{-1}h^{-1}$

(2)

(b) The graph shows the oxyhaemoglobin dissociation curves for these mammals.



The tissues of the shrew have a higher rate of oxygen consumption per gram of body tissue than the elephant. There is an advantage to the shrew in having haemoglobin with a dissociation curve in the position shown. Explain this advantage.

_____

_____

_____

_____

_____

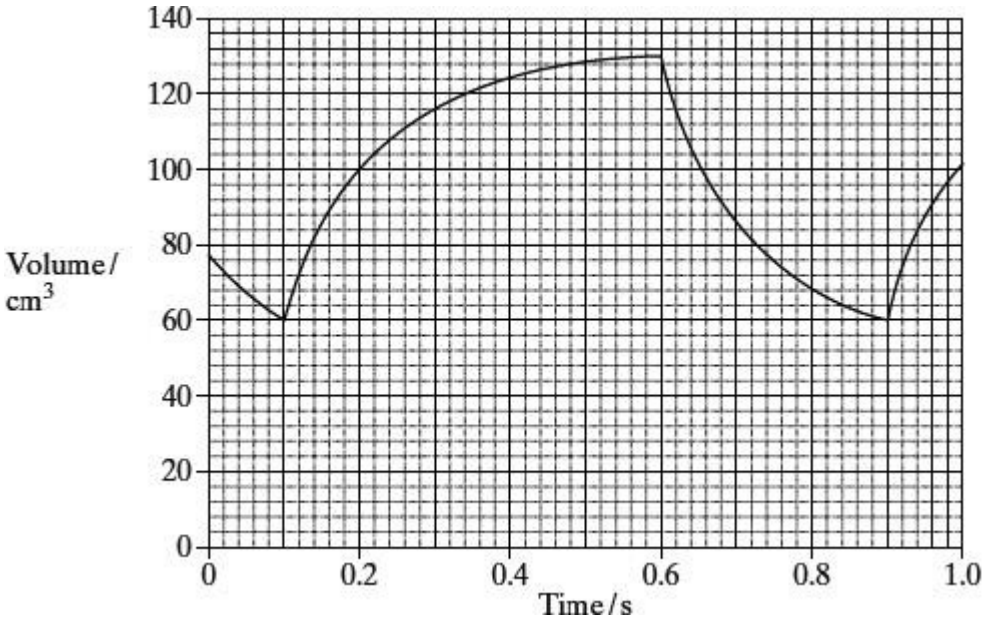
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(3)

(Total 5 marks)

Q69.

The graph shows changes in the volume of blood in the left ventricle.



(a) Between which times is the left *atrium* contracting? Give the evidence from the graph that supports your answer.

Times _____

Evidence _____

_____

(2)

(b) Use the graph to calculate.

(i) the heart rate;

Answer _____

(2)

(ii) stroke volume.

Answer _____

(1)

(c) Describe how you would calculate cardiac output from heart rate and stroke volume.

_____

_____

(1)

The table shows the rate of blood flow to some organs when a person is at rest and during a period of vigorous exercise.

Organ	Rate of blood flow / cm^3 $minute^{-1}$	
	at rest	during exercise
Skeletal muscles	1 000	16 000
Kidney	1 200	1 200
Brain	750	
Heart muscle	300	1 200

(d) Suggest a value for the rate of blood flow to the brain during exercise.

_____

(1)

(e) (i) The coronary arteries take blood to the muscles in the wall of the heart. Calculate the ratio of the rate of blood flow into the coronary arteries during exercise to the rate flowing into these arteries at rest.

Answer _____

(1)

(ii) At rest the rate of flow of blood to the heart muscle is 0.9 cm^3 g^{-1} per minute. Calculate the volume of blood 1g of heart muscle would receive in 5 minutes of vigorous exercise.

Answer _____

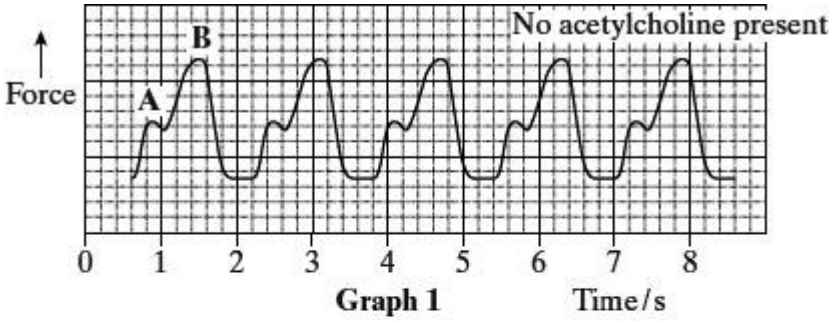
(1)

(Total 9 marks)

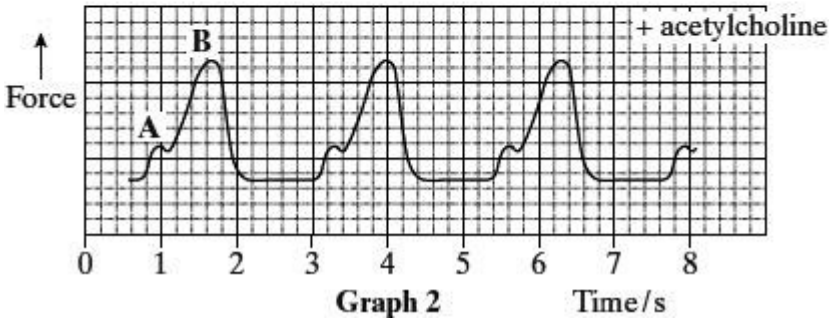
Q70.

A frog's heart was attached to an instrument which measured the force produced as the heart contracted. **Graph 1** shows the changes in force when the heart was bathed in a solution of salts at 20 °C. **Graph 2** shows the results when the heart was bathed in the

same solution at the same temperature, but including acetylcholine.



Graph 1



Graph 2

(a) Points **A** and **B** show when the atria and ventricle were contracting. Which point, **A** or **B**, shows contraction of the ventricle? Give **two** reasons for your answer.

Point _____

Reason 1 _____

_____

Reason 2 _____

_____

(2)

(b) Calculate the frog's heart rate when acetylcholine was **not** present. Show your working.

Heart rate = _____ beats per minute.

(2)

(c) (i) From the graphs, what can you conclude about the effect of acetylcholine on heart rate;

_____

stroke volume?

_____

(2)

(ii) Use your answer to part (i) to explain the effect of acetylcholine on cardiac output.

_____

_____

(1)

(iii) Addition of acetylcholine in the experiment mimics the effect of one branch of the autonomic nervous system. Which branch is this?

_____

(1)

(d) (i) Explain how nervous control in a human can cause increased cardiac output during exercise.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(ii) Explain why increased cardiac output is an advantage during exercise.

_____

_____

_____

_____

_____

_____

(3)

(Total 15 marks)

Q71.

(a) Explain how the shape of a red blood cell allows it to take up a large amount of oxygen in a short time.

_____

_____

_____

_____

(2)

Samples of blood were mixed with equal volumes of different liquids. A drop of each mixture was put on a slide and examined with an optical microscope. The table shows the appearance of each slide.

Slide	Liquid added	Appearance of slide
A	Distilled water	No cells seen. Slide appears a uniform pale red colour
B	Sucrose solution	Cells are smaller in diameter than in an untreated sample of blood
C	Detergent (dissolves lipids)	No cells seen. Slide appears a uniform pale red colour

(b) (i) What does the appearance of slide **B** tell you about the plasma membrane surrounding a red blood cell?

_____

_____

(1)

(ii) Explain the appearance of slide **C**.

