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Candidate surname

StemUp Model Solution

Other names

**Pearson Edexcel
Level 3 GCE**

Centre Number

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Candidate Number

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Tuesday 19 May 2020

Afternoon (Time: 1 hour 30 minutes)

Paper Reference **8BN0/01**

Biology A (Salters Nuffield)

Advanced Subsidiary

Paper 1: Lifestyle, Transport, Genes and Health

You must have:

Calculator, HB pencil, ruler

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.*

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.*
- 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.

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.

Turn over ►

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P 6 2 3 0 2 R A 0 1 2 4

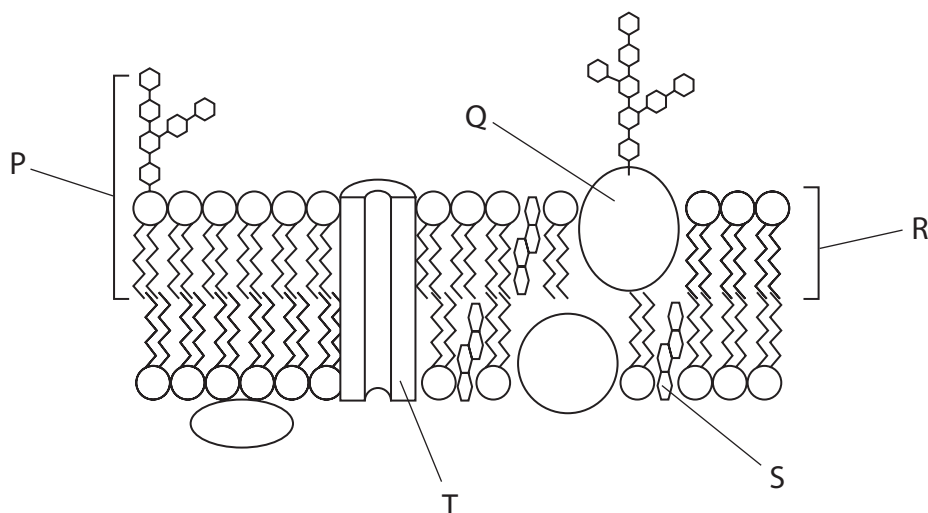

Pearson

Answer ALL questions.

Write your answers in the spaces provided.

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

- 1 The diagram shows the structure of a cell surface membrane.



- (a) (i) The molecule labelled R is a phospholipid.

Give the name of the bond that joins a fatty acid molecule to a glycerol molecule in a phospholipid.

(1)

Ester bond

- (ii) Which of the following describes molecule P?

(1)

- ☐ A carrier protein
- ☐ B cholesterol
- ☒ C glycolipid
- ☐ D glycoprotein

- (iii) Which of the following molecules is involved in cell recognition?

(1)

- ☒ A Q
- ☐ B R
- ☐ C S
- ☐ D T

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(iv) Which molecule allows ions to diffuse into a cell?

(1)

- ☐ A P
☐ B Q
☐ C R
☒ D T

(b) The cell surface membrane controls the movement of substances into the cell.

The concentrations of two substances inside the cytoplasm of a cell and in the fluid surrounding the cell were investigated.

The table shows the concentrations of these two substances.

Substance	Description of substance	Concentration in cytoplasm / mmol dm^{-3}	Concentration in fluid surrounding the cell / mmol dm^{-3}
sodium	small ion	140.0	9.0
glucose	large polar molecule	0.1	14.9

(i) Explain why ATP is required for the movement of sodium ions into the cell.

(2)

The sodium ions are moved against their concentration gradient, from a lower concentration in the fluid surrounding the cell (9.0 mmol dm^{-3}) to a higher concentration in the cytoplasm ($140.0 \text{ mmol dm}^{-3}$).

This is active transport through carrier proteins, which needs energy from the hydrolysis of ATP.

(ii) Describe how glucose molecules move into the cell.

(2)

By facilitated diffusion, down the concentration gradient from $14.9 \text{ mmol dm}^{-3}$ outside to 0.1 mmol dm^{-3} in the cytoplasm.

Glucose is large and polar, so it cannot pass through the phospholipid bilayer; it moves through specific carrier proteins in the membrane.

(Total for Question 1 = 8 marks)

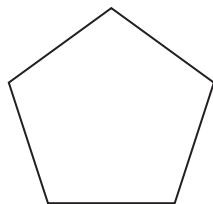


P 6 2 3 0 2 R A 0 3 2 4

2 Genetic information is encoded in DNA. DNA is made from monomers called nucleotides.

(a) A DNA nucleotide is composed of three molecules joined together in condensation reactions.

