A-Level Biology

Mass Transport in Animals

Question Paper

Time available: 83 minutes
Marks available: 57 marks

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1. (a) Give the pathway a red blood cell takes when travelling in the human circulatory system from a kidney to the lungs.

Do **not** include descriptions of pressure changes in the heart or the role of heart valves in your answer.

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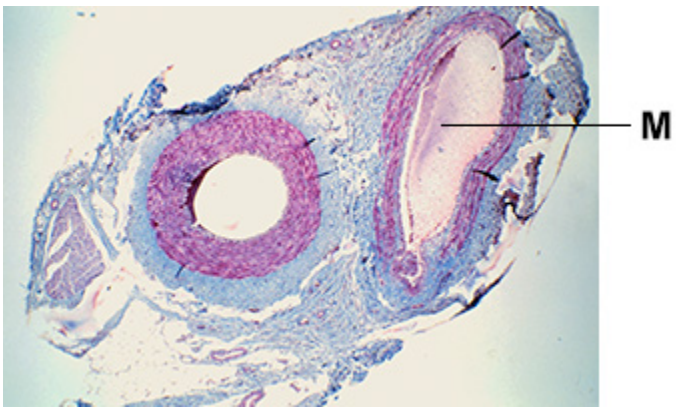
_____

(3)

The figure below shows a section through two types of blood vessels observed using an optical microscope.



(b) Identify the type of blood vessel labelled **M** in the figure above.

Explain your answer.

Type of blood vessel _____

Explanation _____

_____

_____

(2)

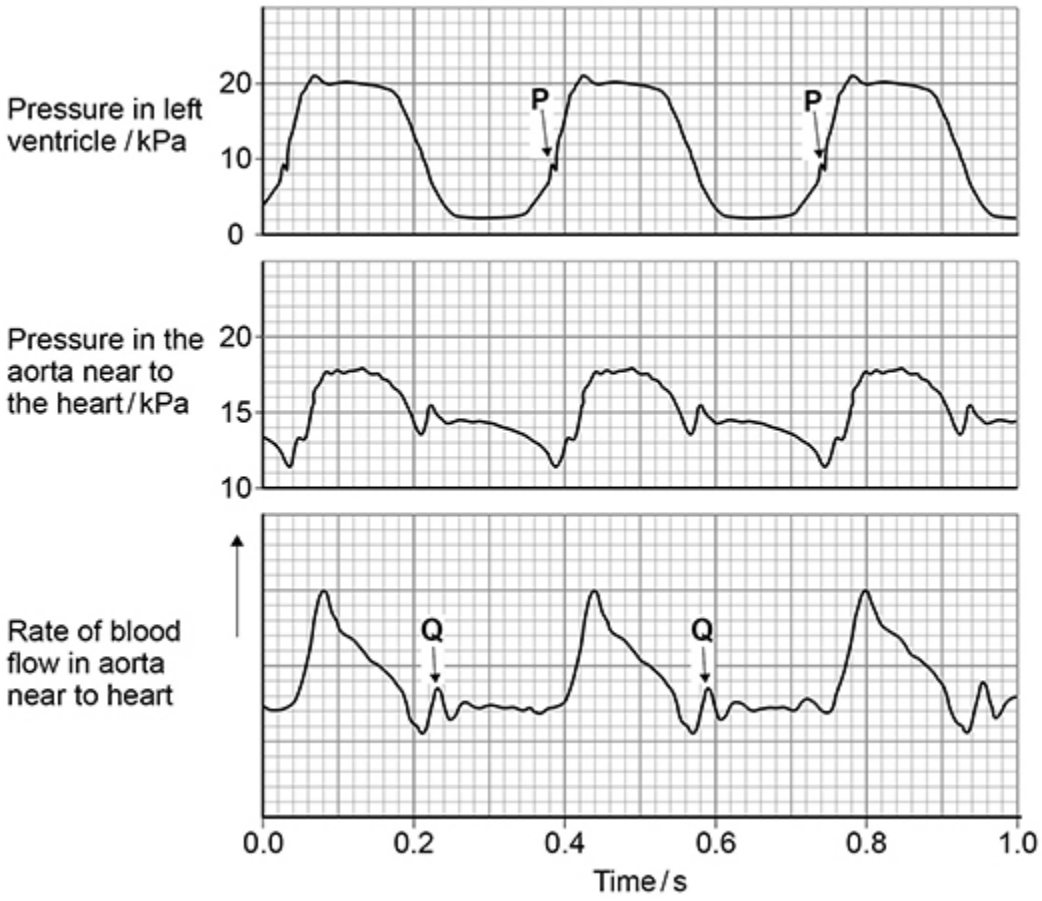
(c) Tissue fluid is formed from blood at the arteriole end of a capillary bed.