_____

_____

_____

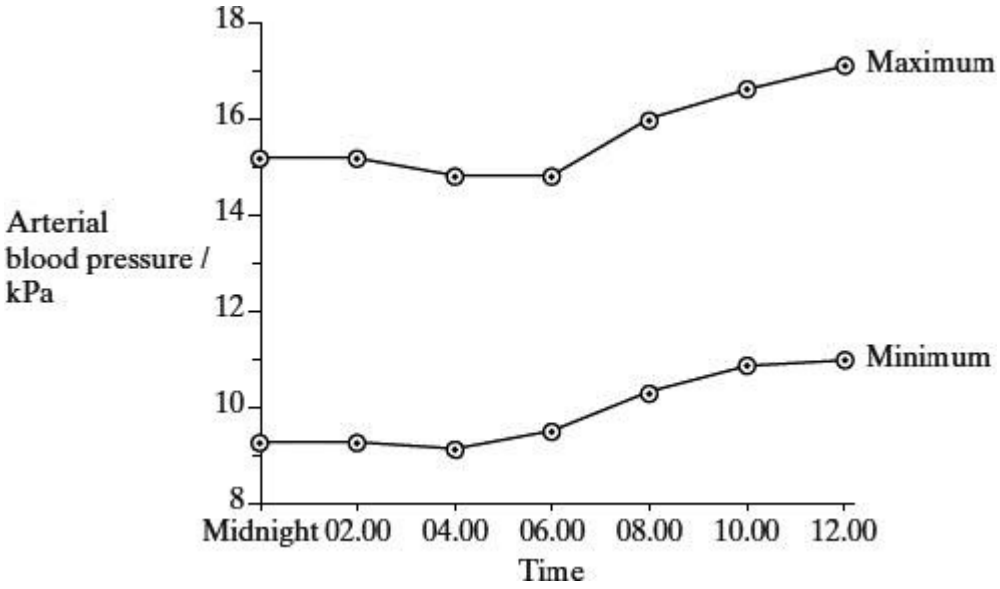
_____

(2)

(Total 5 marks)

Q72.

(a) The graph shows hourly blood pressure recordings from a group of 65 people.



(i) Describe how the mean maximum arterial blood pressure changes over the period shown in the graph.

_____

_____

(1)

(ii) In each cardiac cycle, the arterial pressure has a maximum value. Explain the link between this maximum value and the events of the cardiac cycle.

_____

_____

(1)

(iii) The recordings shown in this graph were taken from an artery. Describe **two** ways in which you would expect blood pressure in a vein to differ from that in an artery.

1 _____

_____

2 _____

_____

(2)

(b) Molecules of different substances differ in size. The relative molecular mass of a substance gives an indication of the size of its molecules. The table shows the relative permeability of the wall of a capillary to different molecules.

Substance	Relative molecular mass	Relative permeability of capillary wall
Water	18	1.00

Urea	60	0.96
Glucose	180	0.60
Haemoglobin	68 000	0.01
Albumin (plasma protein)	69 000	0
Globulin (plasma protein)	140 000	0

(i) Describe the relationship between molecule size and the permeability of the capillary wall.

_____

_____

_____

_____

(2)

(ii) The water potential of the plasma at the venule end of the capillary is more negative than the water potential at the arteriole end. Use the table to explain why.

_____

_____

_____

_____

(2)

(iii) Although the capillary walls are slightly permeable to haemoglobin molecules, there is no haemoglobin in the tissue fluid. Explain what causes the absence of haemoglobin in tissue fluid.

_____

_____

(1)

(Total 9 marks)

Q73.

(a) Haemoglobin is a protein with a quaternary structure. What is meant by a *quaternary* structure?

_____

_____

(1)

(b) Explain how oxygen in a red blood cell is made available for respiration in active tissues.

_____

_____

_____

_____

_____

_____

(3)

(c) Haemoglobin is broken down in the liver. One product of this breakdown is amino acids. Give **one** use in the body of these amino acids.

_____

_____

(1)

(Total 5 marks)

Q74.

(a) Tissue fluid is formed from blood plasma. Complete the table to show substances present in tissue fluid and blood plasma. Use a tick if the substance is present and a cross if it is absent.

	Substance		
	Glucose	**Sodium ions**	**Haemoglobin**
Tissue fluid			
Blood plasma			

(2)

(b) The hydrostatic pressure of the blood at the arteriole end of the capillary helps to form tissue fluid. Explain how.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q75.

The pressure of the blood in an artery was measured during a cardiac cycle. The minimum pressure was 9.6 kPa and the maximum pressure was 13.4 kPa.

(a) Describe how the increase in pressure of the blood in the artery results from the events in the cardiac cycle.

_____

_____

_____

_____

(2)

(b) The elastin fibres in the wall of the artery help to smooth out the flow of blood. What happens to these fibres as the pressure of the blood in the artery changes?

_____

_____

_____

_____

(2)

(c) Give **one** way in which the structure of the wall of an artery is similar to the structure of the wall of a capillary.

_____

_____

(1)

(Total 5 marks)

Q76.

(a) Explain why both the heart and arteries are described as organs.

_____

_____

(1)

The table shows changes in the volume of blood in the left ventricle over a period of one second.

Time / s	Volume of blood as percentage of maximum
0	70
0.1	100

0.2	70
0.3	30
0.4	0
0.5	35
0.6	60
0.7	70
0.8	70
0.9	100
1.0	70

Use information in the table to answer the following questions.

(b) What is the approximate length of one cardiac cycle?

_____

(1)

(c) At what time is there least blood in the *right* ventricle? Explain your answer.

_____

_____

(1)

(d) (i) Between which times are the muscles in the wall of the left atrium contracting?

Give the reason for your answer.

Times _____

Reason

_____

_____

(1)

(ii) Between which times are the semilunar valves in the arteries open? Give the reason for your answer.

Times _____

Reason

_____

_____

(1)

(e) The maximum volume of blood in the left ventricle is 45 cm^3. Calculate the volume of

blood in the left ventricle at 0.5 s. Show your working.

Volume of blood = _____ cm^3

(2)

(Total 7 marks)

Q77.

Lung cancer, chronic bronchitis and coronary heart disease (CHD) are associated with smoking. **Tables 1** and **2** give the total numbers of deaths from these diseases in the UK in 1974.

Table 1 Men

Age/years	**Number of deaths (in thousands)**		
	lung cancer	chronic bronchitis	coronary heart disease
35 - 64	11.5	4.2	31.7
65 - 74	12.6	8.5	33.3
75+	5.8	8.1	29.1
Total (35 - 75+)	29.9	20.8	94.1

Table 2 Women

Age/years	**Number of deaths (in thousands)**		
	lung cancer	chronic bronchitis	coronary heart disease
35 – 64	3.2	1.3	8.4
65 – 74	2.6	1.9	18.2
75+	1.8	3.5	42.3
Total (35 – 75+)	7.6	6.7	68.9

(i) Using an example from the tables, explain why it is useful to give data for men and women separately.

_____

_____

_____

(2)

(ii) Data like these are often given as percentages of people dying from each cause.

Explain the advantage of giving these data as percentages.

_____

_____

_____

_____

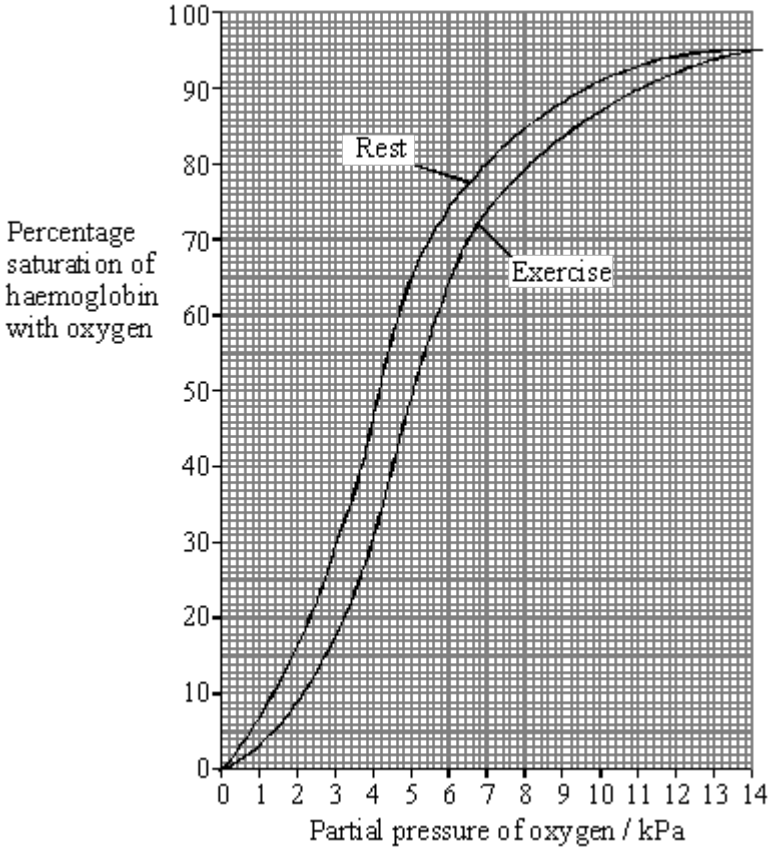
(2)

(Total 4 marks)

Q78.