(i) These shapes represent the components of DNA.



pentose sugar



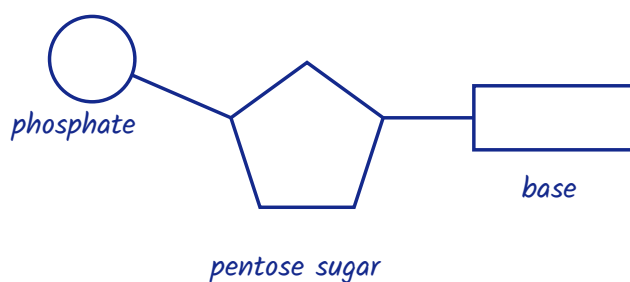
phosphate group



base

Draw a DNA nucleotide using these shapes.

(2)



(ii) Which row shows three components that can be found in a DNA molecule?

(1)

☐ A	glycosidic bond	thymine	deoxyribose
☐ B	glycosidic bond	uracil	ribose
☒ C	phosphodiester bond	thymine	deoxyribose
☐ D	phosphodiester bond	uracil	ribose



(iii) In a molecule of DNA, 17% of the bases were guanine.

What percentage of the bases in the molecule were thymine?

(1)

- ☐ A 17%
- ☒ B 33%
- ☐ C 66%
- ☐ D 83%

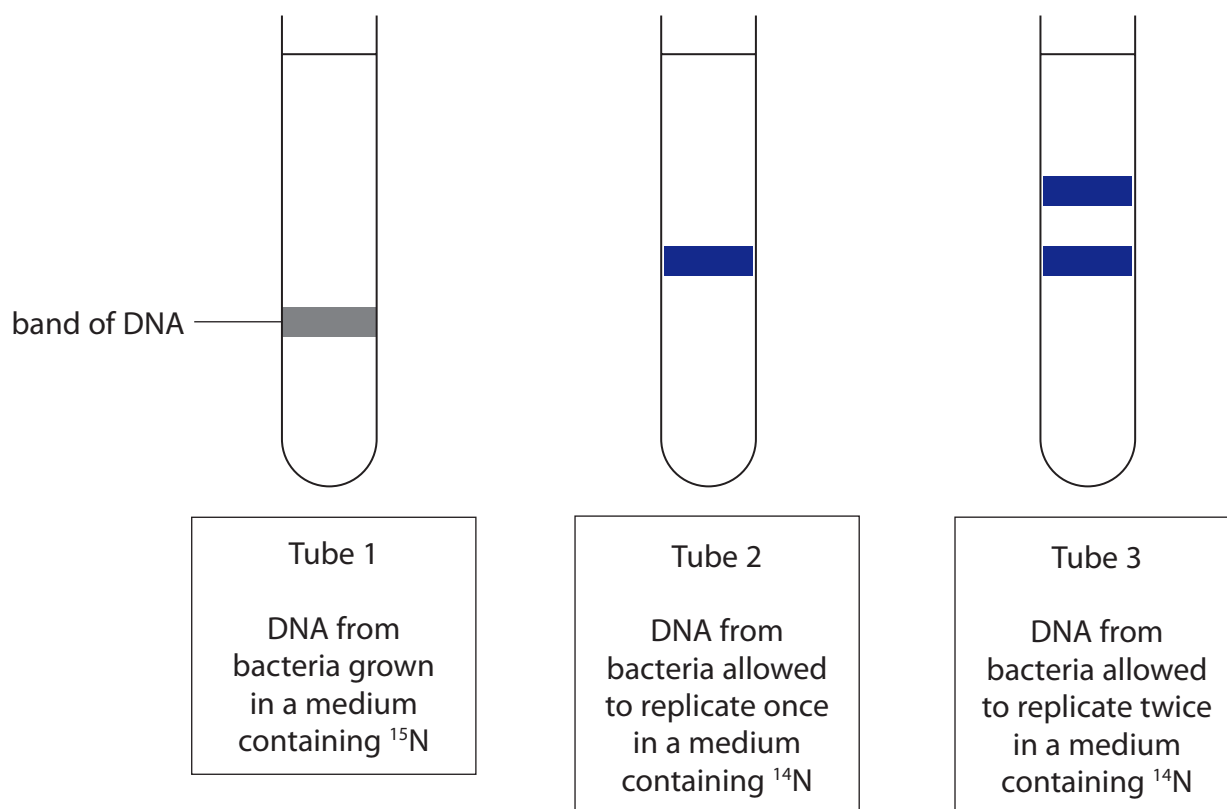
(b) Meselson and Stahl carried out an experiment that demonstrated the semiconservative replication of DNA.

