

Structured Questions: Paper 2

6.2 The Blood System

6.2.1 The Blood System: History / 6.2.2 The Blood System: Vessels / 6.2.3 The Blood System: Double Circulation / 6.2.4 The Blood System: Cardiac Cycle / 6.2.5 The Heart Rate / 6.2.6 Skills: The Blood System

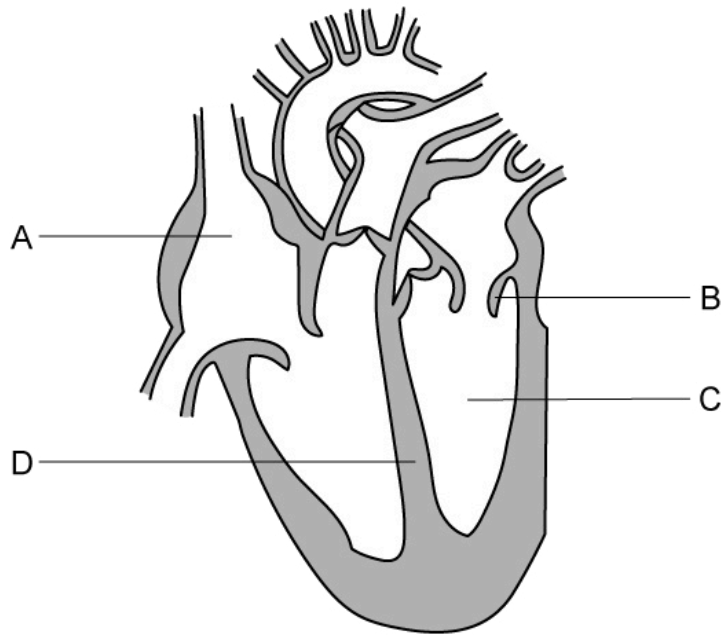
Easy (5 questions)	/39
Medium (5 questions)	/47
Hard (5 questions)	/39
Total Marks	/125

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Easy Questions

1 (a) The following diagram shows the internal structure of the heart.



A and C represents two heart chambers.

(i) Label chambers **A** and **C**.

[2]

(ii) State **one** difference in the function of **A** and **C**.

[1]

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(3 marks)

(b) State the main difference between the blood found in the chambers on the left and right side of the heart.

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(1 mark)

(c) Structure **B** plays an important role in the flow of blood through the heart.

(i) Label structure **B**.

[1]

(ii) State the role of structure **B** in the flow of blood through the heart.

[1]

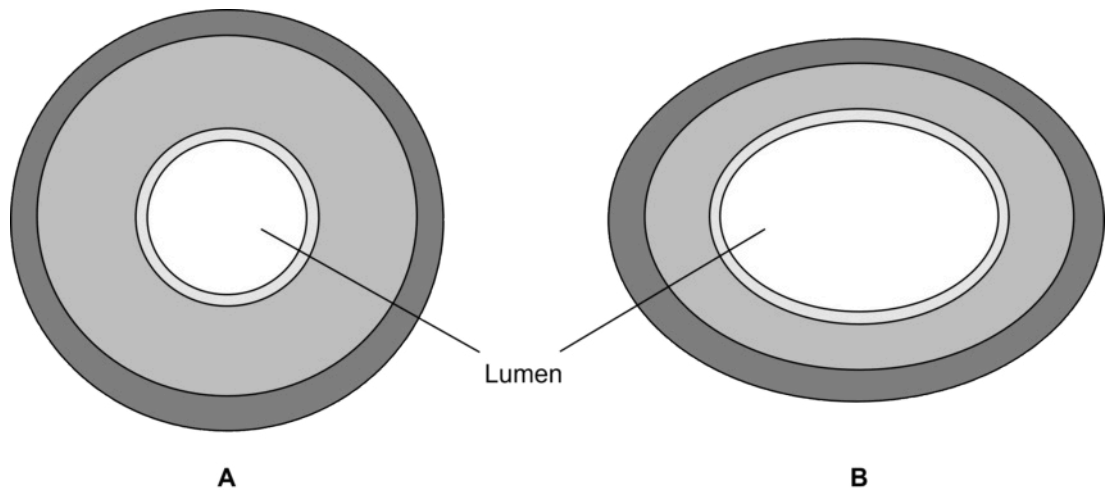
(2 marks)

(d) Structure **D** is a wall of muscular tissue.

