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Pearson Edexcel GCE
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Biology A (Salters Nuffield)

Advanced Subsidiary

Paper 1: Lifestyle, Transport, Genes and Health

Thursday 26 May 2016 – Afternoon

Time: 1 hour 30 minutes

Paper Reference

8BN0/01

You may need a ruler, a pencil and a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

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Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Tay-Sachs disease is a genetic disorder.

- (a) A couple without Tay-Sachs disease are expecting their second child. Their first child died from the disease.

Use a genetic diagram to determine the probability of their second child having Tay-Sachs disease.

(2)

T = normal allele (dominant), t = Tay-Sachs allele

Parents: $Tt \times Tt$ (both carriers)

Gametes: T or t T or t

	T	t
T	TT	Tt
t	Tt	tt

tt = Tay-Sachs disease

Probability of tt = 1 in 4 = 0.25

Answer 0.25 (25%)

- (b) Tay-Sachs disease can be detected during pregnancy.

Name the prenatal test that could be used to detect Tay-Sachs disease at 11 weeks of pregnancy.

(1)

Chorionic villus sampling (CVS)



(c) Explain why this couple may choose not to have this test.

(3)

The test result may be inaccurate, giving a false positive or a false negative.

CVS carries an increased risk of miscarriage due to the procedure, so a healthy fetus could be lost.

A false positive result may lead to the termination of a healthy fetus.

Prenatal testing, or abortion, may be against the values or religious beliefs of the parents, or they may not want to know.

(Total for Question 1 = 6 marks)



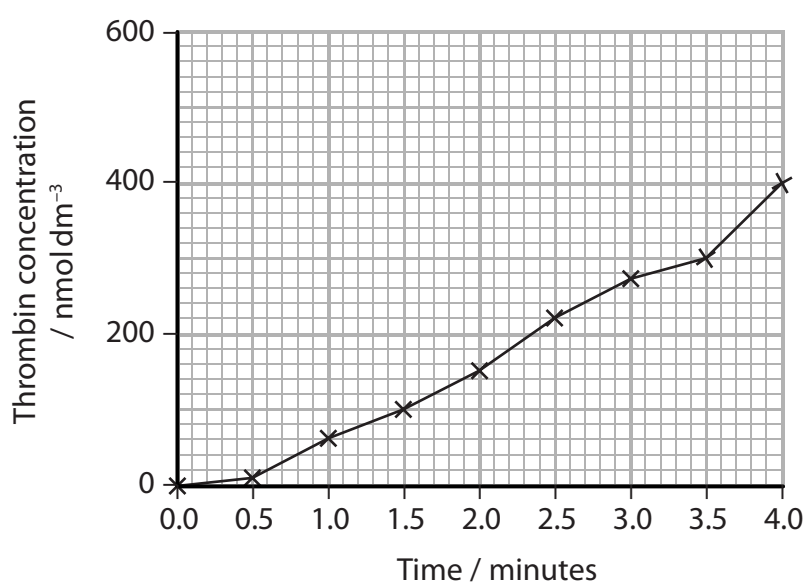
- 2 The photograph shows the tropical rattlesnake, *Crotalus durissus terrificus*.



This snake produces a toxin called convulxin (CVX), which activates platelets leading to blood clotting.

- (a) The effect of CVX on the rate of thrombin production was investigated.

The graph shows the concentration of thrombin in a sample of blood treated with CVX.



