

1(a). An aneurysm is a bulge in a blood vessel caused by a weakness in the wall of the blood vessel.

If an aneurysm bursts it can be very serious or even fatal.

- i. Scientists can measure the size of an aneurysm. An investigation measured the ratio of collagen to elastin in the blood vessel wall in five patients with an aneurysm.

The table shows some of their findings.

Patient	Size of aneurysm (cm)	Ratio of collagen to elastin
A	0.00	2 : 1
B	0.03	3 : 1
C	0.50	4 : 1
D	1.10	7 : 1
E	2.20	8 : 1

Based only on the data in the table, suggest a hypothesis on the formation of aneurysms.

..... [1]

- ii. Students looked at data on aneurysms in different groups of people of the same age.

The table shows their findings.

Group	Observed frequency of people with aneurysms (O)	Expected frequency of people with aneurysms (E)
Females	566	600
Males	377	343

Calculate chi squared for this data.

Use the formula: $\chi^2 = \sum \frac{(O - E)^2}{E}$

Give your answer to **4** significant figures.

$\chi^2 =$ [3]

- iii. The table shows part of a statistical table for the chi squared test.

	Probability (%)			
	10	5	1	0.5
df				
1	2.706	3.841	6.635	7.879
2	4.605	5.991	9.210	10.60
3	6.251	7.815	11.34	12.84
4	7.779	9.488	13.28	14.86

Using the table above and your answer to (ii), state what conclusion the student would make with 95% confidence?

----- [2]

(b).

- i. Explain the role of valves in veins.

----- [2]

- ii. The smooth muscle content in some arteriole walls is more than double the smooth muscle content in the walls of some arteries.

Explain how arterioles are better adapted than arteries to allow the blood to flow into an individual organ.

----- [3]

- ii. Use the information in the table to explain the formation of tissue fluid and its return to the blood.

----- [2]

3. Lymph and tissue fluid are both formed from the blood.

Which statement describes the composition of these fluids?

- A Lymph contains more protein than tissue fluid because of antibody production.
- B Lymph is similar in composition to tissue fluid but has more oxygen and nutrients
- C Tissue fluid does not contain hormones such as insulin and glucagon.
- D Tissue fluid contains red blood cells and platelets.

Your answer

[1]

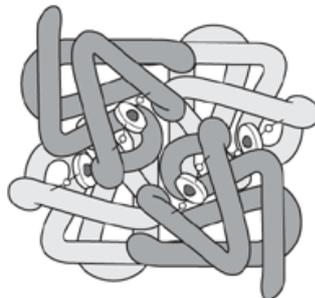
4. Which statement describes features of the mammalian heart?

- A Branches of the pulmonary artery supply blood to the heart muscle.
- B Semi-lunar valves prevent backflow of blood from the ventricles to the atria.
- C The left ventricle pumps deoxygenated blood to the lungs.
- D The wall of the left ventricle is thicker because it needs to pump blood around the whole body.

Your answer

[1]

5. The image shows the quaternary structure of a haemoglobin molecule.



i.

- ii. In addition to having a quaternary structure, haemoglobin also has primary, secondary and tertiary structures.

The table below contains statements about the structure of haemoglobin.

Complete the table to show the level of protein structure described in each statement.

You can choose each level of protein structure **once**, **more than once** or **not at all**.

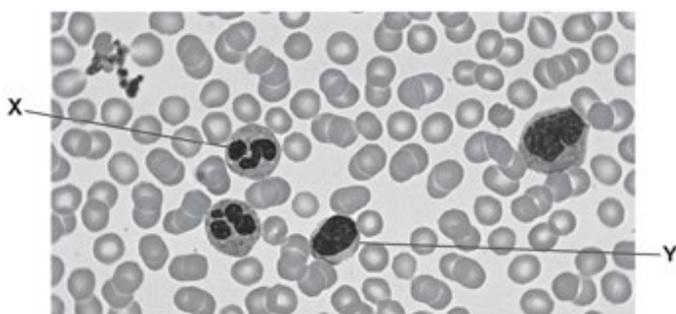
Statement	Level of Protein Structure
Disulfide bonds are formed when two cysteine amino acids in an α -globin chain come together after the alpha helix folds	
Haemoglobin is made up of two α -globin chains and two β -globin chains	
Each α -globin and β -globin chain is folded into a spherical shape	
The β -globin chain has 147 amino acids in a specific sequence	

[3]

- ii. Name the enzyme in an erythrocyte that allows haemoglobin to be formed.