The graph shows dissociation curves for human oxyhaemoglobin at rest and during exercise.

Table 1 gives information about conditions in the body at rest and during exercise.



	Rest	Exercise
Plasma pH	7.4	7.2
Blood temperature / °C	37.0	39.0

Alveolar partial pressure of oxygen / kPa	13.3	13.3
Tissue partial pressure of oxygen / kPa	5.0	4.0

Table 1

(a) What is meant by the term *partial pressure*?

_____

_____

(1)

(b) Use **Table 1** and the graph to calculate the difference in the percentage saturation of haemoglobin in the tissues between rest and exercise.

Answer _____ %

(1)

(c) Explain the differences between the figures shown in **Table 1** for rest and exercise.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) Explain the advantage of the difference in position of the dissociation curve during exercise.

_____

_____

_____

_____

(2)

Table 2 shows how the oxygen concentration in the blood going to and from a muscle changes from rest to heavy exercise.

		Oxygen concentration / cm^3 per 100 cm^3 blood	
		Blood in arteries	**Blood in veins**
At rest	**In solution**	0.3	0.2
	As oxyhaemoglobin	19.5	15.0
	Total oxygen	19.8	15.2
During heavy exercise	**In solution**	0.3	0.1
	As oxyhaemoglobin	20.9	5.3
	Total oxygen	21.2	5.4

Table 2

(e) By how many times is the volume of oxygen removed from the blood by the muscle in **Table 2** during heavy exercise greater than the volume removed at rest?

Show your working.

Answer _____ times

(2)

(f) Does enriching inspired air with oxygen have any effect on the amount of oxygen reaching the tissues? Support your answer with evidence from the graph and **Table 2**.

_____

_____

_____

_____

_____

_____

(3)

(g) The change to the dissociation curve is one of a number of ways in which the total oxygen supplied to muscles is increased during exercise. Give **two** other ways in which the total oxygen supplied to muscles during exercise is increased.

1. _____

_____

2. _____

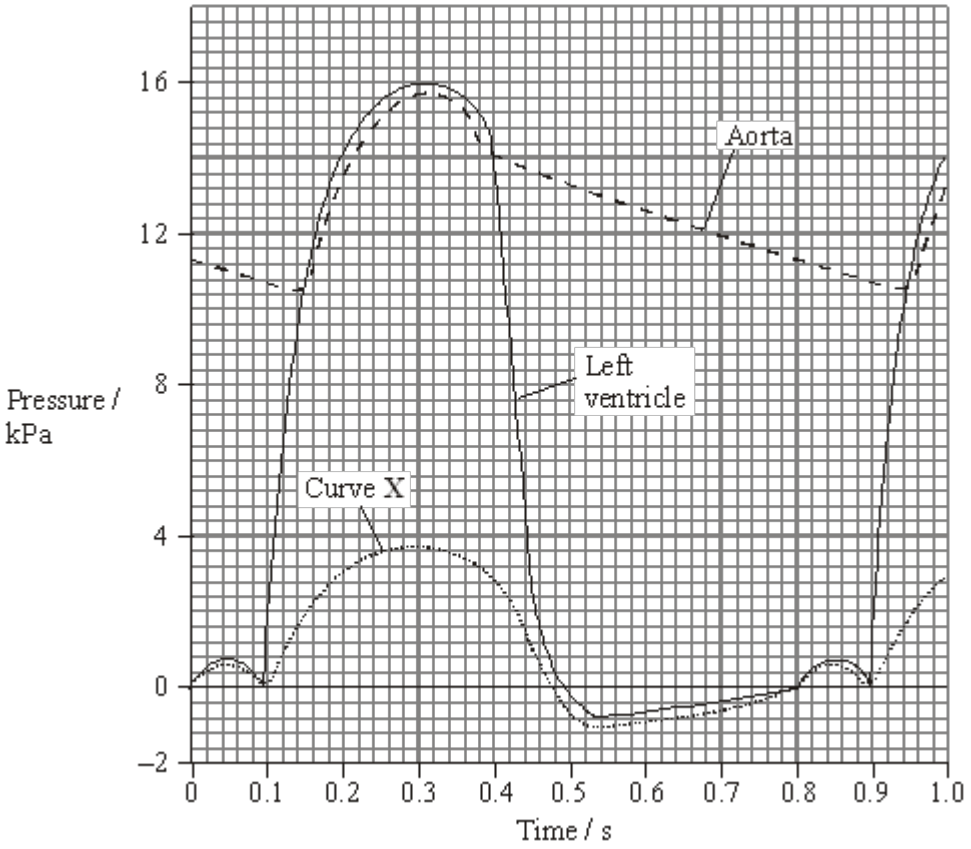
_____

(2)

(Total 15 marks)

Q79.

The graph shows changes in pressure in different parts of the heart during a period of one second.



(a) (i) At what time do the semilunar valves close?

_____

(1)

(ii) Use the graph to calculate the heart rate in beats per minute.

Show your working.

Answer _____ beats per minute

(1)

(iii) Use the graph to calculate the total time that blood flows out of the left side of the heart during one minute when beating at this rate. Show your working.

Answer _____ seconds

(1)

(b) What does curve **X** represent? Explain your answer.

X = _____

Explanation _____

_____

(2)

(c) The volume of blood pumped out of the left ventricle during one cardiac cycle is called the stroke volume.

The volume of blood pumped out of the left ventricle in one minute is called the cardiac output. It is calculated using the equation

Cardiac output = stroke volume × heart rate

After several months of training, an athlete had the same cardiac output but a lower resting heart rate than before. Explain this change.

_____

_____

_____

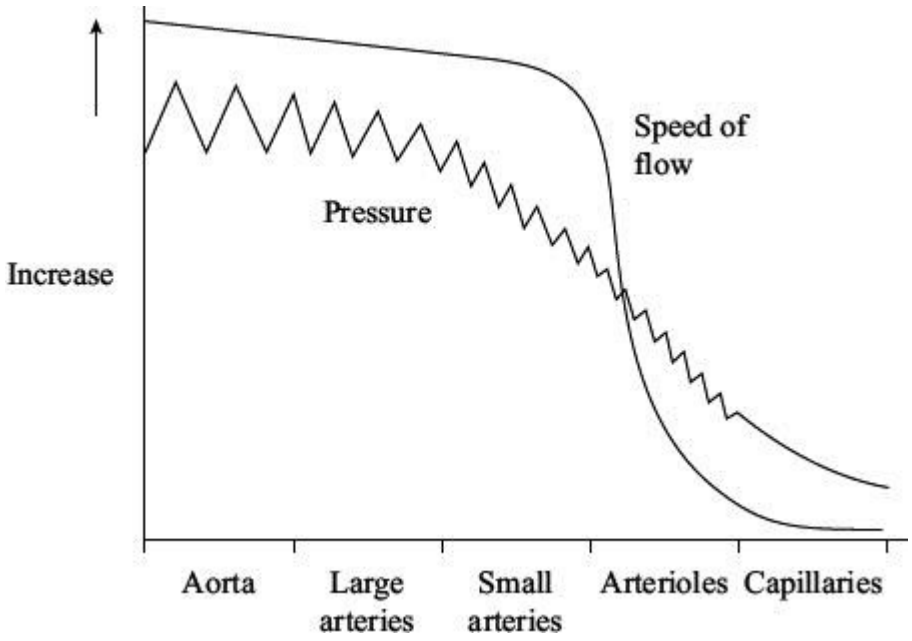
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(2)

(Total 7 marks)

Q80.

The chart shows the change in the speed of flow and pressure of blood from the start of the aorta into the capillaries.



(a) Describe and explain the changes in the speed of flow of the blood shown in the chart.

_____

_____

_____

_____

(2)

(b) Explain how the structure of the arteries reduces fluctuations in pressure.

_____

_____

_____

_____

(2)

(c) Explain how the structure of capillaries is related to their function.

_____

_____

_____

_____

(2)

(d) In one cardiac cycle, the volume of blood flowing out of the heart along the pulmonary artery is the same as the volume of blood returning along the pulmonary vein. Explain why the volumes are the same although the speed of flow in the artery is greater than in the vein.