Explain how water from tissue fluid is returned to the circulatory system.

(4)

(Total 9 marks)

2. The diagram below shows pressure and blood flow during the cardiac cycle in a dog.



(a) At **P** on the diagram above, the pressure in the left ventricle is increasing. At this time, the rate of blood flow has not yet started to increase in the aorta.

Use evidence from diagram above to explain why.

_____

_____

_____

_____

_____

(2)

(b) At **Q** on the diagram above there is a small increase in pressure **and** in rate of blood flow in the aorta.

Explain how this happens **and** its importance.

_____

_____

_____

_____

_____

(2)

(c) A student correctly plotted the right ventricle pressure on the same grid as the left ventricle pressure in diagram above.

Describe **one** way in which the student's curve would be similar to and **one** way it would be different from the curve shown in the diagram above.

Similarity _____

_____

_____

_____

Difference _____

_____

_____

_____

(2)

(d) Use information from the diagram above to calculate the heart rate of this dog.

Heart rate _____ beats minute^{-1}

(1)

(Total 7 marks)

3. A student dissected an organ from a mammal to observe blood vessels.

He dissected a slice of the organ and identified two blood vessels.

Figure 1 shows a photograph of his dissection.

Figure 1

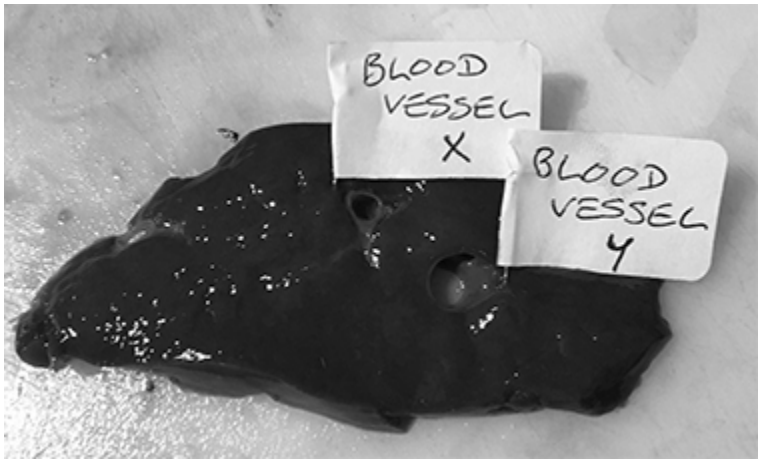
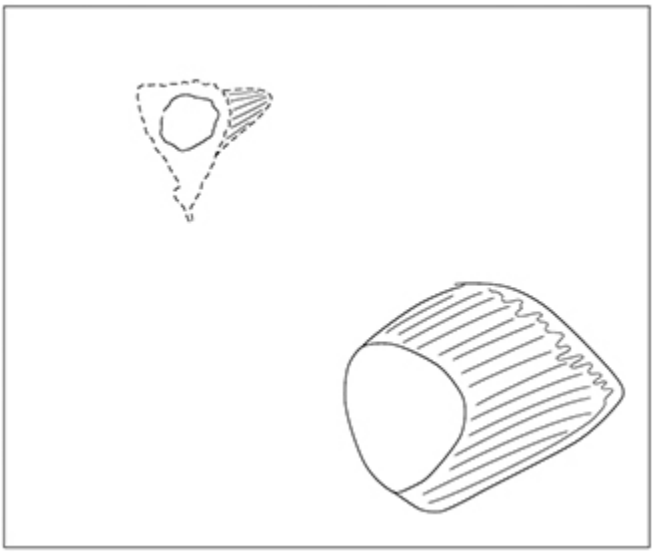


Figure 2 shows a drawing of the blood vessels from his dissection.