Describe the purpose of structure **D** in the heart.

(1 mark)

2 (a) The following diagram compares the structure of two main blood vessels in the body.



(i) Identify blood vessel **A**.

[1]

(ii) State a reason for your answer in part i).

[1]

(2 marks)

(b) Blood vessel **B** has a very large lumen.

(i) Identify blood vessel **B**.

[1]

(ii) State **one** reason for the presence of a large lumen in blood vessel **B**.

[1]

(2 marks)

- (c) The flow of blood in veins is not assisted by the pressure generated by the beating of the heart.

List **two** structures that assist with the flow of blood in veins.

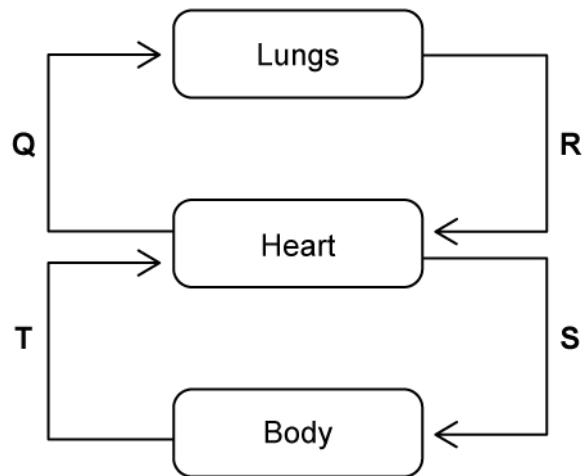
(2 marks)

- (d) Systolic pressure is one of the measurements taken by a doctor to determine the blood pressure of a patient.

Define the term 'systolic pressure'.

(1 mark)

3 (a) The following diagram shows part of the blood circulation of a mammal.



(i) Identify **one** example of an artery in this diagram.

[1]

(ii) Based on the information in the diagram, state a reason for your answer in part i).

[1]

(2 marks)

(b) Mammals have two separate circulations that supply blood to different organs.

State the name of the circulation that blood vessels **T** and **S** form part of.

(1 mark)

(c) The following table shows the mean pressure (in mmHg) measured in different blood vessels of the body.

Blood vessel	Mean blood pressure / mmHg
Aorta	94
Arteries	90
Arterioles	68
Capillaries	24
Venules	10
Veins	3
Vena Cava	2

Calculate the percentage difference between the mean blood pressure of the aorta and vena cava. Show your working and give your answer to three significant figures.

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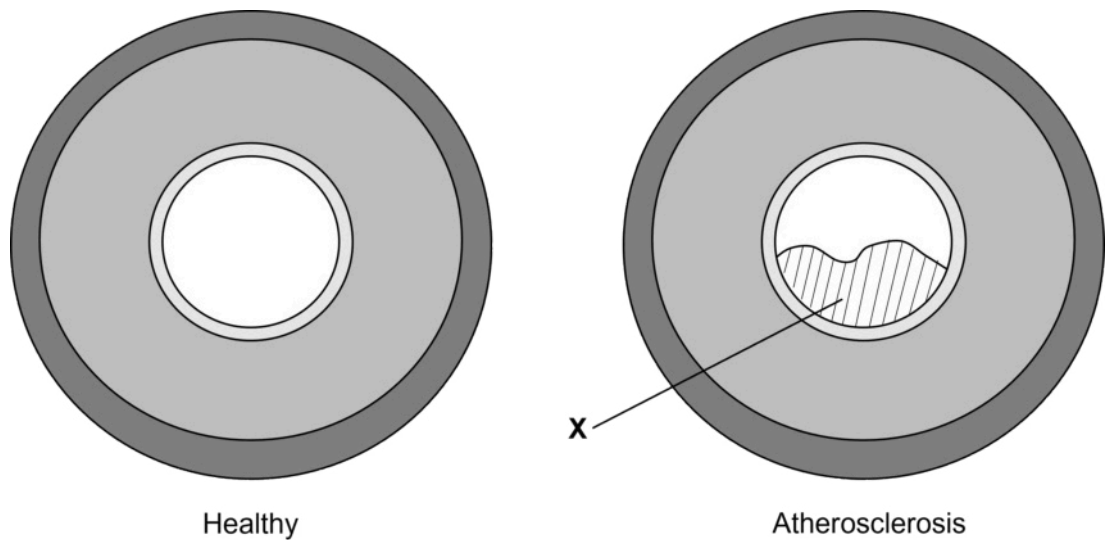
(2 marks)