- (i) Calculate the rate of thrombin production during the last two minutes of this investigation. (2)

$$\begin{aligned} \text{rate} &= (400 - 150) \div 2 \\ &= 125 \end{aligned}$$

Answer $125 \text{ nmol dm}^{-3} \text{ min}^{-1}$

- (ii) State and justify a suitable control for this investigation. (2)

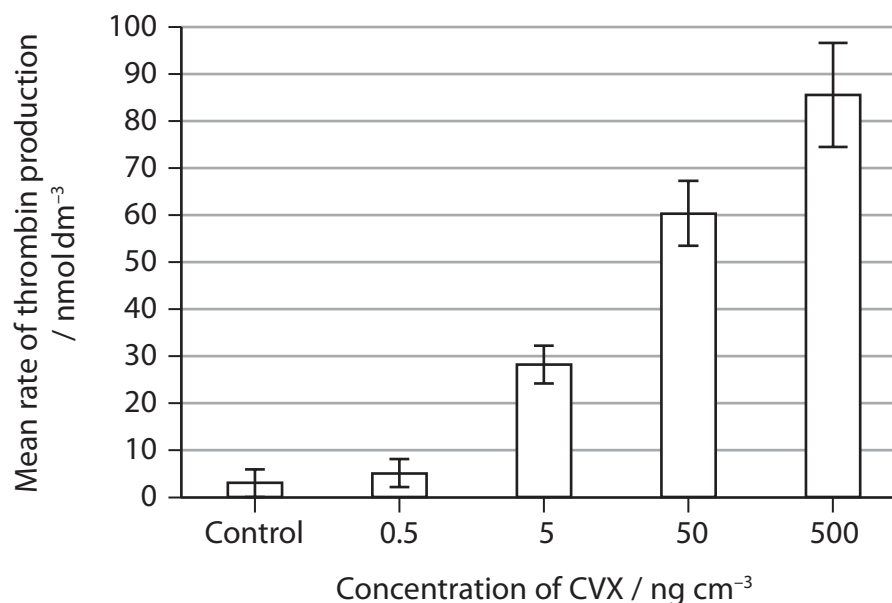
A sample of the same blood without CVX (untreated, or treated with the same volume of saline).

This allows comparison with the normal rate of thrombin production, to show that any increase is due to CVX.



- (b) The effect of four different concentrations of CVX on thrombin production was investigated.

The graph shows the results of this investigation, with bars showing the standard deviation.



Analyse the data to assess the effect of CVX on the rate of blood clotting.

(5)

Thrombin production increases as CVX concentration increases, from about 3 in the control to 85 nmol dm^{-3} at 500 ng cm^{-3} .

The relationship is not directly proportional (not linear): each tenfold increase in CVX does not give the same increase.

There is little difference between the control and 0.5 ng cm^{-3} ; the greatest increase is from 5 to 50 ng cm^{-3} .

The standard deviation bars overlap between the control and 0.5 ng cm^{-3} , so there is no significant difference between them.

Greater thrombin production leads to faster conversion of fibrinogen to fibrin, so CVX increases the rate of blood clotting.



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- (c) Haemophilia is a disease that affects blood clotting. People with haemophilia are sometimes given a protein called factor VIII. Factor VIII is an enzyme that is involved in the process of blood clotting.

Explain how a change in the primary structure of factor VIII could cause difficulties with blood clotting.

(4)

A change in the primary structure results in a different sequence of amino acids in factor VIII.

The change in R groups changes the bonding (hydrogen bonds, ionic bonds, disulfide bridges) and so the folding and tertiary structure.

This changes the shape (or charge) of the active site, so the substrate is no longer complementary and cannot bind.

This stops or reduces the clotting cascade, so less fibrin is produced and blood does not clot properly.

(Total for Question 2 = 13 marks)



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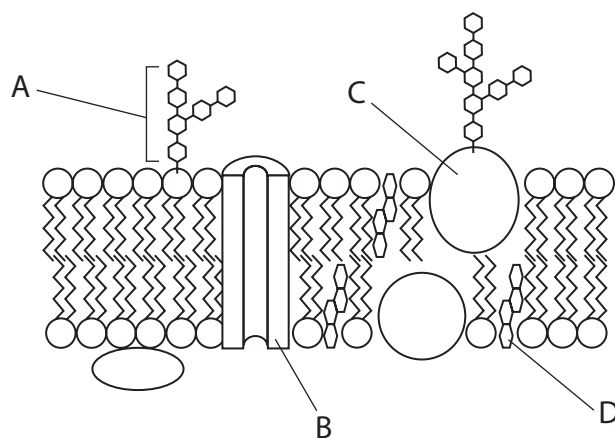
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3 The diagram shows part of a cell surface membrane.



