

6.2 The Blood System

Question Paper

Course	DP IB Biology
Section	6. Human Physiology
Topic	6.2 The Blood System
Difficulty	Hard

Time allowed: 50
Score: /39
Percentage: /100

Question 1a

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

[2 marks]

[2 marks]

Question 1b

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]

[2 marks]

Question 1c

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 mark]

ii)
Explain your answer in part i).

[1 mark]

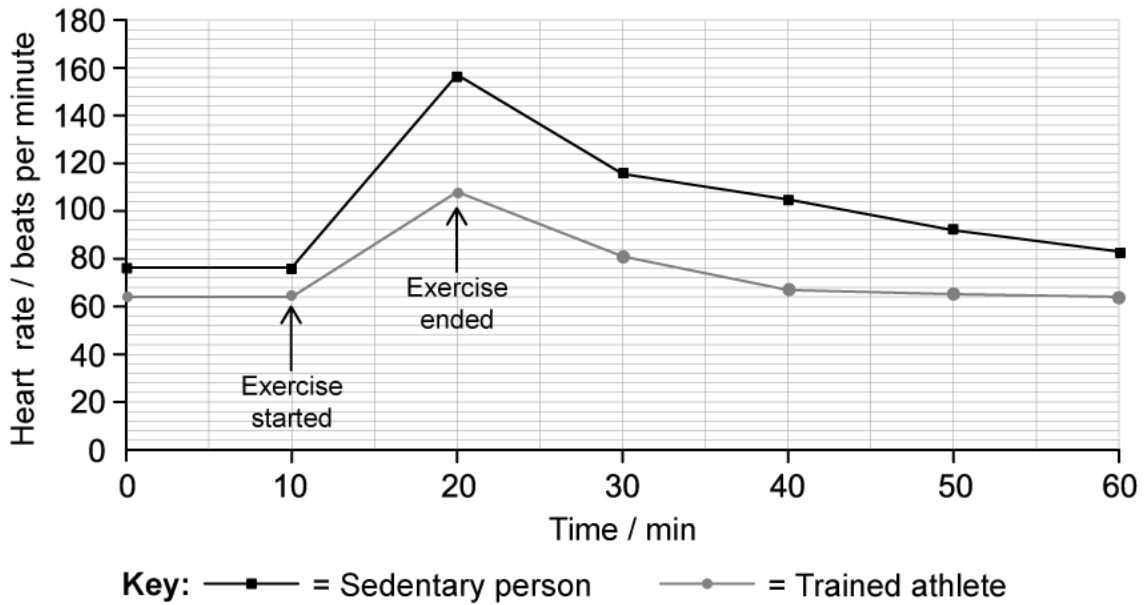
[2 marks]

Question 2a

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.

[3 marks]

[3 marks]

Question 2b

b)

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

[3 marks]

[3 marks]

Question 2c

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.

[3 marks]

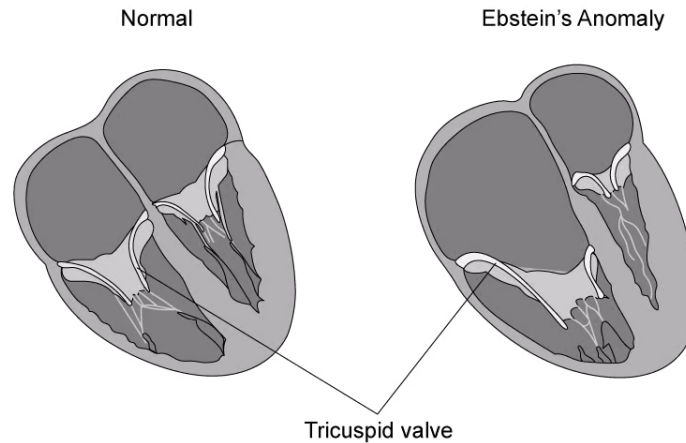
[3 marks]

Question 3a

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.

[2 marks]

[2 marks]

Question 3b

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.

[2 marks]

[2 marks]

Question 3c

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.

[2 marks]

[2 marks]

Question 3d

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.

[1 mark]

[1 mark]

Question 4a

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]

[2 marks]

Question 4b

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.

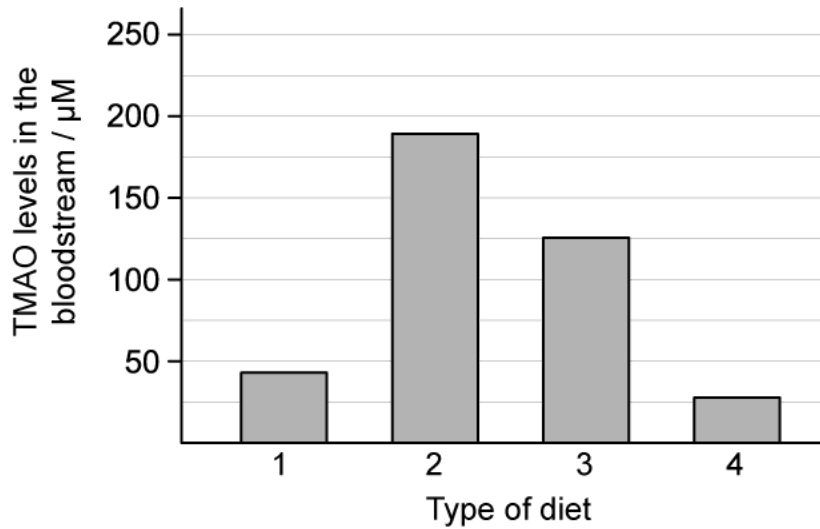
[1 mark]

[1 mark]

Question 4c

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.

[1 mark]

[1 mark]

Question 4d

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]

[3 marks]

Question 5a

One mark is available for clarity of communication throughout this question.

a)

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

Explain this statement.

[3 marks]

[3 marks]

Question 5b

b)

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

[7 marks]

[7 marks]