(d) Using the table provided, identify the blood vessels where the greatest decrease in mean blood pressure occurs.

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(1 mark)

- 4 (a) The following diagram compares the structure of an artery of a healthy person with that of someone suffering from atherosclerosis.



Identify structure X.

.....
(1 mark)

- (b) Atherosclerosis can lead to the occlusion of arteries over time.

Define the term 'occlusion'.

.....
(1 mark)

- (c) Occlusion of the arteries can have a serious impact on cardiovascular health.

List **two** consequences of an occlusion of the arteries.

.....
.....
(2 marks)

- (d) When blood flow to part of the heart muscle is restricted it will impair its ability to contract fully. This will reduce blood flow, and therefore oxygen flow, to the body tissues.

State **one** way in which the heart will compensate for this.

(1 mark)

5 (a) *One mark is available for clarity of communication throughout this question.*

Atherosclerosis results in a build-up of fatty deposits known as plaque inside arteries, which may lead to coronary heart disease.

Outline the risk factors for developing atherosclerosis.

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(5 marks)

(b) Capillaries provide the exchange surface in the tissues of the body.

List **three** characteristics of capillaries.

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(3 marks)

(c) Describe the flow of oxygenated blood through the left side of the heart as it returns from the lungs.

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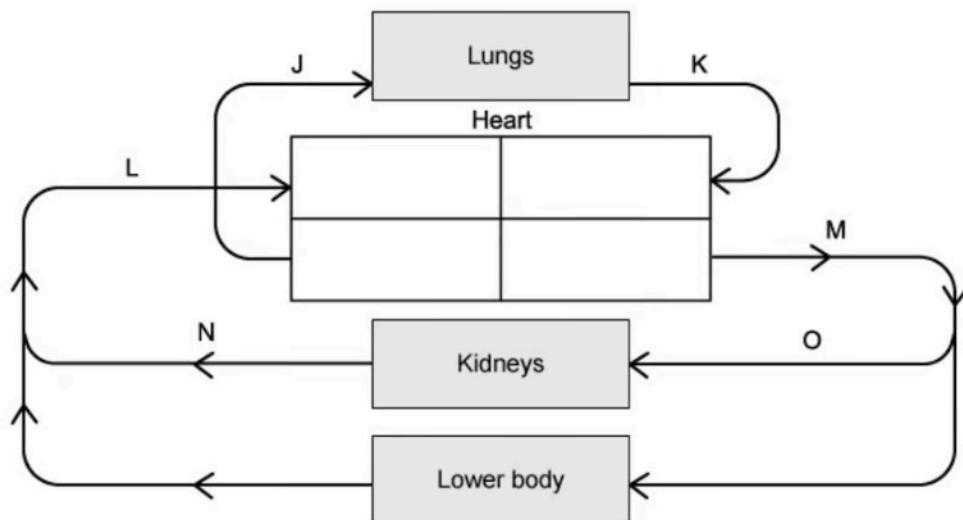
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(6 marks)

Medium Questions

1 (a) The diagram below shows part of the blood circulation in a mammal.



Identify the letter that represents each of the following blood vessels

Pulmonary vein

Pulmonary artery

(2 marks)

(b) Explain the function of the coronary arteries.

(2 marks)

(c) The human circulatory system is a closed, double circulatory system.

Explain what is meant by this.