[1]

6. The image shows a photomicrograph of a blood smear.



Which row in the table below correctly identifies cell X and cell Y?

	X	Y
A	neutrophil	erythrocyte
B	neutrophil	lymphocyte
C	lymphocyte	neutrophil
D	platelet	neutrophil

Your answer

[1]

7. During exercise the cardiac output of an athlete is $28 \text{ dm}^3 \text{ min}^{-1}$ and their stroke volume is 160 cm^3 .

How many heart beats occur when the athlete exercises for five minutes? Assume the cardiac output and stroke volume stay constant during the exercise time.

- A 22
- B 175
- C 875
- D 4480

Your answer

[1]

8. Which option is a feature of tissue fluid?

- A Tissue fluid carries oxygen away from muscle cells
- B Tissue fluid does not contain erythrocytes
- C Tissue fluid forms when net hydrostatic pressure < net oncotic pressure
- D Tissue fluid forms when net hydrostatic pressure = oncotic pressure

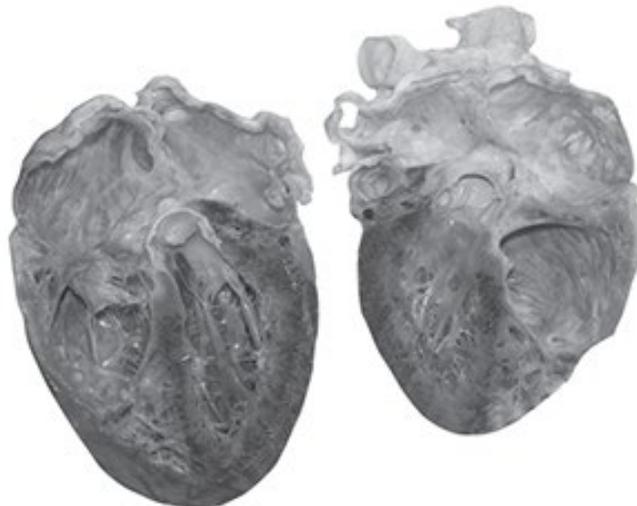
Your answer

[1]

9(a). The figure below shows a dissected human heart.