_____

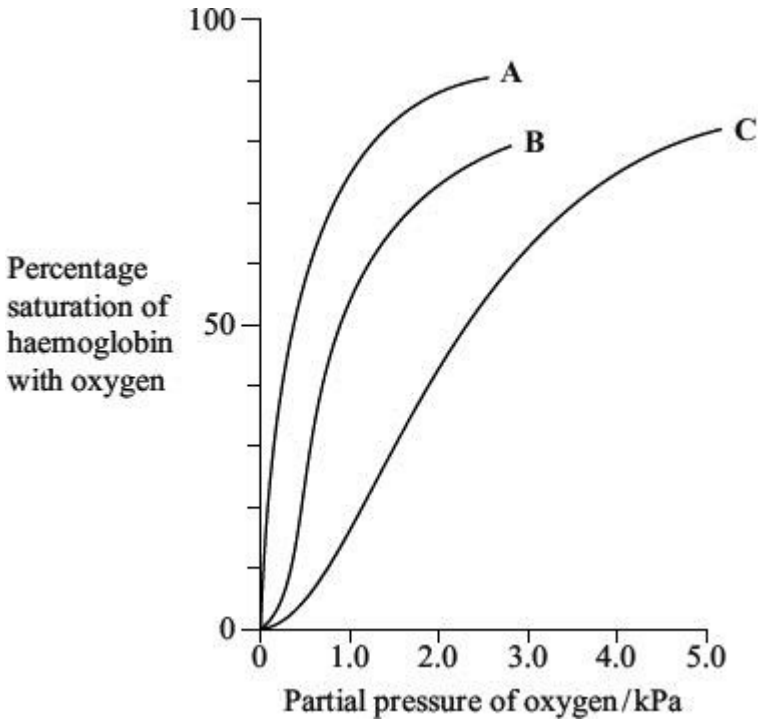
_____

(1)

(Total 7 marks)

Q81.

The graph shows the oxygen haemoglobin dissociation curves for three species of fish.



(a) Species **A** lives in water containing a low partial pressure of oxygen. Species **C** lives in water with a high partial pressure of oxygen. The oxygen haemoglobin dissociation curve for species **A** is to the left of the curve for species **C**. Explain the advantage to species **A** of having haemoglobin with a curve in this position.

_____

_____

_____

_____

_____

_____

(3)

(b) Species **A** and **B** live in the same place but **B** is more active. Suggest an advantage to **B** of having an oxygen haemoglobin dissociation curve to the right of that for **A**.

_____

_____

_____

_____

_____

(2)

(Total 5 marks)

Q82.

(a) Explain how a rise in blood pressure results in a decrease in the rate of heartbeat.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(b) Some drugs inhibit the transmission of nerve impulses to the heart. Explain how these drugs reduce high blood pressure.

_____

_____

_____

_____

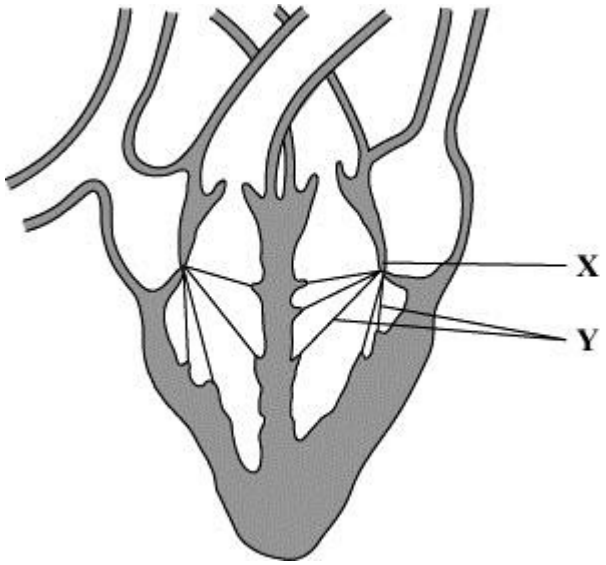
_____

(2)

(Total 8 marks)

Q83.

(a) The diagram shows a section through the heart at one stage of the cardiac cycle.



(i) Name the structure labelled **X**.

_____

(1)

(ii) Suggest how the structures labelled **Y** help to maintain the flow of blood in one direction through the heart.

_____

_____

_____

_____

(2)

(b) The chart shows the actions of the atria and the ventricles during a complete cardiac cycle. Different stages have been given letters and a time scale added.

	Stage		
	A	B	C
Atria	Contracting	Relaxing	
Ventricles	Relaxing	Contracting	Relaxing

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8

Time / seconds

(i) Give the letter of the stage which is shown in the diagram of the heart.

_____

(1)

(ii) The heart beats for one minute at the rate shown by the chart. Calculate the total time the ventricles are relaxed during one minute. Show your working.

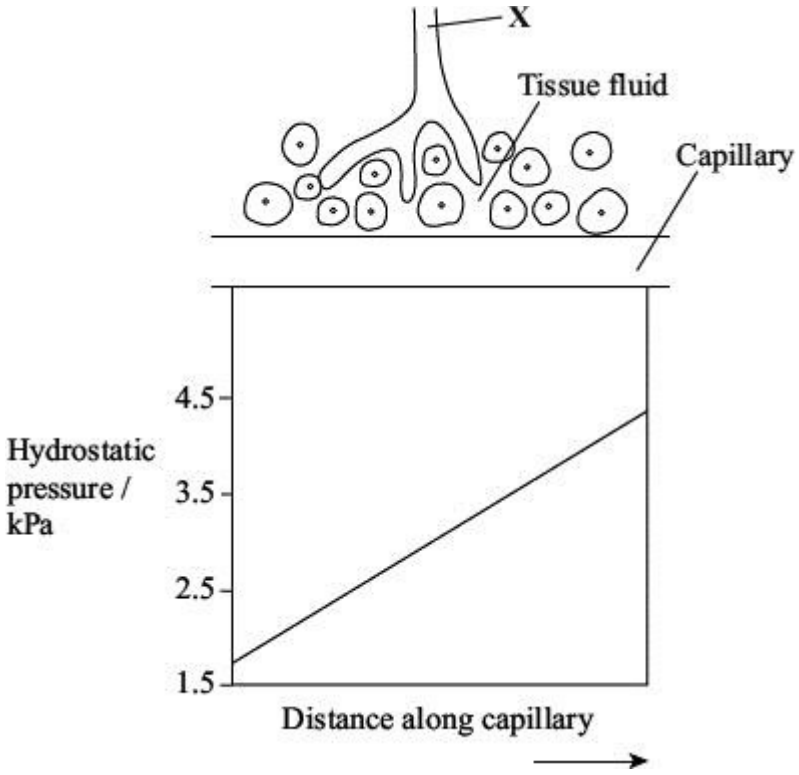
Answer _____ seconds

(2)

(Total 6 marks)

Q84.

The diagram shows vessels in a small piece of tissue from a mammal. The chart shows the hydrostatic pressure of the blood as it flows through the capillary.



(a) Name the fluid contained in vessel **X**. _____

(1)

(b) Draw an arrow on the capillary to show the direction of the flow of blood. Describe the evidence from the chart to support your answer.

_____

_____

(1)

(c) Describe and explain how water is exchanged between the blood and tissue fluid as blood flows along the capillary.

_____

_____

_____

_____

_____

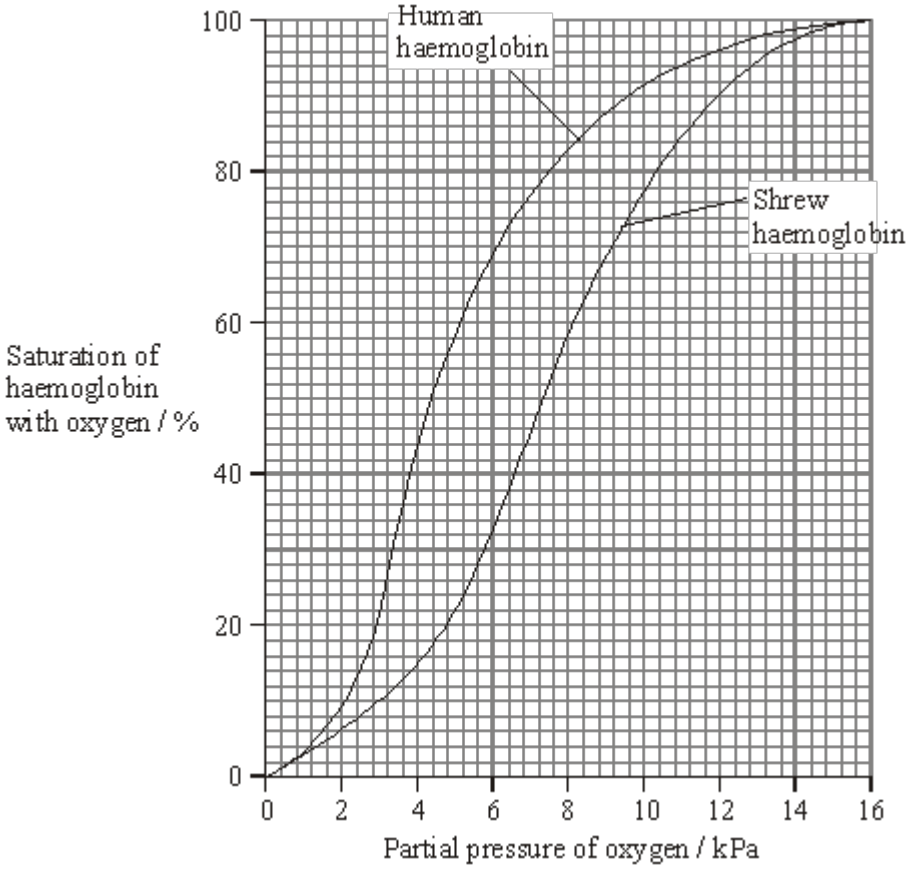
_____

_____

_____

(4)