(a) (i) Which of the molecules labelled in the diagram is a glycoprotein?

(1)

- ☐ A
- ☐ B
- ☒ C
- ☐ D

(ii) Describe the function of carrier proteins in a cell surface membrane.

(4)

Carrier proteins are involved in facilitated diffusion.

They move large molecules, polar molecules or ions across the membrane, which cannot pass through the phospholipid bilayer.

In facilitated diffusion, molecules move from a high concentration to a low concentration (down the concentration gradient).

Carrier proteins are also involved in active transport, which needs ATP to move molecules from a low to a high concentration, against the concentration gradient.



(b) Anthocyanins are purple pigments found in the cells of red cabbage leaves.

A student investigated the following hypothesis:

'The permeability of cell membranes in a red cabbage leaf is affected by the age of the plant.'

Devise an investigation the student could use to test this hypothesis and collect valid data.

(4)

Use red cabbage plants of at least five different ages, e.g. 2, 4, 6, 8 and 10 weeks old.

Use a cork borer to cut discs of leaf with the same surface area and mass from the same position on each plant, and rinse them in distilled water to remove pigment from cut cells.

Control other variables: grow the plants in the same conditions, and place the discs in the same volume (10 cm³) of distilled water at the same temperature (25 °C in a water bath) and pH for the same time (30 minutes).

Measure the permeability by placing a sample of the liquid in a colorimeter (green filter) and recording the absorbance; more anthocyanin leaked means a more permeable membrane.

Carry out at least three replicates for each age so that mean values can be calculated, and plot mean absorbance against age.

(Total for Question 3 = 9 marks)



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4 Cardiovascular disease (CVD) is a major cause of death in developed countries.

(a) A high body mass index (BMI) and diabetes are two risk factors for CVD.

(i) Which of the following is another risk factor for CVD?

(1)

- ☒ A high blood pressure
- ☐ B low blood cholesterol
- ☐ C low salt intake
- ☐ D using statins

(ii) A woman is 154 cm tall and has a mass of 61 kg. Her body mass index is calculated using the following formula.

$$\text{BMI} = \frac{\text{mass in kilograms}}{(\text{height in metres})^2}$$

Calculate her BMI to one decimal place.

(2)