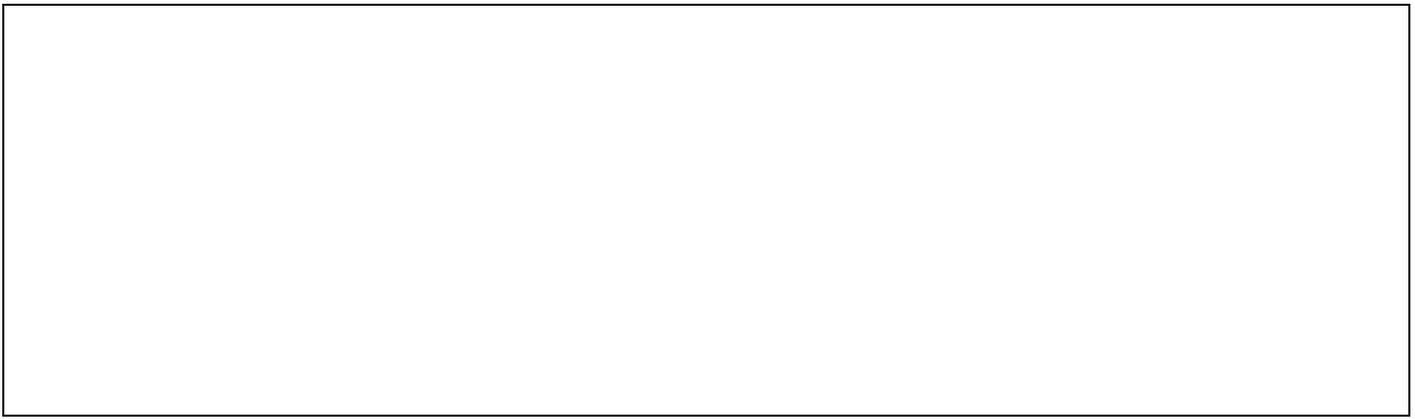
Back (dorsal) half of heart

Front (ventral) half of heart



Draw a simple diagram of the front half of the heart in the space below.

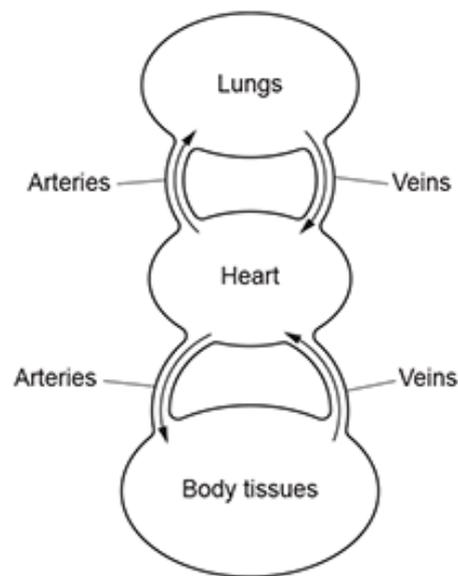
On your diagram, label the left ventricle.



[3]

(b). Birds have hearts with a similar structure to mammalian hearts.

The figure below shows a diagram of the circulatory system of a bird.



i. Describe the type of circulatory system shown in the figure.

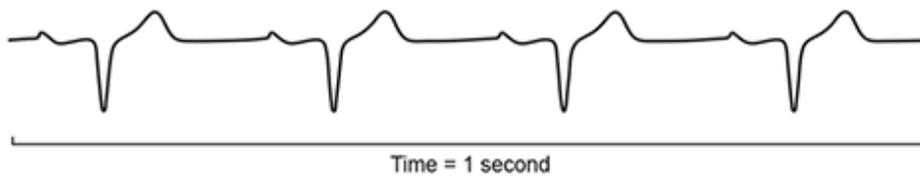
[1]

ii. Explain why larger organisms, such as a bird, need a circulatory system but some smaller organisms do not need a circulatory system.

[2]

(c). An electrocardiogram (ECG) trace from a bird and an ECG trace from a human have many differences.

The ECG trace below is from a bird.



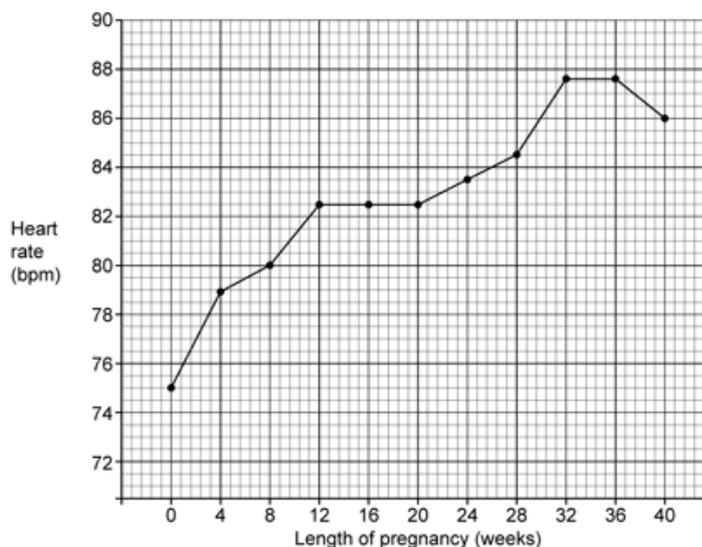
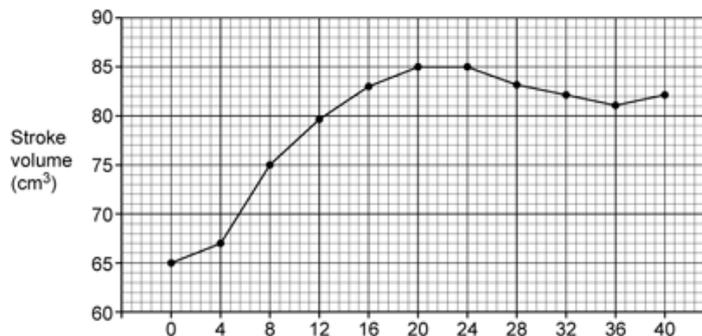
Describe how the ECG trace from a bird is different from a normal ECG trace from a human.