(d) Shrews are small mammals. Their tissues have a much higher respiration rate than human tissues. The graph shows the position of the oxygen haemoglobin dissociation curves for a shrew and a human.



Explain the advantage to the shrew of the position of the curve being different from that of a human.

_____

_____

_____

_____

_____

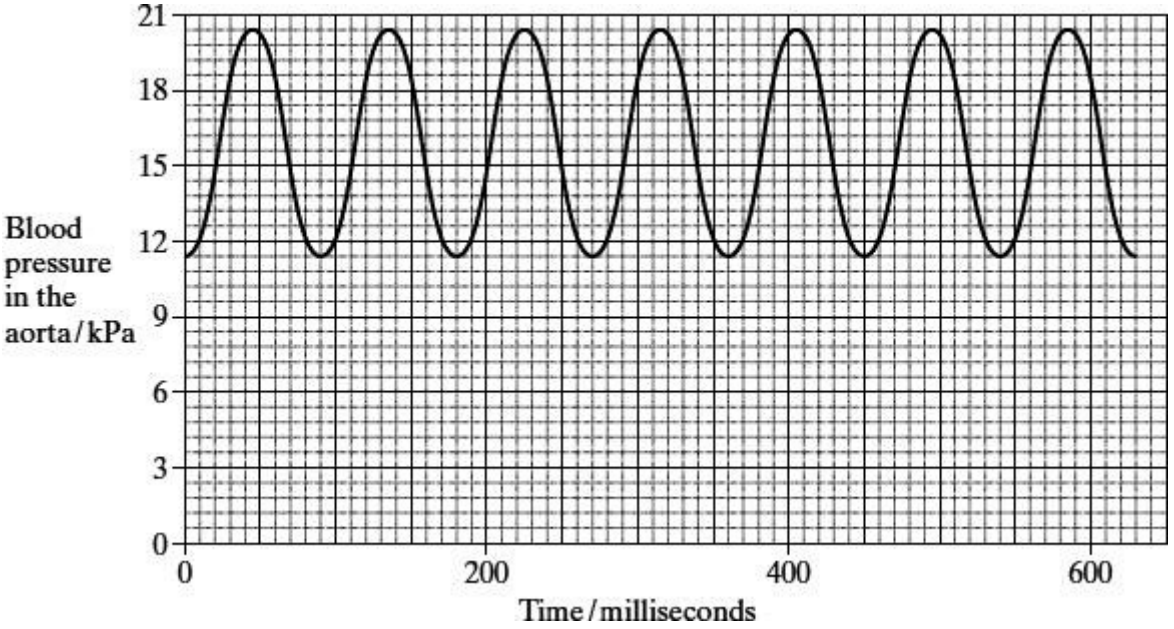
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(3)

(Total 9 marks)

Q85.

The graph shows the changes in pressure which take place in the aorta of a mouse during several heartbeats.



(a) Which chamber of the heart produces the increase in pressure recorded in the aorta?

_____

(1)

(b) The pressure of blood in the aorta decreases during each heartbeat but does not fall below 10 kPa. Explain what causes the pressure of blood to

(i) decrease during each heartbeat;

_____

_____

(1)

(ii) stay above 10 kPa.

_____

_____

_____

_____

(2)

(c) The heart rate of a mouse is much higher than the heart rate of a human. Use the graph to calculate the heart rate of the mouse. Show your working.

Heart rate = _____ beats per minute

(2)

(d) The cardiac output is the volume of blood pumped by a heart in one minute. The stroke volume is the volume of blood pumped by a heart in a single heartbeat.

cardiac output = stroke volume × heart rate

The cardiac output for a mouse with a heart rate of 550 beats per minute is 16.6 cm^3 per minute. Calculate the stroke volume for this mouse. Show your working.

Stroke volume = _____ cm^3

(2)

(Total 8 marks)

Q86.

A decrease in the pH of blood plasma reduces the affinity of haemoglobin for oxygen.

(a) (i) Explain how aerobic respiration in cells leads to a change in the pH of blood plasma.

_____

_____

_____

_____

(2)

(ii) What is the advantage to tissue cells of a reduction in the affinity of haemoglobin for oxygen when the plasma pH decreases?

_____

_____

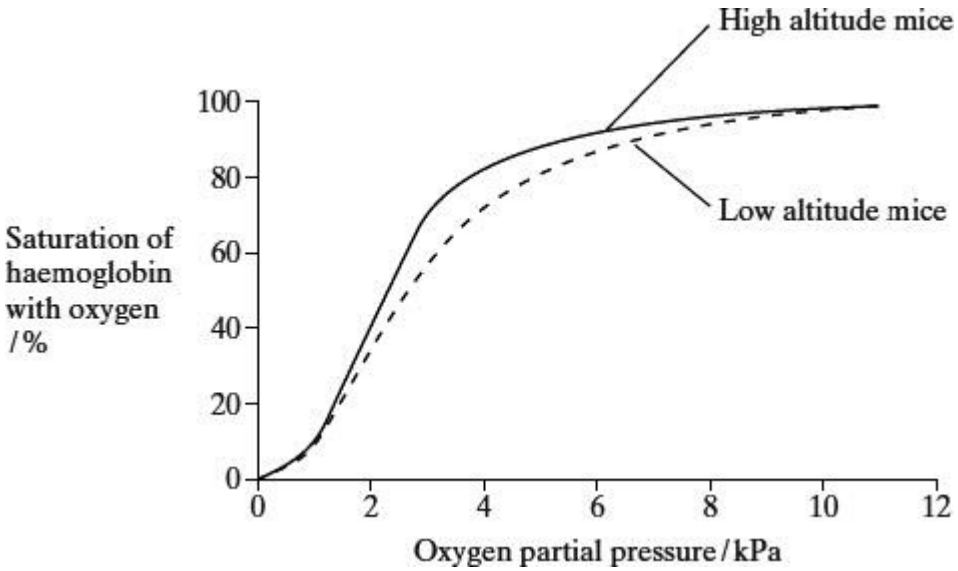
_____

_____

(2)

(b) Deer mice are small mammals which live in North America. One population lives at

high altitude and another at low altitude. Less oxygen is available at high altitude. The graph shows the oxygen haemoglobin dissociation curves for the two populations of deer mice.



(i) Explain the advantage for mice living at high altitude in having a dissociation curve which is to the left of the curve for mice living at low altitude.

_____

_____

_____

_____

(2)

(ii) Suggest why it would be a disadvantage for the curve to be much further to the left.

_____

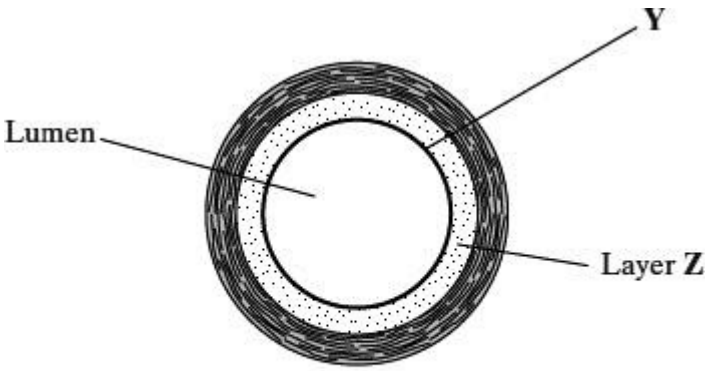
_____

(1)

(Total 7 marks)

Q87.