$$\text{BMI} = 61 \div 1.54^2$$

$$= 61 \div 2.3716$$

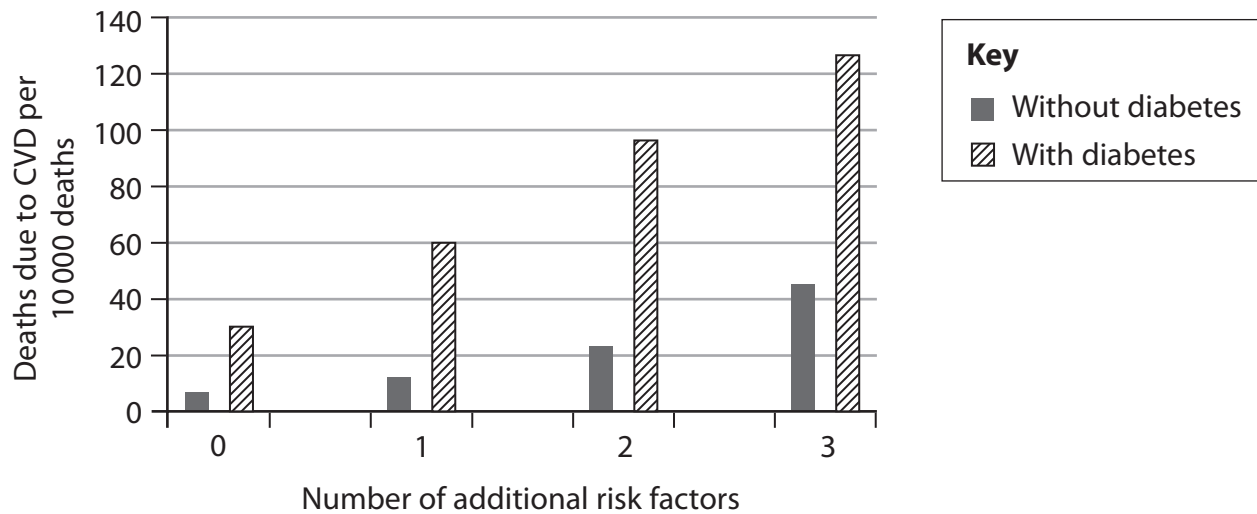
$$= 25.72$$

Answer 25.7



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(iii) The graph shows the effect of additional risk factors on deaths due to CVD for people with and without diabetes.



Identify the effect of the number of additional risk factors on deaths due to CVD for people with and without diabetes.

(2)

There is a positive correlation: as the number of additional risk factors increases, deaths due to CVD increase in both groups.

Deaths due to CVD are higher for people with diabetes than without diabetes for every number of risk factors, e.g. about 127 compared with 45 for three factors.



(b) It is possible to reduce the risk of CVD by taking medication or changing diet.

Explain the role of antihypertensive drugs in reducing the risk of atherosclerosis.

(4)

Antihypertensive drugs lower blood pressure.

Lower blood pressure reduces the risk of damage to the endothelium lining the artery.

This reduces the risk of an inflammatory response, in which white blood cells move into the artery wall and cholesterol builds up.

So there is a reduced risk of atheroma (plaque) formation, which narrows and hardens the artery in atherosclerosis.

(Total for Question 4 = 9 marks)



P 4 9 8 2 9 A 0 1 3 2 8

5 Muscle cells contain globular and fibrous proteins.

(a) Compare and contrast the molecular structures of globular and fibrous proteins.

(4)

Both globular and fibrous proteins are chains of amino acids joined by peptide bonds.

Both contain hydrogen bonds, ionic bonds and disulfide bridges holding the molecule in its three-dimensional shape.

Globular proteins have hydrophilic R groups on the outside (so are soluble), whereas fibrous proteins have hydrophobic groups on the outside (so are insoluble).

Globular proteins have tertiary or quaternary structures, whereas fibrous proteins have little or no tertiary structure.

Globular proteins are folded into compact, spherical shapes, whereas fibrous proteins are long chains (strands).

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(b) Describe the roles of transcription and translation in the synthesis of a globular protein by a muscle cell.

(5)

In transcription, the gene (sequence of DNA) for the globular protein is transcribed in the nucleus: the DNA unwinds and one strand is used as a template.

Free RNA nucleotides line up by complementary base pairing with the DNA bases (A with U, C with G) and are joined by RNA polymerase to produce mRNA.

The mRNA leaves the nucleus through a nuclear pore and attaches to a ribosome.

In translation, the codons on the mRNA pair with complementary anticodons on tRNA molecules.

Each tRNA provides a specific amino acid, and peptide bonds form between adjacent amino acids.

The sequence of bases (codons, the triplet code) determines the sequence of amino acids, i.e. the primary structure of the protein.

(Total for Question 5 = 9 marks)

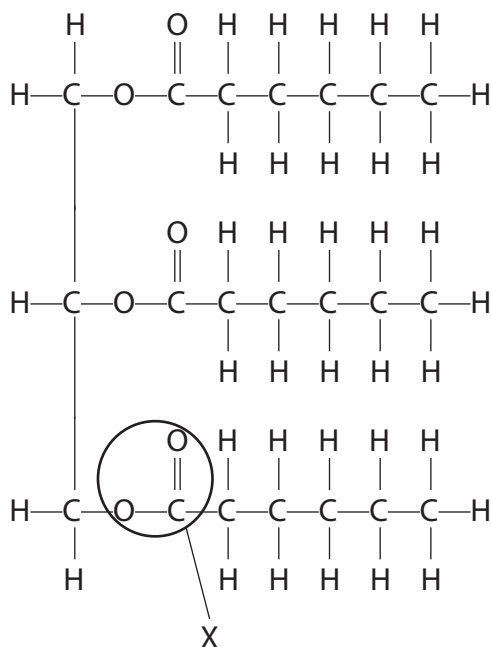


P 4 9 8 2 9 A 0 1 5 2 8

6 Hydrolytic enzymes are released by organs in the digestive system.

(a) Cells in the pancreas and small intestine synthesise lipase. Lipase hydrolyses lipids in food.