[2]

10(a). During pregnancy the mother's body undergoes several physiological changes to support the developing fetus. These changes affect every organ system in the body.

Changes to the heart and circulatory system begin in the first few weeks of pregnancy.

The figures below shows the changes in stroke volume and heart rate that occur during pregnancy.



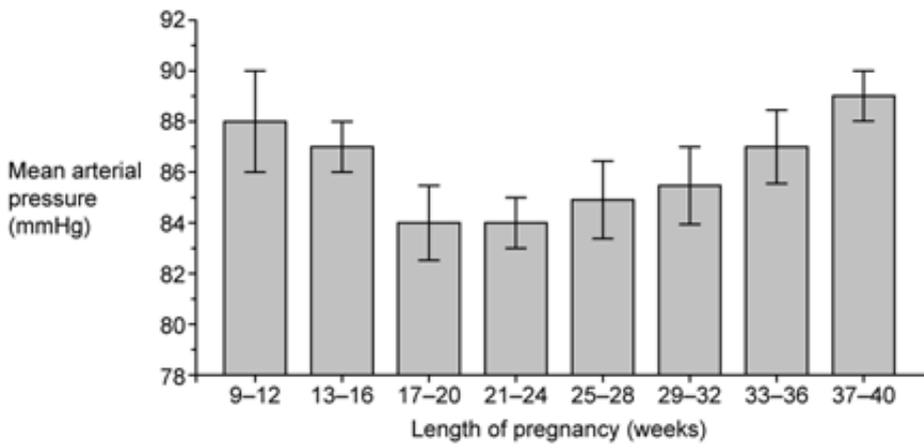
i. Use the data in the figures to calculate the cardiac output in week 20.

Cardiac output = Unit [3]

ii. Suggest an advantage of the increase in cardiac output.

[1]

iii. The figure below shows how blood pressure varies throughout pregnancy.



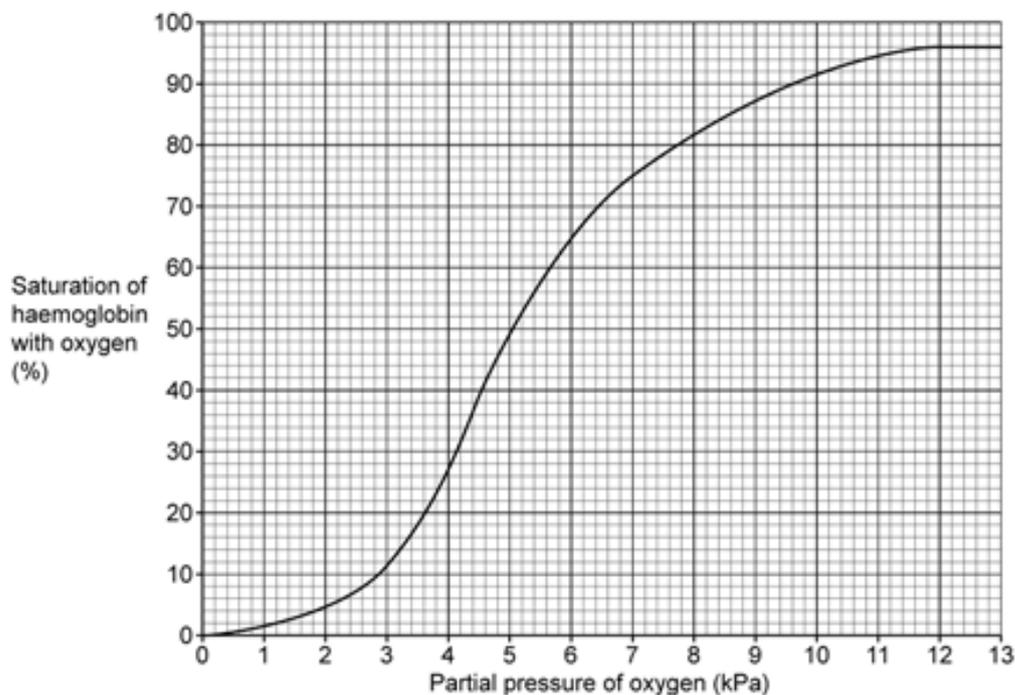
A student looked at the data in all the figures and drew the following conclusion:

‘As cardiac output increased blood pressure dropped so there must have been a decrease in vascular resistance.’

Evaluate this conclusion.

(c). A change that occurs in pregnancy is an increase in oxygen uptake by the mother. This is partly due to an increase in the mother's metabolic rate and partly to supply the developing fetus.

The figure below shows the oxygen dissociation curve for the mother's haemoglobin.



- i. Sketch the oxygen dissociation curve for fetal haemoglobin.

Answer on the figure.

[1]

- ii. Explain how the different affinities of maternal and fetal haemoglobin enable transfer of oxygen from the maternal circulation to the fetus.

[3]

11. Which of the statements about the heart is correct?

- A Contraction of the ventricles is known as ventricular systole.
- B Deoxygenated blood enters the heart by the pulmonary vein.
- C The pressure in the ventricles is always greater than in the atria because of the thicker ventricle wall.
- D The wall of the left ventricle is less thick because it only has to pump blood to the lungs

Your answer

[1]

12. The sea sponge, *Aplysina aerophoba*, and the zebra shark, *Stegostoma fasciatum*, are both animals.

A. aerophoba does not have an internal circulatory system. Instead, it filters food and oxygen from the surrounding water, as shown in **Fig. 4.1**.

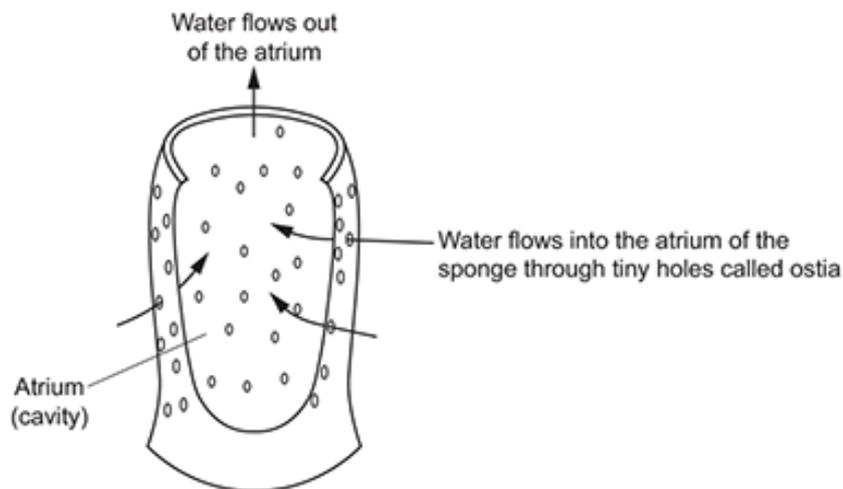


Fig. 4.1

- i. Suggest why *A. aerophoba* does not need a circulatory system.

[1]

- ii. A diagram of the circulatory system of *S. fasciatum* is shown in **Fig. 4.2**.