The diagram shows a cross-section of an artery.



Magnification × 10

(a) Name the layer labelled **Y**.

_____

(1)

(b) Layer **Z** contains a high proportion of elastic tissue.

Describe the advantage of having elastic tissue in the wall of an artery.

_____

_____

_____

_____

(2)

(c) Calculate the cross-sectional area of the lumen of the artery shown in the diagram. Show your working.

The area of a circle is given by πr^2, where r is the radius of a circle (π = 3.14).

Answer _____ mm^2

(3)

(Total 6 marks)

Q88.

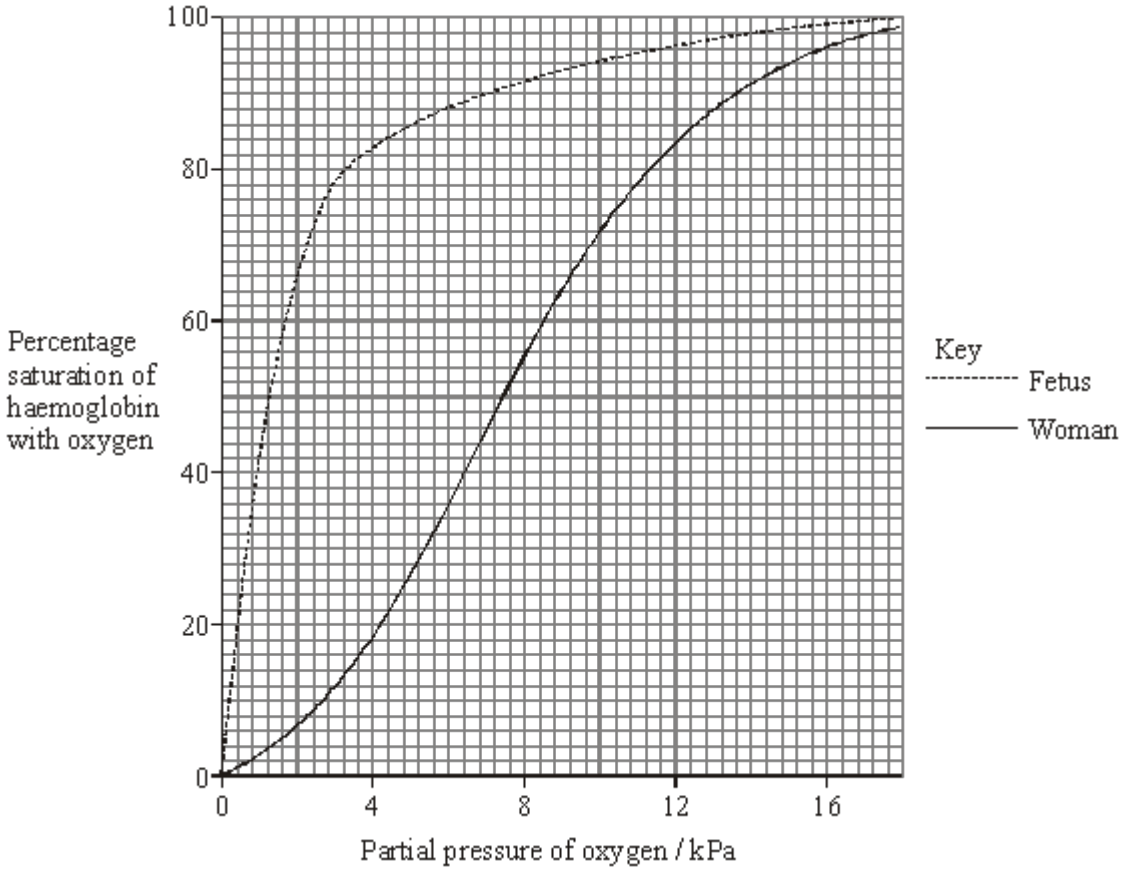
(a) Gas exchange in a fetus occurs across the placenta. Explain why it is important to maintain a supply of blood to the lungs of the fetus, even when they are not being used for gas exchange.

_____

_____

(1)

(b) The oxygen haemoglobin dissociation curves for a woman and her fetus are shown in the graph.



(i) Use the graph to find the difference between the percentage saturation of haemoglobin in the blood of the woman and the fetus when the partial pressure of oxygen in the placenta is 4 kPa.

Answer _____

(1)

(ii) Explain how efficient gas exchange is ensured by the dissociation curve for the fetus being to the left of the dissociation curve for the woman.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q89.

(a) A woman takes moderate exercise. Explain what causes her heart rate to increase while she exercises.

_____

_____

_____

_____

_____

_____

_____

_____

_____

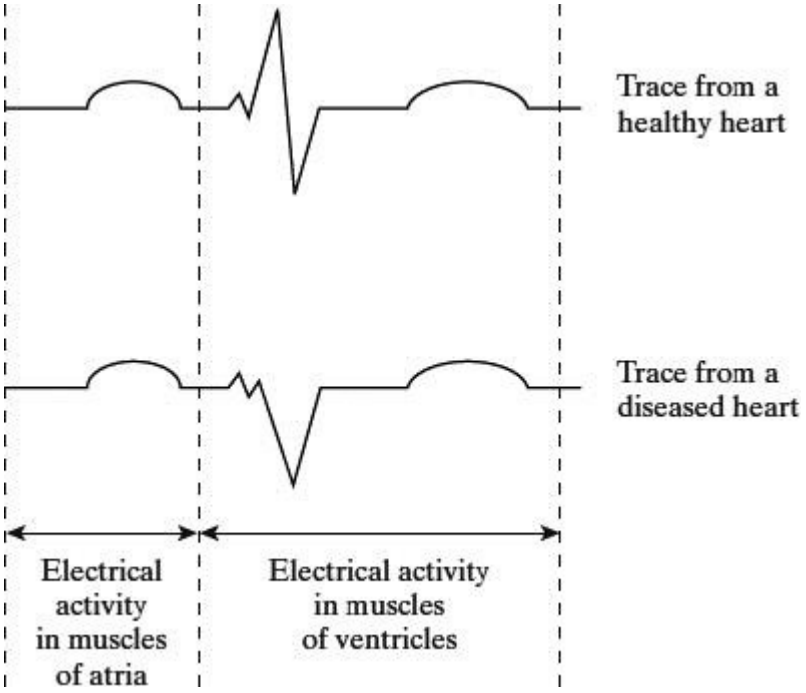
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_____

_____

(6)

(b) An electrocardiogram (ECG) measures the electrical changes occurring in cardiac muscle as a heart is beating. An ECG trace for a healthy person and an ECG trace for a person suffering from heart disease are shown.



(i) Describe the route taken when electrical impulses are transmitted from the sinoatrial node to the muscles of the ventricles in a healthy heart.

_____

_____

_____

_____

(2)

(ii) Explain how information from these ECG traces suggests that the damage caused to the diseased heart is unlikely to have affected the sinoatrial node.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q90.

In an investigation, the effects of caffeine on performance during exercise were measured. One group of athletes (**A**) was given a drink of decaffeinated coffee. Another group (**B**) was given a drink of decaffeinated coffee with caffeine added. One hour later the athletes started riding an exercise bike and continued until too exhausted to carry on. Three days later the same athletes repeated the experiment, with the drinks exchanged.

(a) (i) The researchers added caffeine to decaffeinated coffee. Explain why they did not just use normal coffee.

_____

_____

(1)

(ii) The performance of the athletes might have been influenced by how they expected the caffeine to affect them. How could the researchers avoid this possibility?

_____

_____

(1)

During the exercise the concentrations of glycerol and fatty acids in the blood plasma were measured. The results are shown in the table.

Drink	**Mean time to exhaustion /minutes**	**Mean concentration of blood glycerol/ mmol dm^{-3}**	**Mean concentration of blood fatty acids/ mmol dm^{-3}**
With caffeine	90.2	0.20	0.53
Without caffeine	75.5	0.09	0.31

(b) (i) Describe the effect of caffeine on exercise performance.

_____

_____

(1)

(ii) Suggest **one** explanation for the higher glycerol and fatty acid concentrations in the blood plasma of the athletes after they were given caffeine.