The diagram shows a triglyceride molecule.



(i) Which of the following is the name of the bond labelled X?

(1)

- ☒ A ester bond
- ☐ B glycosidic bond
- ☐ C hydrogen bond
- ☐ D phosphodiester bond

(ii) Name the process by which enzymes leave the cells of the pancreas and small intestine.

(1)

Exocytosis

(iii) Explain why the pH in the small intestine would change after lipase hydrolyses lipids.

(2)

Hydrolysis of lipids produces glycerol and fatty acids.

The fatty acids would cause the pH to decrease.



(b) The triglyceride in the diagram can combine with protein to form a lipoprotein.

Explain the effect that large quantities of this lipoprotein would have on blood cholesterol levels.

(4)

Large quantities of this lipoprotein would increase blood cholesterol levels.

This is because the triglyceride is saturated; its fatty acids have no C=C double bonds.

So the lipoprotein formed is an LDL (low-density lipoprotein).

LDLs transport cholesterol in the blood.

LDLs bind to receptors on cell surface membranes; if the receptors are overloaded, LDL accumulates in the blood, raising cholesterol.



(c) Glycogen and starch can be hydrolysed by enzymes.

Which row shows the correct features of the structure of glycogen?

(1)

☐ A	1,4-glycosidic bonds only	branched
☐ B	1,6-glycosidic bonds only	unbranched
☒ C	1,4-glycosidic bonds and 1,6-glycosidic bonds	branched
☐ D	1,4-glycosidic bonds and 1,6-glycosidic bonds	unbranched

(d) Starch contains two different molecules, amylose and amylopectin. The percentage of each molecule found in starch varies depending on its source.

The effect of amylose content on the hydrolysis of starch from different sources by enzymes was investigated.

Source of starch	Amylose content (%)	Percentage of starch hydrolysed after 4 hours (%)
Cassava	20.0	51.9
Peruvian carrot	18.7	54.2
Potato	28.9	39.6
Yellow maize	35.8	37.5

(i) Calculate the ratio of amylose to amylopectin in cassava. Give your answer in simplest form.

(1)

$$\text{amylopectin} = 100 - 20 = 80\%$$

$$20 : 80$$

Answer 1 : 4



- (ii) Explain the relationship between the composition of the starch and the rate of hydrolysis by enzymes.

(4)

As amylose content increases, the percentage of starch hydrolysed decreases, e.g. maize (35.8%) 37.5% compared with Peruvian carrot (18.7%) 54.2%.

The less amylose present, the greater the proportion of amylopectin.

Amylose is unbranched, whereas amylopectin is branched.

Amylopectin contains 1,4 and 1,6-glycosidic bonds.

The branches give a greater number of terminal ends for enzymes to act on, which increases the rate of hydrolysis.

(Total for Question 6 = 14 marks)



P 4 9 8 2 9 A 0 1 9 2 8

- 7 DNA is a double-stranded molecule. During transcription, the antisense and sense strands are separated.

Part of the antisense strand, with base sequence TACGCTGAC, is transcribed.

- (a) (i) State where transcription occurs in an animal cell.

(1)

In the nucleus

- (ii) Which row shows the correct sequence for the complementary sense strand and the mRNA produced in transcription?