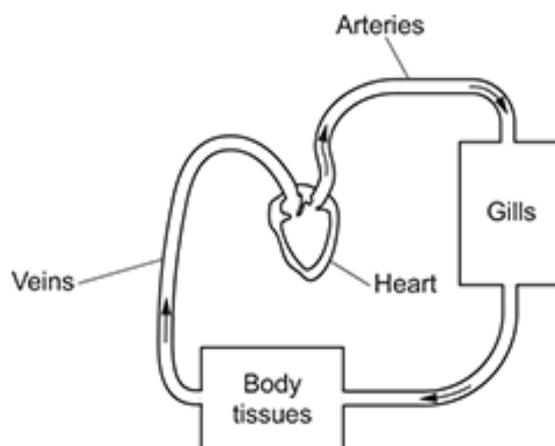


Fig. 4.2

Describe the type of circulatory system that *S. fasciatum* has.

[2]

13. Haemoglobin plays a crucial role in transporting oxygen in animals. Several ions also have roles in oxygen transport.

Three ions are listed in the table below.

Place ticks (✓) in the correct boxes to indicate which properties and features are true for each ion.

Ion	Has a negative charge	Binds to haemoglobin	A product of the dissociation of carbonic acid	Involved in the chloride shift
Hydrogen				
Hydrogencarbonate				
Chloride				

[3]

15(a). Fig. 2.1 shows a light micrograph of a blood smear.

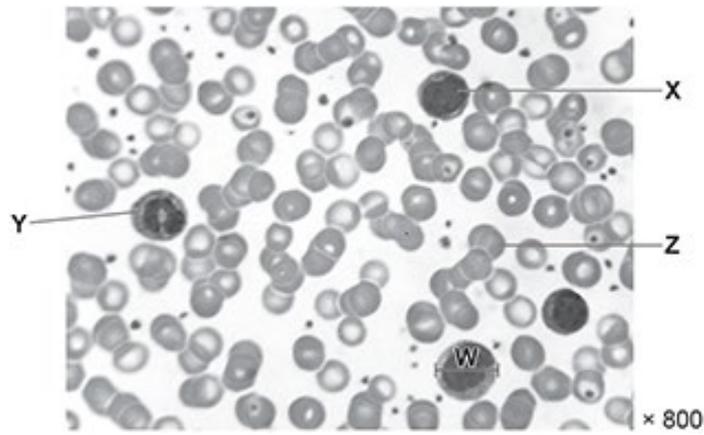


Fig. 2.1

- i. The cells labelled **X** and **Y** in Fig. 2.1 are two different types of white blood cell.

Identify the types of white blood cell labelled **X** and **Y**.

X

Y

[2]

- ii. The blood cell labelled **Z** in Fig. 2.1 contains a high concentration of haemoglobin.

Outline **two** other ways in which the blood cell labelled **Z** is adapted for its function.

----- [2]

- iii. The diameter of another blood cell is represented by the line **W** in **Fig. 2.1**.

The magnification used to produce **Fig. 2.1** was $\times 800$.

Calculate the actual diameter, **W**, of the blood cell.

Give your answer in μm .

Diameter = μm [2]

- (b). **Fig. 2.2** shows stained tissue that includes two different blood vessels, labelled **L** and **M**, and a substance labelled **N**.