Figure 2



(a) Suggest **two** ways the student could improve the quality of his scientific drawing of the blood vessels in this dissection.

1 _____

_____

2 _____

_____

(2)

(b) Identify the type of blood vessel labelled as **X** and the type of blood vessel labelled as **Y** in **Figure 1**.

Describe **one** feature that allowed you to identify the blood vessels.

Blood vessel **X** _____

Blood vessel **Y** _____

Feature _____

_____

(2)

(c) Describe **two** precautions the student should take when clearing away after the dissection.

1 _____

_____

2 _____

_____

(2)

(Total 6 marks)

4. (a) Explain how an arteriole can reduce the blood flow into capillaries.

_____

_____

_____

_____

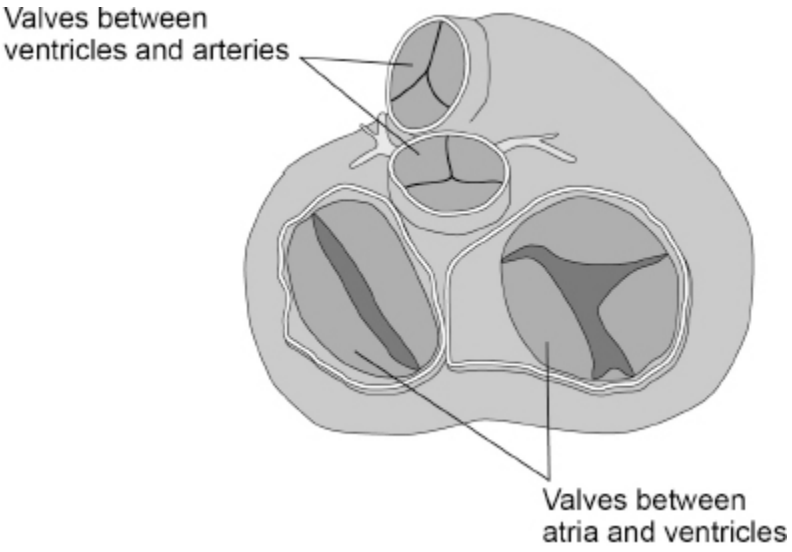
_____

_____

(2)

The image below shows heart valves during one stage of a cardiac cycle.

Ventricles are visible through the open valves.



(b) What can you conclude from the appearance of valves in the image above about heart muscle activity and blood movement between:

1. ventricles and arteries?

_____

_____

_____

_____

_____

_____

(2)

2. atria and ventricles?

_____

_____

_____

_____

_____

_____

(2)

(c) Tick (✓) **one** box next to the blood vessel carrying blood at the lowest blood pressure.

Capillary	☐
Pulmonary vein	☐
Renal vein	☐
Vena cava	☐

(1)

(d) A scientist measured the heart rate and the volume of blood pumped in a single heart beat (stroke volume) of an athlete before exercise and calculated the cardiac output.

Cardiac output is calculated using this equation.

cardiac output = heart rate × stroke volume

Her results are shown in the table below.

Heart rate / beats minute^{-1}	**Stroke volume / cm^3**	**Cardiac output / cm^3 minute^{-1}**
62	80	4960

After exercise, the athlete's stroke volume increased by 30% and the cardiac output was 13 832 cm^3 minute $^{-1}$

Calculate the athlete's heart rate after exercise.

Give the answer to 2 significant figures. Show your working.