They grew bacteria in a medium containing heavy nitrogen (^{15}N) for a period of time. The density of the DNA extracted from these bacteria is shown by the position of the band in tube 1.

The bacteria were then transferred to a medium containing light nitrogen (^{14}N) and allowed to replicate.

Complete the diagram to show the positions of the DNA bands in tubes 2 and 3.

(2)



(c) Give three differences between replication of DNA and transcription of DNA.

(3)

- 1 *Replication uses DNA nucleotides, whereas transcription uses RNA nucleotides.*
- 2 *Replication uses DNA polymerase, whereas transcription uses RNA polymerase.*
- 3 *Replication produces two identical double-stranded DNA molecules, whereas transcription produces a single-stranded mRNA molecule that is a complementary copy of one gene.*

(Total for Question 2 = 9 marks)



3 Cardiovascular disease (CVD) is a major cause of death.

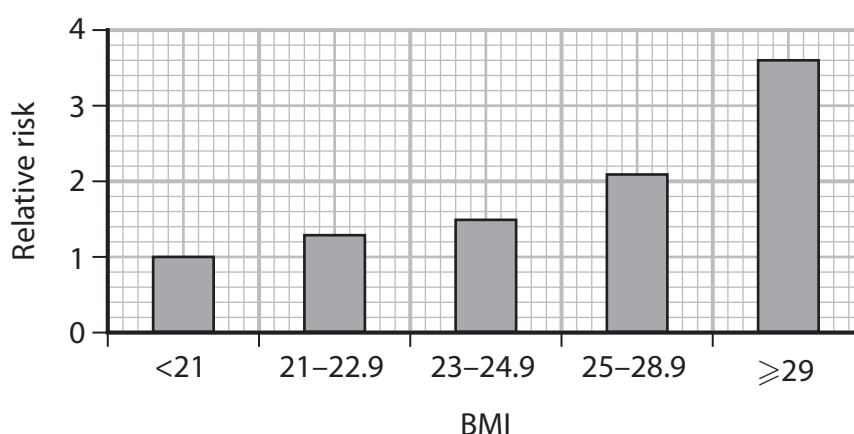
- (a) Obesity and high blood pressure are two risk factors for CVD.

One way of determining if a person is obese is to calculate their body mass index (BMI).

BMI is calculated using the following formula.

$$\text{Body mass index (BMI)} = \frac{\text{mass (kg)}}{\text{height (m)}^2}$$

The graph shows the relationship between BMI and the relative risk of developing CVD.



- (i) Determine the relative risk of developing CVD for a person with a height of 1.54 m and a mass of 61 kg.

(2)

$$BMI = 61 \div 1.54^2$$

$$= 61 \div 2.3716 = 25.7$$

25.7 is in the 25 to 28.9 group

Answer 2.1

- (ii) State another method that could be used to determine if a person is obese.

(1)

Measure the waist to hip ratio (waist:hip).



(iii) Describe how high blood pressure could be reduced by medication and lifestyle changes.

(3)

Medication: take antihypertensive drugs, for example ACE inhibitors, calcium channel blockers, beta blockers or diuretics.

Lifestyle changes: reduce salt intake, stop smoking, increase exercise and reduce weight (lose body mass).

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(b) A heart attack may occur when a coronary artery is blocked with a blood clot. The risk of this can be reduced by treatment with platelet inhibitors.

Explain why platelet inhibitors would reduce the risk of a heart attack.

(2)

Platelet inhibitors prevent platelets becoming sticky and aggregating, so the clotting cascade is not triggered and the risk of blood clots forming is reduced.

Therefore the coronary arteries are less likely to be blocked, so blood flow and the oxygen supply to the heart muscle are maintained.

(Total for Question 3 = 8 marks)

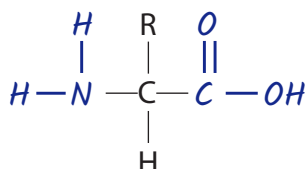


- 4 Blood plasma contains many different proteins. Prothrombin is a plasma protein that is involved in the blood clotting process.

(a) (i) The protein prothrombin is composed of monomers called amino acids.

Complete the diagram to show the structure of an amino acid.

(2)



(ii) Name the products formed when several amino acids are joined together.

(1)

A polypeptide and water.



*(b) Mutations in the gene coding for the prothrombin protein have been identified.

These mutations have resulted in different forms of prothrombin being produced.