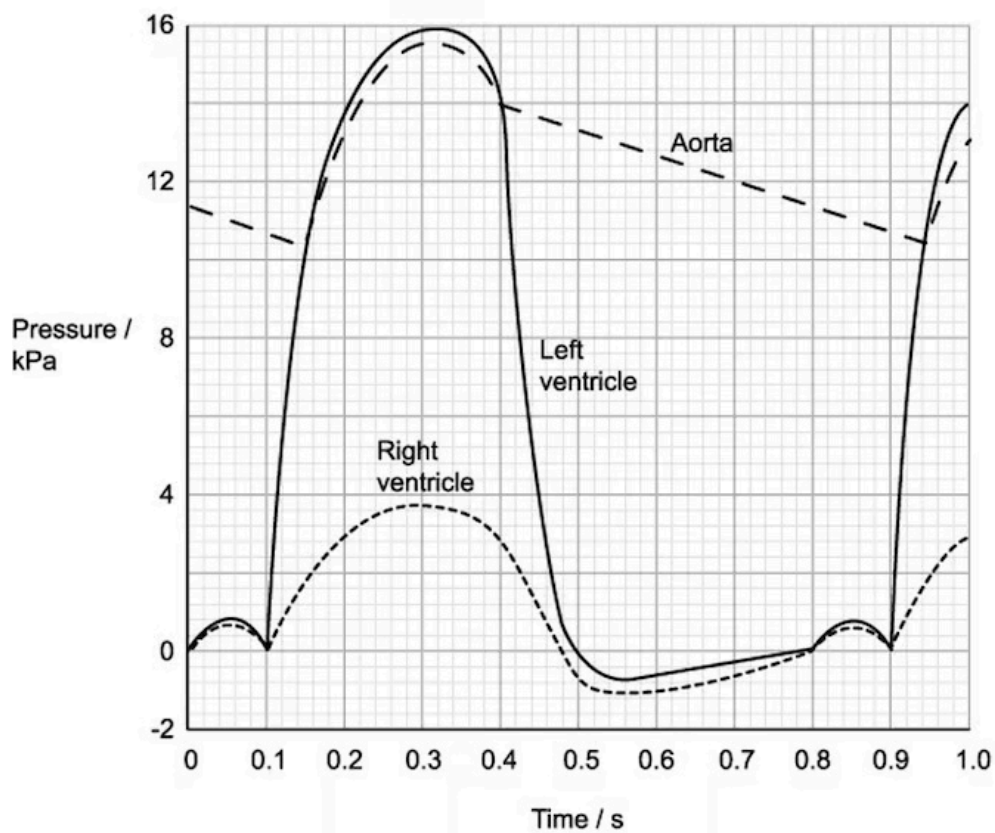
(2 marks)

(d) Babies can sometimes be born with a small hole between the right and left ventricles of their heart.

Suggest why these babies often have problems supplying their tissues with enough oxygen.

(2 marks)

2 (a) The graph below shows changes in pressure in parts of a human heart during one second.



Identify the time at which the semilunar valves open.

..... (1 mark)

(b) Use the graph from part (a) to calculate the heart rate in beats per minute (bpm)

..... (1 mark)

(c) Valves are important structures found in the heart and veins.

Explain how valves work.

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(2 marks)

- (d)** Ventricular systole causes an increase in pressure in the aorta shown at around 0.16 seconds in part (a)

Explain why this increase in aortic pressure is important for the organism.