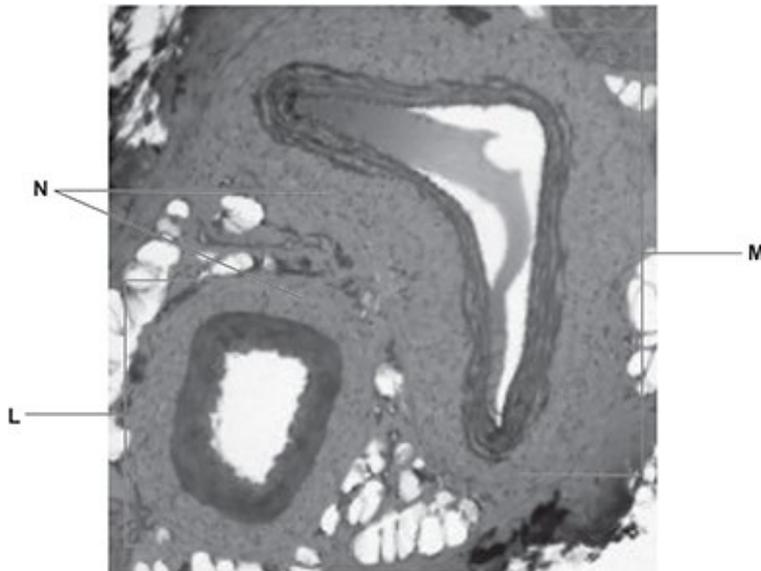


Fig. 2.2

- i. State whether **L** is an artery or a vein **and** give **two** pieces of evidence from **Fig. 2.2** that allow you to reach your decision.

L

Evidence 1

Evidence 2

[2]

- ii. State the substance labelled **N**.

----- [1]

16. Most of the oxygen in blood is transported bound to haemoglobin.

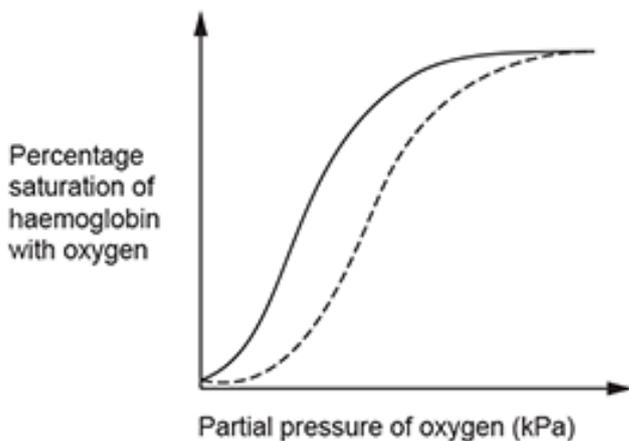
Haemoglobin also plays an important role during the transportation of carbon dioxide by acting as a buffer and preventing a lowering of the pH in the erythrocytes.

- i. Explain how haemoglobin acts as a buffer.

----- [2]

- ii. **Fig. 4.2** shows the shape of oxygen dissociation curves for haemoglobin for a person at rest and during exercise.

The changes to the dissociation curve at different carbon dioxide concentrations is known as the Bohr effect.



KEY

— At rest

--- During exercise

Fig. 4.2

With reference to **Fig. 4.2** explain why the Bohr effect is important during exercise.

----- [2]

17. Fig. 3.4 shows the changes in pressure in the left side of the heart and aorta during one cardiac cycle.

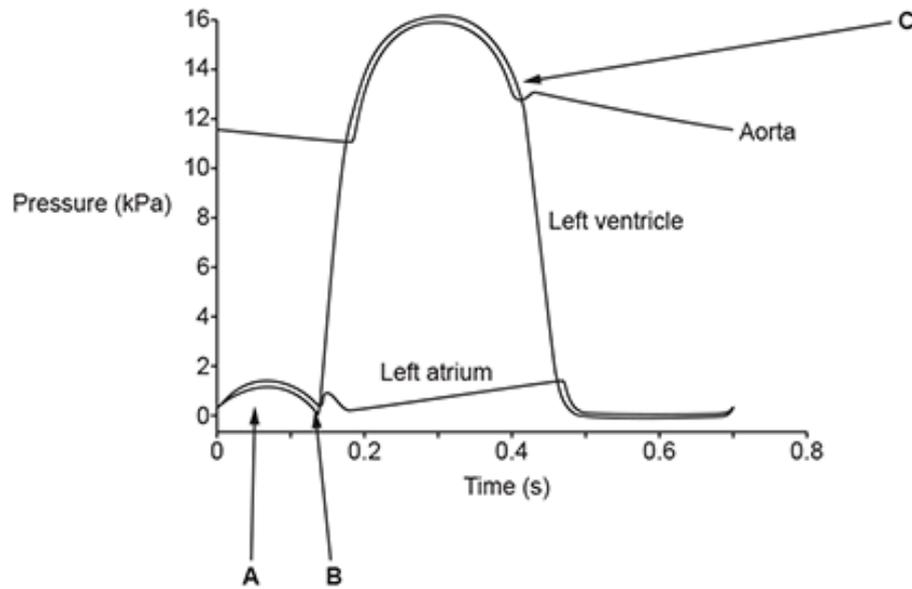


Fig. 3.4

A student described the events shown in Fig. 3.4.