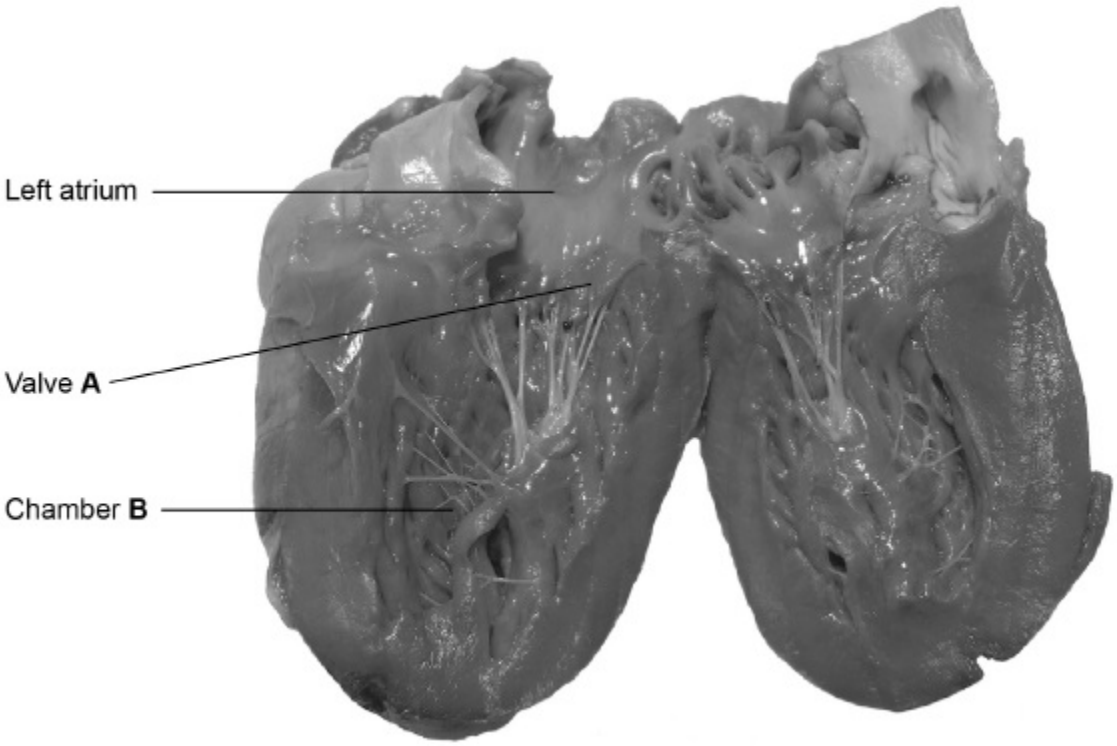
Heart rate _____ beats minute $^{-1}$

(2)

(Total 9 marks)

5. **Figure 1** shows a photograph of a dissected heart.

Figure 1



(a) Name valve **A** and chamber **B**.

Valve **A** _____

Chamber **B** _____

(1)

(b) Give **two** safety precautions that should be followed when dissecting a heart.

1 _____

_____

_____

_____

2 _____

_____

_____

_____

(1)

(c) Explain how valve **A** in **Figure 1** maintains a unidirectional flow of blood.

(2)

A research scientist investigated the effect of caffeine on heart rate in human volunteers.

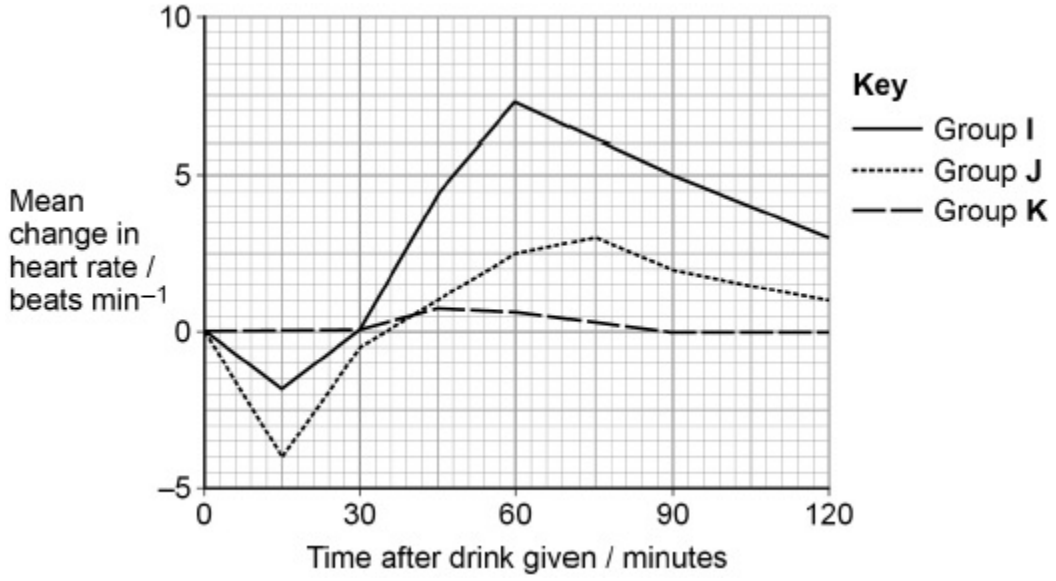
The scientist divided volunteers into three groups. Each group was given the same volume of fluid.