(1)

	Sense strand	mRNA
☐ A	ATGCGACTG	ATGCGACTG
☐ B	TACGCTGAC	AUGCGACUG
☐ C	TACGCTGAC	ATGCGACTG
☒ D	ATGCGACTG	AUGCGACUG

- (b) A human gene is 27 000 base pairs long. In this section of double-stranded DNA there are 4050 nucleotides containing the base cytosine.

- (i) State what is meant by the term gene.

(1)

A sequence of bases (nucleotides) in DNA that codes for a polypeptide (protein).

- (ii) How many nucleotides in this gene contain the base adenine?

(1)

- ☐ A 9000
☐ B 18000
☒ C 22950
☐ D 45900



(c) Mutations to DNA can affect the structure of proteins produced in the cell.

Removing one base from a DNA sequence will affect the primary structure of a protein.

Changing one base for another may not affect the primary structure of a protein.

Explain why these two types of mutation have different effects on protein structure.

(4)

Deleting one base causes a frame shift, so every codon (on the mRNA) after the mutation could be affected, whereas a substitution will only affect one codon.

A deletion is also more likely to affect the position of the stop codon (or start codon).

So a deletion results in a different sequence of amino acids, whereas a substitution may not affect the sequence of amino acids.

This is because the substituted codon may still code for the same amino acid.

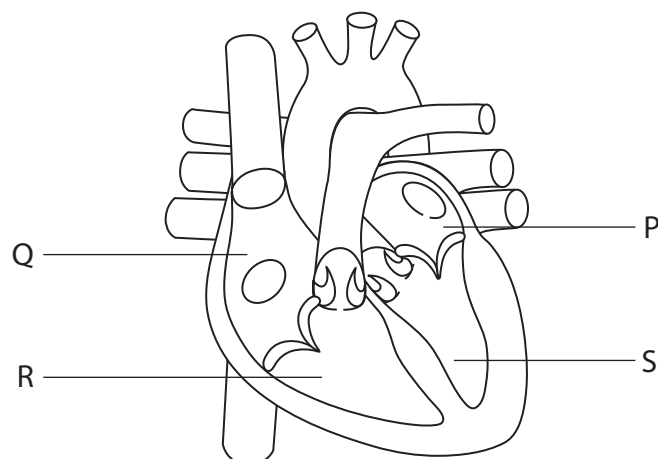
This is due to the degenerate nature of the genetic code: most amino acids are coded for by more than one triplet.

(Total for Question 7 = 8 marks)



P 4 9 8 2 9 A 0 2 1 2 8

8 This diagram shows the structure of a normal human heart.



(a) (i) Which chamber of the heart generates the highest blood pressure?

(1)

- ☐ A P
- ☐ B Q
- ☐ C R
- ☒ D S

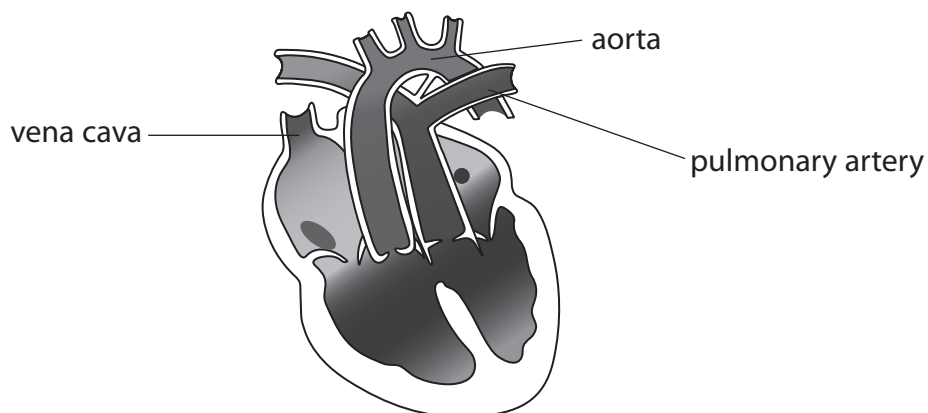
(ii) Which stage of the cardiac cycle is shown in the diagram of the heart?