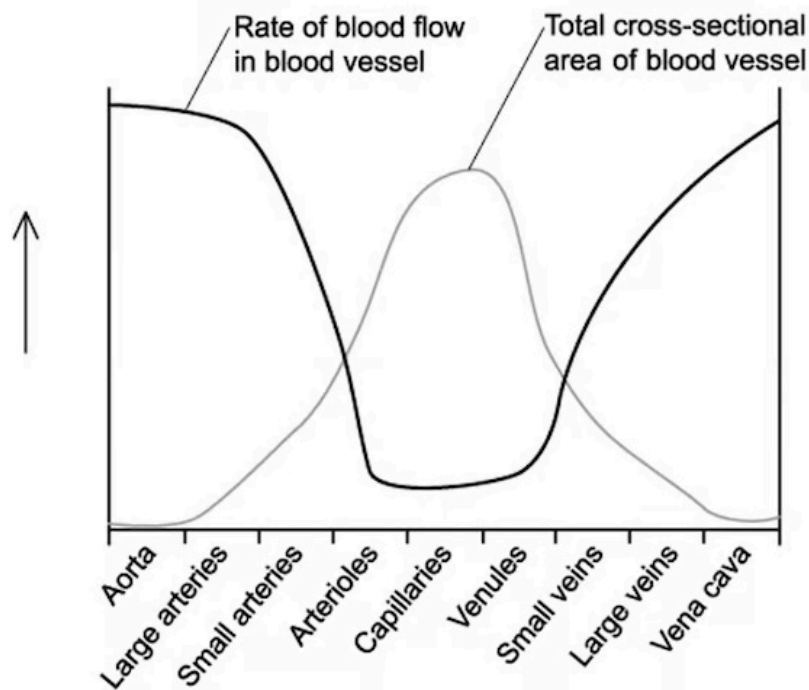
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(3 marks)

- 3 (a) The graph below shows the rate of blood flow in various blood vessels in the body. It also shows the total cross-sectional area of the vessels.



Suggest why the rate of blood flow increases from the venules to the vena cava despite a large decrease in the total cross-sectional area.

(1 mark)

- (b) The relative thickness of layers in the wall of an artery and a vein are shown in the table below.

Layer in wall	Thickness / μm	
	Artery	Vein
Endothelium	25	25
Smooth muscle	495	245
Elastic tissue	375	245
Connective tissue	125	125

Explain the difference in the thickness of elastic tissue for the artery versus the vein.

(2 marks)

(c) The external diameter of a vein was measured at 1.5 mm.

Calculate the diameter of the lumen of the vein.

(2 marks)

(d) Explain how the structure of capillaries enable them to function efficiently as exchange surfaces.

(3 marks)

- 4 (a) Plant sterols and plant stanols are found in a range of food, including vegetables, cereals, seeds and nuts. Plant sterols and stanols have a similar structure to cholesterol and reduce the absorption of cholesterol in the small intestine, so more cholesterol is lost in the faeces. This helps to lower the levels of cholesterol in the blood and in turn, reduce the risk of coronary heart disease (CHD).

A group of scientists wanted to investigate the effects of eating plant sterols and stanols on the risk of CHD. The scientists randomly divided healthy volunteers into two groups. Every day for eight weeks, one group was given plant sterols and stanols to eat. The other group acted as a control.

Each week, the scientists measured the diameter of the lumen of the main artery in the arm of the volunteers.

State how the control group should have been treated.

(2 marks)

- (b) The results of the experiment in part (a) are shown in the table below.

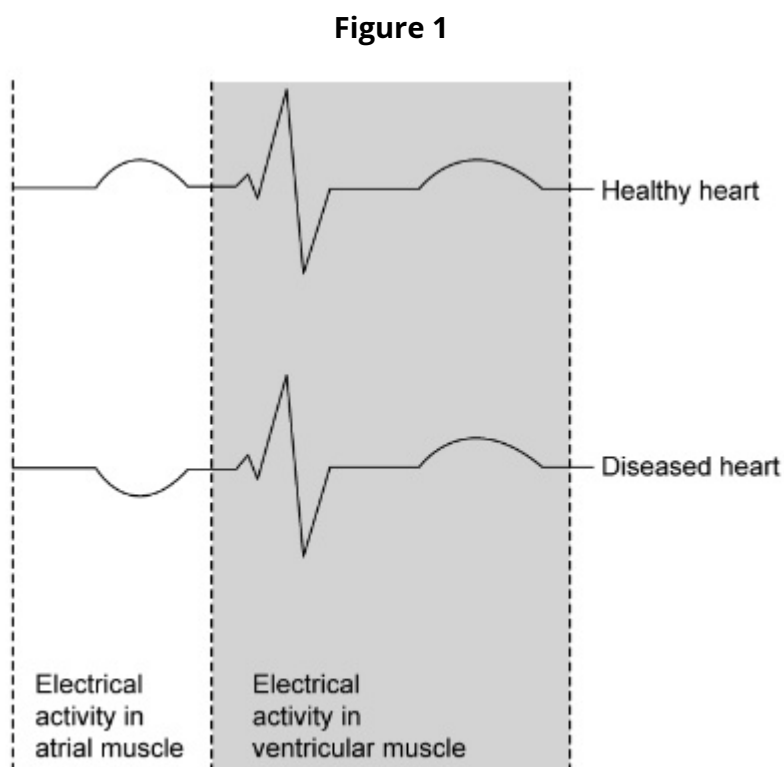
	Mean maximum diameter of lumen of main artery in the arm (mm)	
	Experimental group (\pm standard deviation)	Control group (\pm standard deviation)
Before experiment	0.69 (\pm 0.02)	0.71 (\pm 0.02)
After 8 weeks	0.74 (\pm 0.03)	0.72 (\pm 0.05)