_____

_____

_____

_____

(2)

(c) The researchers measured the volumes of carbon dioxide exhaled and oxygen inhaled during the exercise. From the results they calculated the respiratory quotient (RQ), using the formula

$$RQ = \frac{\text{volume of carbon dioxide exhaled per minute}}{\text{volume of oxygen inhaled per minute}}$$

When a person is respiring carbohydrate only, RQ = 1.0

When a person is respiring fatty acids only, RQ = 0.7

(i) The basic equation for the respiration of glucose is

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

Explain why the RQ for glucose is 1.0.

_____

_____

_____

_____

(2)

(ii) The researchers found that, when the athletes were given the drink containing caffeine, their mean RQ was 0.85. When given the drink without caffeine their mean RQ was 0.92.

The researchers concluded that when the athletes had caffeine they used glycogen more slowly than when they did not have caffeine, and that the store of glycogen in their muscles was used up less quickly during the exercise.

Explain the evidence from the information above and from the table which supports these conclusions.

_____

_____

_____

_____

_____

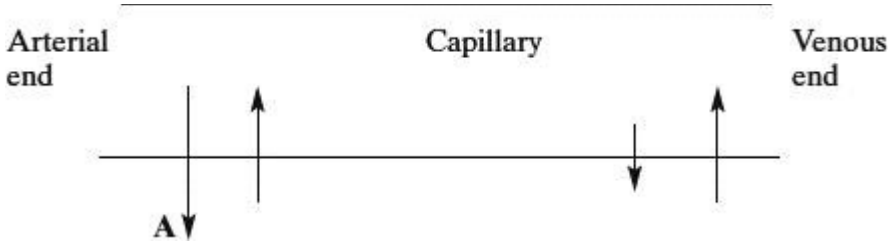
_____

(3)

(Total 10 marks)

Q91.

Tissue fluid is formed when water and small molecules pass out of capillaries at their arterial end. The diagram shows some pressures involved in tissue fluid formation. The relative lengths of the arrows indicate the size of the pressures.



(a) What causes the pressure represented by the arrow labelled **A**?

_____

_____

(1)

(b) Explain why there is a net loss of water from a capillary at the arterial end.

_____

_____

_____

_____

(2)

(c) The total volume of fluid that passes from the capillaries to the surrounding tissue fluid is normally greater than the volume that is reabsorbed into them. Describe what happens to this extra fluid.

_____

_____

_____

_____

(2)

(d) Tissue fluid accumulates in the tissues of people who do not eat enough protein. Explain why.

_____

_____

_____

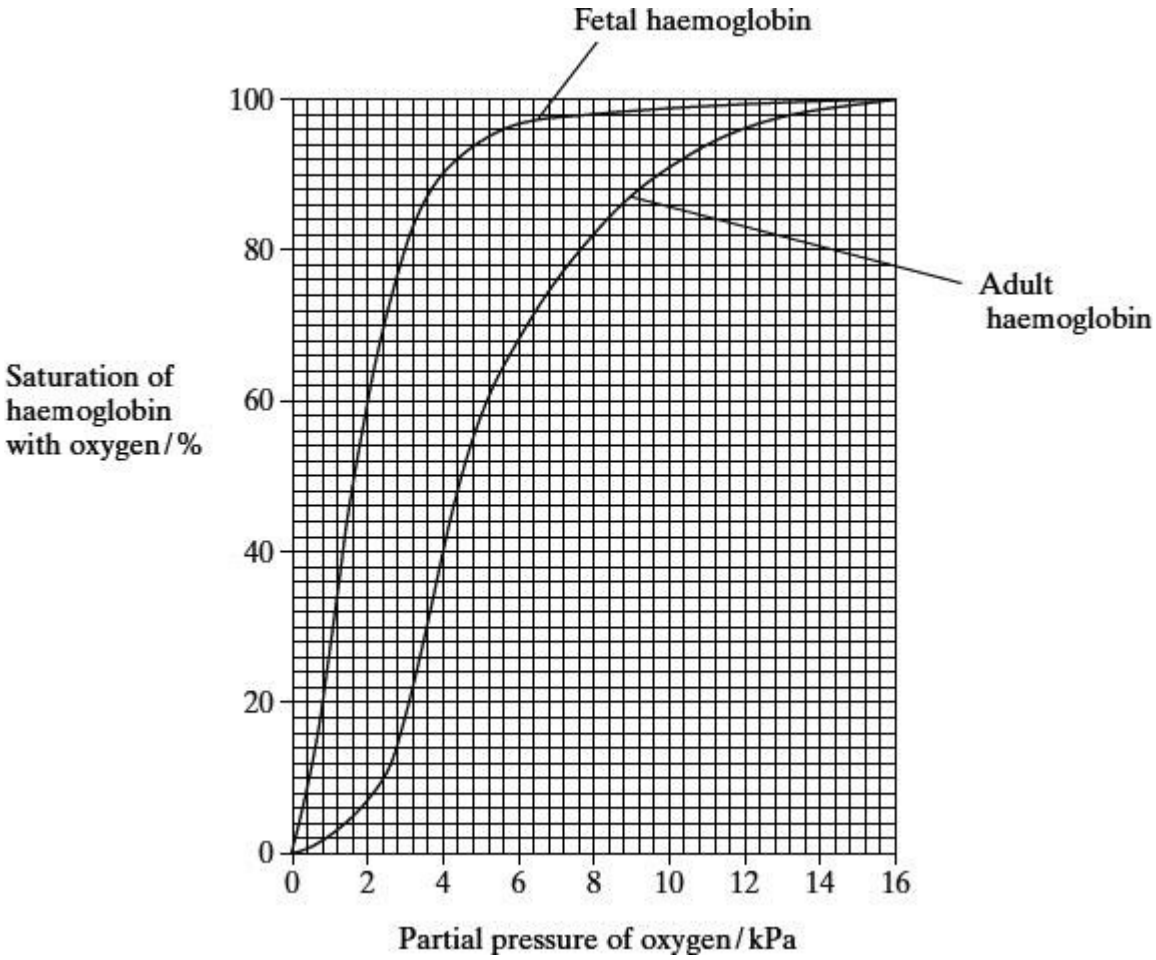
_____

(2)

(Total 7 marks)

Q92.

The graph shows dissociation curves for haemoglobin in a fetus and in an adult.



(a) (i) What is the difference in percentage saturation between fetal haemoglobin and adult haemoglobin at a partial pressure of 3 kPa?

_____

(1)

(ii) Explain the advantage of the curve for fetal haemoglobin being different from the curve for adult haemoglobin.

_____

_____

_____

_____

(2)

(b) The dissociation curve for adult haemoglobin changes during vigorous exercise.

(i) Sketch on the graph the position of the curve during vigorous exercise.

(1)

(ii) Explain the advantage of this change in position.

_____

_____

_____

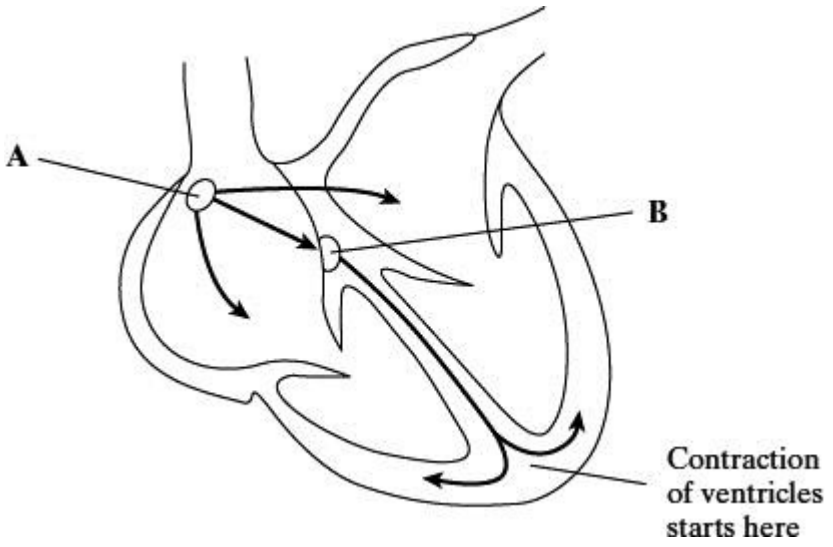
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(2)

(Total 6 marks)

Q93.

The diagram shows the pathways in the heart for the conduction of electrical impulses during the cardiac cycle.



(a) The table shows the blood pressure in the left atrium, the left ventricle and the aorta at different times during part of a cardiac cycle.