'At **A**, the muscles in the wall of the atrium are contracting. This is caused by a wave of electrical excitation that starts at the atrio ventricular node (AVN).

At **B**, the muscles in the wall of the ventricle are contracting. The atrioventricular valve opens and the pressure in the aorta falls. The ventricular pressure rises above that of the aorta.

At **C**, the muscles in the walls of the ventricle are relaxing. The semilunar valve opens. The pressure in the ventricle drops.'

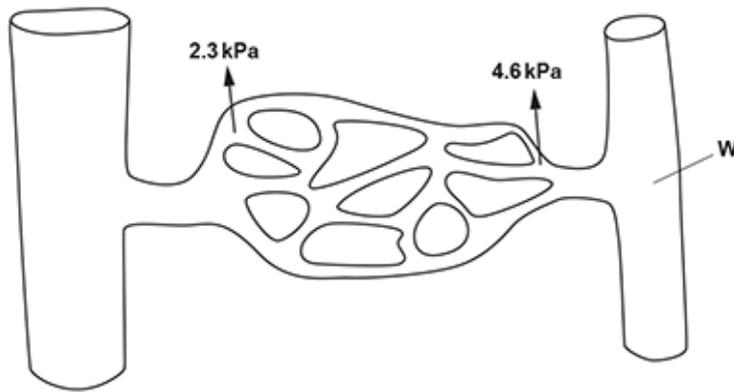
Identify **three** errors in the student's description and write the correction for each error.

Error and correction 1

Error and correction 2

Error and correction 3

18(a). The diagram shows the change in hydrostatic pressure across a capillary network in muscle tissue.



- i. **On the diagram**, draw an arrow to show the direction of movement of blood through the capillary network.

[1]

- ii. **On the diagram**, draw an arrow to show the direction in which oncotic pressure is acting **and** suggest a value for oncotic pressure.

Write the value for oncotic pressure next to the arrow.

[2]

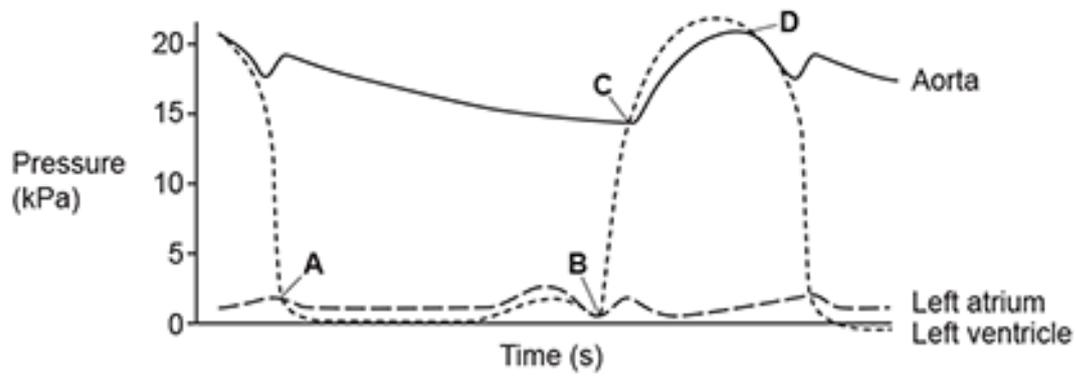
- iii. Name the structure labelled **W**.

..... [1]

(b). Describe how oncotic pressure is established.

..... [3]

19. The diagram shows the changes in pressure in the left atrium, left ventricle and aorta in a single cardiac cycle.



Which letter shows the point at which the semilunar valve opens?

Your answer

[1]

END OF QUESTION PAPER