A student reading the results concluded that there was sufficient evidence to assume a causal relationship between plant sterols and stanols, and a reduced risk of CHD.

Evaluate the student's conclusion.

(3 marks)

- (c) An electrocardiogram (ECG) measures the electrical fluctuation within a cardiac muscle as a heart is beating. The diagram below shows an ECG trace for a normal, healthy person and an ECG trace for a person suffering from heart disease.



Describe the path that electrical impulses follow when they are transmitted from the sinoatrial node to cause contraction in the ventricular muscle in a healthy heart.

(2 marks)

- (d) Suggest how the information from part (c) shows that the damage caused to the diseased heart is likely to have affected the sinoatrial node (SAN).

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Explain what causes heart rate to increase during exercise.

(6 marks)

(b) Describe how blood returns to the heart from the legs.

(4 marks)

(c) Outline William Harvey's theories about circulation

(5 marks)

Hard Questions

- 1 (a) Based on your knowledge of diffusion, explain why multicellular organisms need a specialised transport system.

(2 marks)

- (b) The following table shows the volume of blood present in the left ventricle of a person at different times over the course of one second.

Time / s	Volume of blood in left ventricle / cm ³
0.0	105
0.1	117
0.2	89
0.3	63
0.4	45
0.5	55
0.6	87
0.7	105
0.8	119
0.9	90
1.0	62

Use the information in the table to calculate the heart rate (beats min⁻¹) of this person. Show your working.

(2 marks)

(c) During ventricular systole, the muscular wall of the ventricles contract.

(i) Based on the information provided in the table in part a), determine during which time interval(s) the heart was in ventricular systole.

[1]

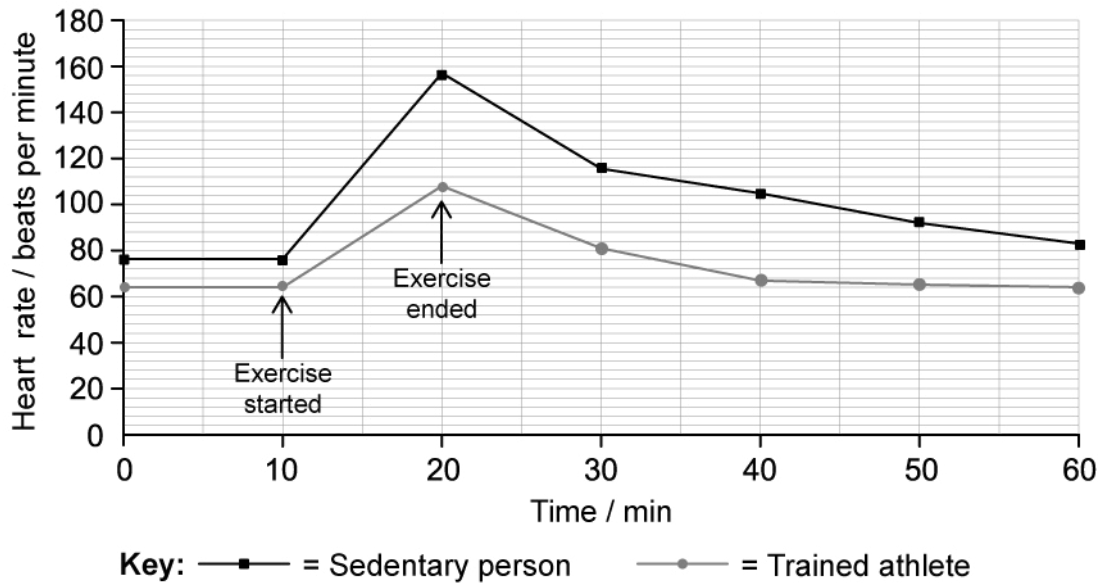
(ii) Explain your answer in part i).