The diagram shows the same part of the genetic sequence for prothrombin A and prothrombin B.

Prothrombin A:

TCC CAA TAA AAG TGA CTC TCA GCG AGC

Prothrombin B:

TCC CAA TAA AAG TGA CTC TCA GAG AGC

Prothrombin A and prothrombin B were used in an investigation into blood clotting.

A sample of blood had all of the prothrombin removed.

Equal volumes of this blood were poured into test tubes.

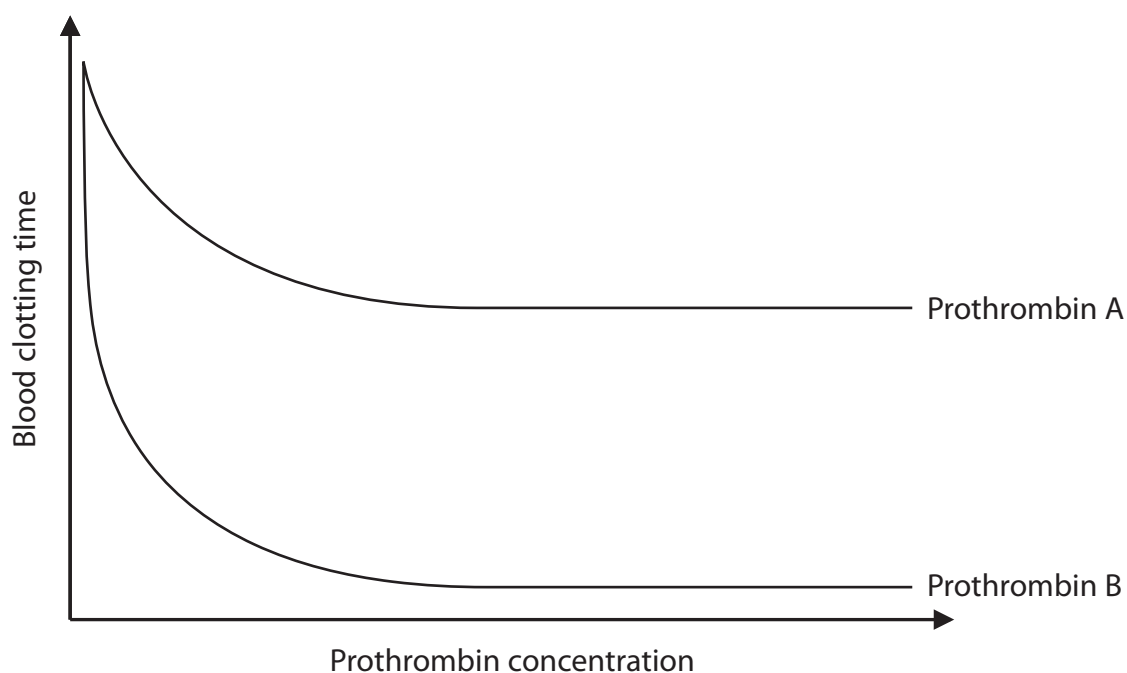
Each test tube of blood received a different concentration of prothrombin A.

The volume of prothrombin A was the same in each tube.

The time taken for the blood to clot in each tube was measured.

The investigation was repeated with different concentrations of prothrombin B.

The results are shown in the graph.



Explain the results of this investigation.

(6)

As the prothrombin concentration increases, the blood clotting time decreases, then levels off at higher concentrations. Prothrombin B gives a faster (shorter) clotting time than prothrombin A at every concentration.

The greater the concentration of prothrombin, the greater the concentration of thrombin produced. The greater the concentration of thrombin, the faster soluble fibrinogen is converted into insoluble fibrin. The fibrin forms a mesh that traps red blood cells and platelets to form a blood clot, so clotting is faster.

The clotting time levels off because something else becomes a limiting factor, for example the concentration of the enzyme that converts prothrombin into thrombin, as all its active sites are occupied.

The two DNA sequences differ by a substitution mutation: the codon GCG in A is GAG in B. Only one codon is affected, so only one amino acid in the primary structure is different.

This changes the tertiary structure, so prothrombin B has a slightly different shape (or charge). It therefore forms an enzyme-substrate complex more easily, so more enzyme-prothrombin B complexes form per unit time. More thrombin is produced per unit time, so fibrin forms faster and prothrombin B gives a shorter clotting time.