- Each member of Group **I** was given a sports drink containing caffeine and sugar.
- Each member of Group **J** was given a sports drink containing caffeine and no sugar.
- Each member of Group **K** was given water.

The scientist recorded the volunteers' heart rate before the drink was given and for 120 minutes after the drink was given.

Her results can be seen in **Figure 2**.

Figure 2



(d) Caffeine affects the autonomic nervous system.

Suggest how caffeine could account for the results of Group **I** in **Figure 2** at 60 minutes.

_____

_____

_____

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_____

(2)

(e) Before taking the drink, the mean heart rate of Group **J** was 68 beats per minute.

Fifteen minutes after taking the drink, the mean volume of blood leaving the hearts of Group **J** was 4700 cm^3 per minute.

Calculate the mean volume of blood leaving the heart at each beat fifteen minutes after taking the drink.

Answer = _____ cm^3

(1)

(f) The increase seen in Group **I** could be due to the combination of caffeine and sugar.

Suggest **one** drink to be given to an **additional** group that should be investigated to find out if this is true.

Give a reason for your answer.

Group to be given _____

_____

_____

Reason _____

_____

_____

_____

_____

_____

_____

(2)

(Total 9 marks)

6. 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.

_____

_____

_____

(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?

(3)

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

(2)

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

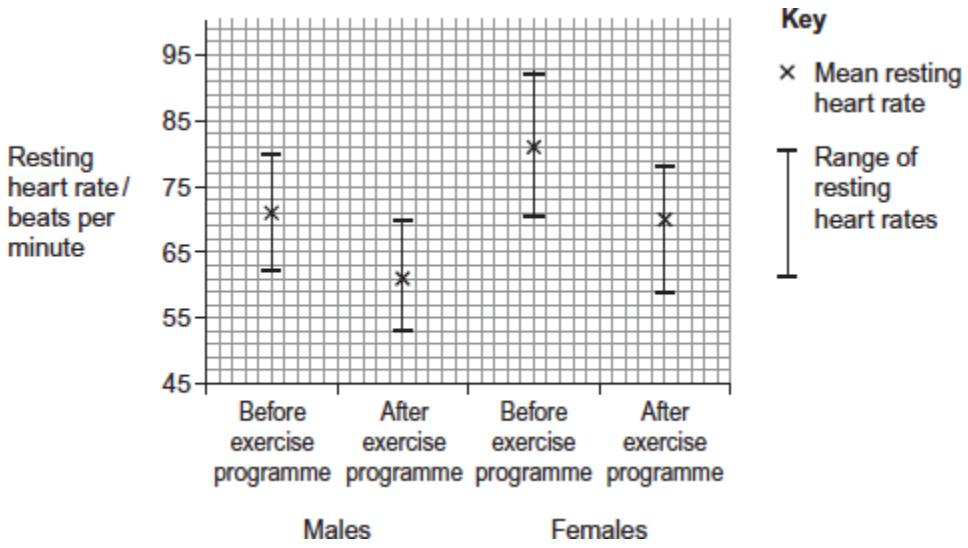
(1)

(Total 10 marks)

7. 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.

_____

_____

_____

_____

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(2)

(Total 7 marks)