[1]

(2 marks)

2 (a) A group of students investigated the effect of a person's fitness level on the heart rate before, during and after exercising. They measured the resting heart rate of an unfit person leading a sedentary lifestyle and that of a trained athlete. After monitoring their resting heart rate for 10 minutes, both participants were asked to run for a period of 10 minutes. Their heart rates were monitored during this time by a heart rate monitor that was attached to their wrists. After exercising, their heart rates were monitored for a period of 40 minutes.

The results of this investigation is shown in the following graph.



Contrast the results of the two participants.

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(3 marks)

(b) Explain the mechanisms that caused the change in heart rate that was observed after the exercise ended.

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(3 marks)

- (c)** The group of students concluded that an increased fitness level enables the heart to recover more quickly after exercise.

Evaluate the conclusion of the students.

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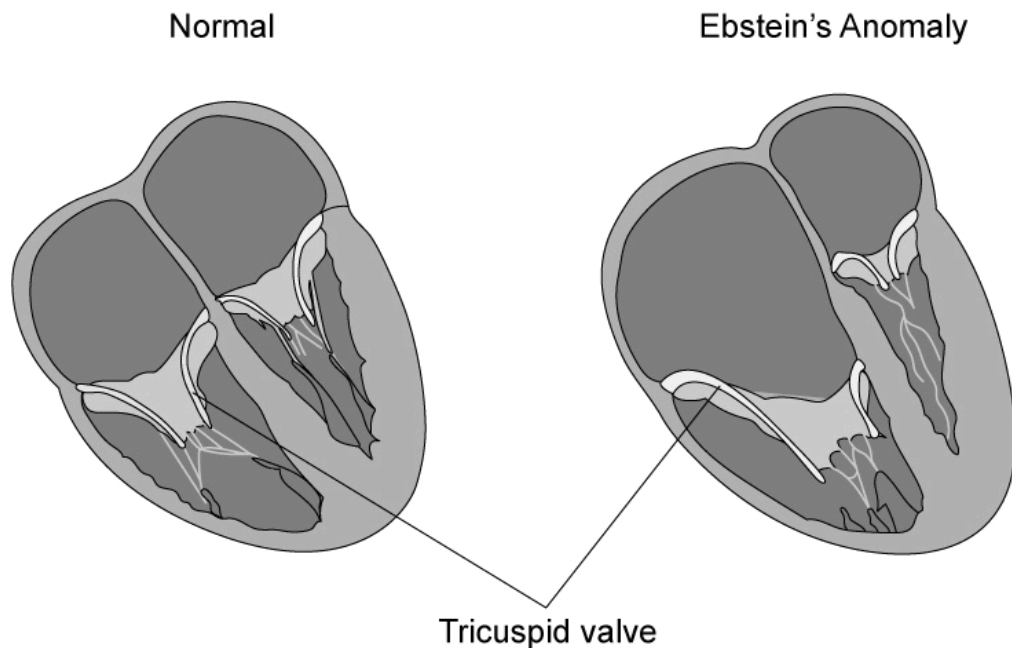
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(3 marks)

- 3 (a)** Ebstein's anomaly is a birth defect where the tricuspid valve is displaced from its normal position between the right atrium and ventricle. This defect will often cause the valve to not function properly. Babies born with Ebstein's anomaly will require surgery to correct the defect.

The following diagram compares the structure of a normal heart with the heart of a person born with Ebstein's anomaly.



Explain the effect that a faulty heart valve may have on the flow of blood through the right side of the heart.