(1)

- ☐ A atrial diastole
- ☐ B atrial systole
- ☐ C ventricular diastole
- ☒ D ventricular systole



- (b) A baby was born with an abnormal heart. The diagram shows the heart of this baby. There is a hole in the septum between the two ventricles.



- (i) Identify the problem with the blood vessels of this heart.

(1)

The aorta and pulmonary artery are attached to the wrong ventricles: the aorta leaves the right ventricle and the pulmonary artery leaves the left ventricle.

- (ii) The baby survived because of the hole in the septum of the heart.

Explain how the hole in the septum allowed this baby to survive.

(3)

The hole allows oxygenated and deoxygenated blood to mix between the two ventricles.

So some oxygenated blood from the lungs enters the aorta and travels to the body (and some deoxygenated blood enters the pulmonary artery to go to the lungs).

This provides some oxygen to the body cells for aerobic respiration, so the baby can survive.



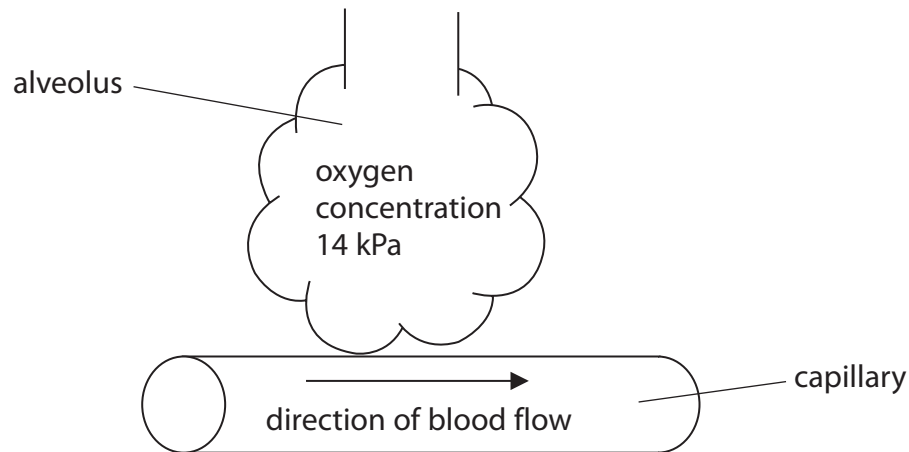
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(iii) Oxygen diffuses between the alveoli of the lungs and the blood.

Fick's Law shows how three factors affect the rate of diffusion:

$$\text{Rate of diffusion} = \frac{\text{surface area} \times \text{concentration difference}}{\text{diffusion distance}}$$

The diagram and the table give information about the oxygen concentration in the alveoli and in the blood.



Heart	Oxygen concentration / kPa	
	Blood entering the lungs	Blood leaving the lungs
Normal	5	13
With hole in the septum between the ventricles	8	10



*Assess the effect of this heart defect on the rate of oxygen diffusion between the alveoli and the blood.

(6)

The rate of oxygen diffusion would be lower with the abnormal heart.

Blood entering the lungs from the abnormal heart has more oxygen, 8 kPa, than blood entering the lungs from a normal heart, 5 kPa, because oxygenated blood mixes into it through the hole.

This results in a smaller difference in oxygen concentration between the alveoli (14 kPa) and the blood: $14 - 8 = 6$ kPa instead of $14 - 5 = 9$ kPa.

The surface area of the alveoli and the diffusion distance are not affected by the heart defect, so only the concentration difference changes.

Fick's law states that the rate of diffusion is proportional to the concentration gradient, so a lower concentration gradient for oxygen between the alveoli and the blood results in a lower rate of oxygen diffusion.

This is shown by the data: oxygen in the blood increases by only 2 kPa (8 to 10) in the lungs with the abnormal heart, instead of 8 kPa (5 to 13) normally, so less oxygen is taken up and the blood leaving the lungs is less oxygenated.

(Total for Question 8 = 12 marks)

TOTAL FOR PAPER = 80 MARKS



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