	Blood pressure / kPa		
Time / s	**Left atrium**	**Left ventricle**	**Aorta**
0.0	0.5	0.4	10.6
0.1	1.2	0.7	10.6
0.2	0.3	6.7	10.6
0.3	0.4	17.3	16.0
0.4	0.8	8.0	12.0

(i) At which time is blood flowing into the aorta?

_____

(1)

(ii) Between which times are the atrioventricular valves closed?

_____

(1)

(b) The maximum pressure in the left ventricle is higher than the maximum pressure in the right ventricle. What causes this difference in pressure?

_____

_____

(1)

(c) The information below compares some features of different blood vessels.

		Blood vessel		
		Artery	**Capillary**	**Vain**
Property	Mean diameter of vessel	4.0 mm	8.0 μm	5.0 mm
	Mean thickness of wall	1.0 mm	0.5 μm	0.5 mm
		Relative thickness (shown by length of bar)		
Tissues present in wall	Endothelium			
	Elastic tissue			
	Muscle			

Use the information to explain how the structures of the walls of arteries, veins and capillaries are related to their functions.

_____

_____

_____

_____

_____

_____

_____

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_____

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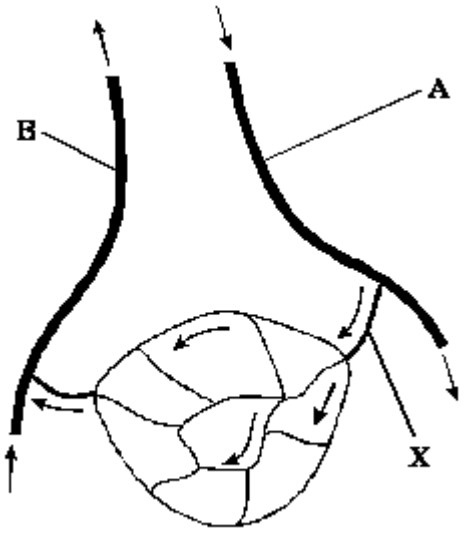
_____

(6)

(Total 9 marks)

Q94.

The diagram shows some blood vessels in muscle tissue.



Not drawn to scale

(a) (i) Which type of blood vessel is **X**?

_____

(1)

(ii) Name **two** substances which are at a higher concentration in the blood at **A** than in the blood at **B**.

1. _____

2. _____

(1)

(b) The table shows the mean diameter of the lumen and the rate of blood flow in some types of human blood vessel.

Type of blood vessel	Mean diameter of lumen / μm	Rate of blood flow / cm s^{-1}
Artery	400	10 – 40
Arteriole	30	0.1 – 10
Capillary	8	less than 0.1

Using information in the table, explain what causes the rate of blood flow to be slower in capillaries than in other vessels.

_____

_____

_____

_____

(2)

(c) (i) Which type of blood vessel has most elastic tissue in its wall?

_____

(1)

(ii) How does this elastic tissue help to smooth out the flow of blood in the blood vessel?

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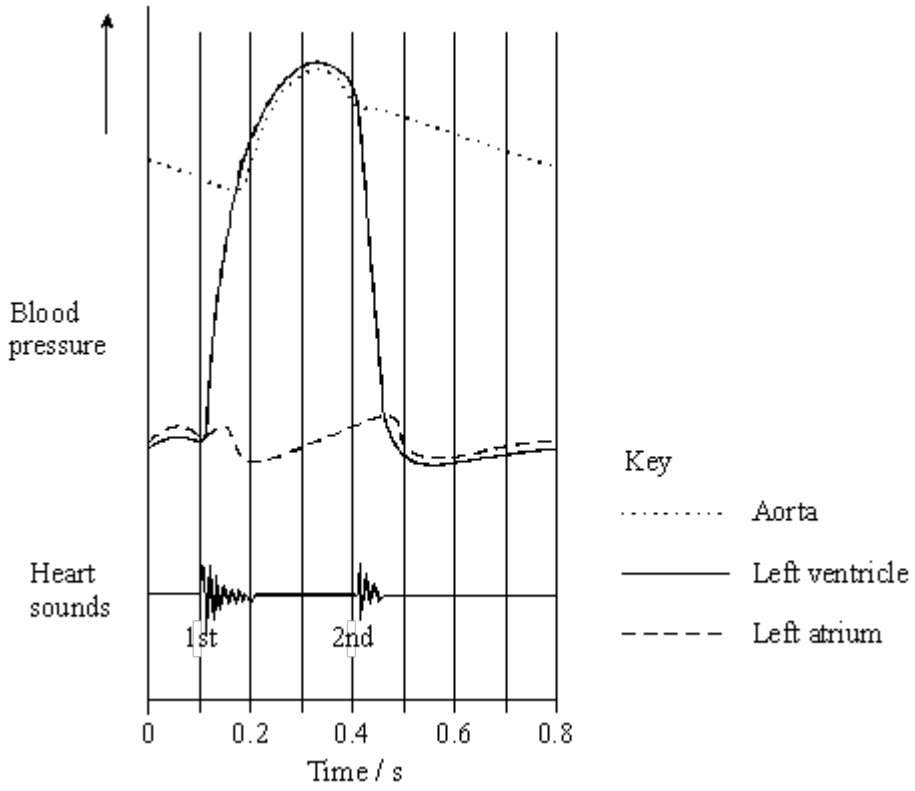
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(2)

(Total 7 marks)

Q95.

The graph shows changes in pressure in the aorta, left ventricle and left atrium during one heart beat.



(a) The maximum pressure in the left atrium is lower than the maximum pressure in the left ventricle. What causes this difference in maximum pressure?

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(1)

(b) A stethoscope can be used to listen to the sounds made by the heart.

(i) What is the evidence from the graph that the first heart sound is caused by the atrioventricular valve closing?

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(1)

(ii) What causes the second heart sound? Give the reason for your answer.

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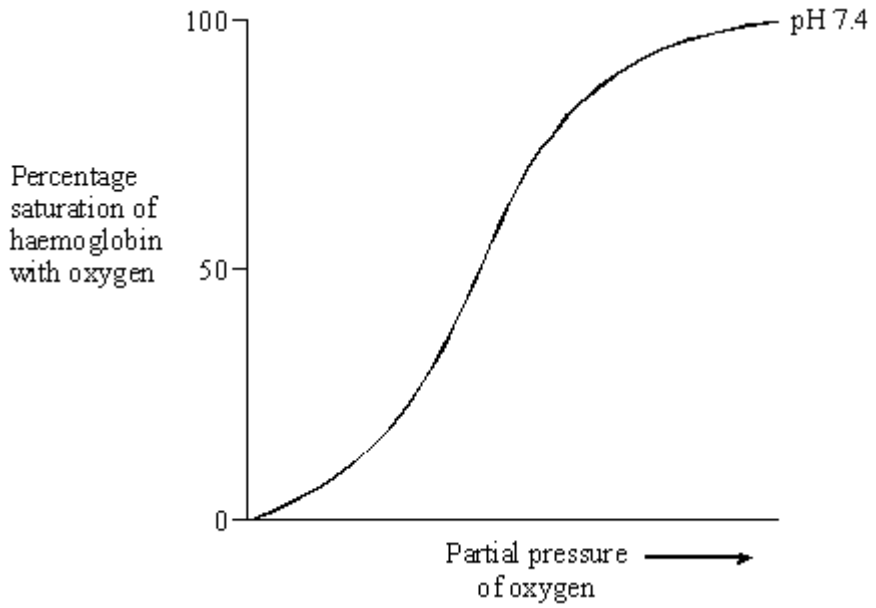
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(2)

(Total 4 marks)

Q96.

(a) The graph shows a dissociation curve for human haemoglobin at pH 7.4. The position of the curve is different at pH 7.2.



(i) Sketch a curve on the graph to show the likely position of the dissociation curve at pH 7.2.

(1)

(ii) Explain how a change in pH from 7.4 to 7.2 affects the supply of oxygen by haemoglobin to the tissues.

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(2)

(b) Explain what causes the pH to be reduced from 7.4 to 7.2 in a tissue.

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(3)

(Total 6 marks)

Q97.

This question should be answered in continuous prose.

Quality of Written Communication will be assessed in these answers.

(a) Describe and explain **four** ways in which the structure of a capillary adapts it for the exchange of substances between blood and the surrounding tissue.

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(4)

(b) Explain how tissue fluid is formed and how it may be returned to the circulatory system.

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(6)

(Total 10 marks)