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(2 marks)

- (b)** Babies born with Ebstein's anomaly will often develop an enlarged heart and swollen limbs once they reach adulthood.

Based on the information provided in part a), suggest a reason for each of these symptoms.

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(2 marks)

- (c) Tricuspid valve surgery is a very effective way to treat patients born with Ebstein's anomaly and restore heart function back to normal. One way to measure the effectiveness of this treatment is to investigate the increase in cardiac output before and after surgery.

Cardiac output is the amount of blood that the heart pumps per minute.

A patient born with Ebstein's anomaly has a mean heart rate of 78 beats per minute and with every heart beat, 45 cm^3 of blood leaves the heart.

Calculate the cardiac output ($\text{dm}^3\text{min}^{-1}$) of this patient. Show your working.

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(2 marks)

- (d) After the surgery, the cardiac output of the patient from part c) increased by 25%.

Calculate the cardiac output ($\text{dm}^3\text{min}^{-1}$) after surgery.

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(1 mark)

- 4 (a)** Carnitine is a chemical that plays an essential role in energy metabolism by transporting long-chain fatty acids into mitochondria in cells where they are then oxidised. It is often used as a supplement by athletes to enhance their athletic performance and to aid in weight loss.

Recent studies have linked the prolonged use of carnitine supplements with increased levels of trimethylamine N-oxide (TMAO) in the bloodstream. TMAOs can trigger inflammatory and immune responses in the body, as well as elevated blood glucose levels.

Based on the information provided, explain why increased TMAO levels could increase the risk of suffering a heart attack.

(2 marks)

- (b)** Scientists investigated the effect of carnitine in the diet on the plasma concentration of TMAO in mice. Four groups, consisting of ten mice each, were fed one of four possible diets.

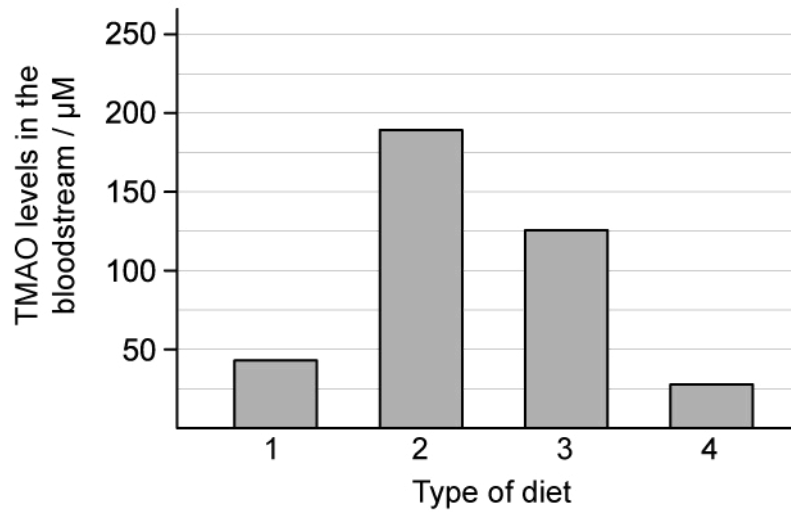
- Diet 1 - a normal mouse diet with natural carnitine levels
- Diet 2 - a normal mouse diet with added carnitine
- Diet 3 - a low carnitine mouse diet
- Diet 4 - a normal mouse diet with added carnitine and antibiotics

The TMAO levels in the bloodstream of the mice were measured over time and a mean for each group was calculated.

Suggest a possible hypothesis for this investigation.

(1 mark)

- (c)** The results of the investigation described at part b) are shown in the following graph.



Key: 1 - normal 3 - carnitine poor
 2 - carnitine rich 4 - carnitine + antibiotics

Explain the results from the group that followed diet 4.

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(1 mark)

(d) The scientists concluded that a diet high in carnitine will increase levels of TMAO in the bloodstream in humans.

Evaluate this conclusion.

.....

(3 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

The sinoatrial node (SAN) is considered to be the pacemaker of the heart.

Explain this statement.

(3 marks)

(b) Outline the pressure changes that occur during one cardiac cycle and the effect this has on the valves in the heart.

(7 marks)