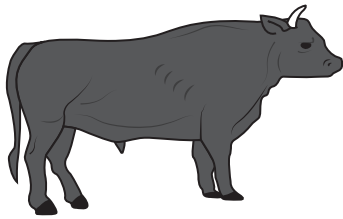
(Total for Question 4 = 9 marks)



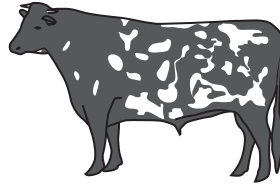
5 The phenotype of organisms is affected by their genotype.

(a) Cattle have different patterns and colours in their coats as a result of their genotype.

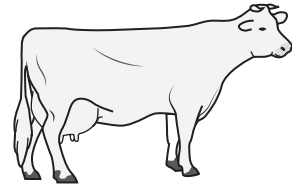
The image shows the genotype and phenotype of three offspring from the same parents.



pure red
(RR)



roan
(RW)



pure white
(WW)

(Source from: http://wps.pearsoned.com.au/wps/media/objects/8476/8680015/_images_/ch3c.jpg)

(i) Name the type of inheritance shown in this example.

(1)

Incomplete dominance

(ii) What is the probability of the next offspring of the same parents being roan?

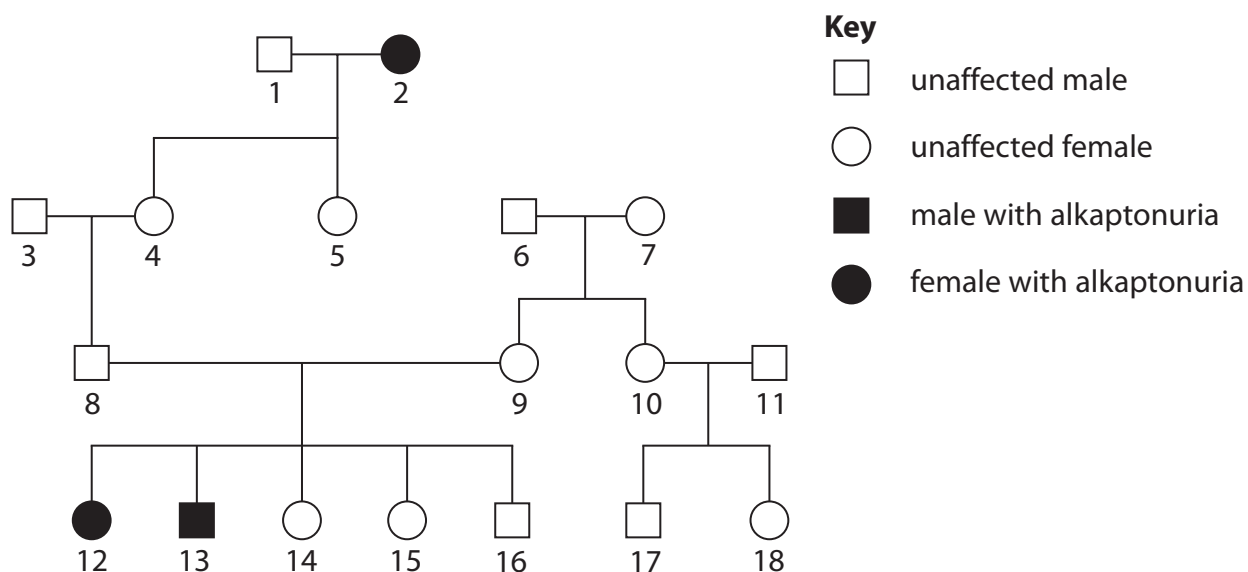
(1)

- ☐ A 25%
- ☒ B 50%
- ☐ C 75%
- ☐ D 100%



- (b) Alkaptonuria is a rare condition where the body cannot break down the amino acids phenylalanine and tyrosine.

The pedigree diagram shows part of a family tree in which alkaptonuria is an inherited condition.



- (i) State and justify whether alkaptonuria is caused by a recessive or a dominant allele. (4)

Alkaptonuria is caused by a recessive allele.

A person must inherit two recessive alleles (be homozygous recessive) to have the condition.

Individuals 8 and 9 do not have alkaptonuria, but some of their children (12 and 13) do.

Therefore 8 and 9 must both be heterozygous (carriers), each passing a recessive allele to 12 and 13. If the allele were dominant, at least one parent of an affected child would have to be affected.

(ii) Individual 12 is pregnant and wants to know if her baby has alkaptonuria.

State and justify a suitable method of collecting cells for prenatal testing.

(3)

Chorionic villus sampling (CVS).

Cells (tissue) are taken from the chorionic villi of the placenta, through the cervix or the abdomen, between 10 and 14 weeks of pregnancy.

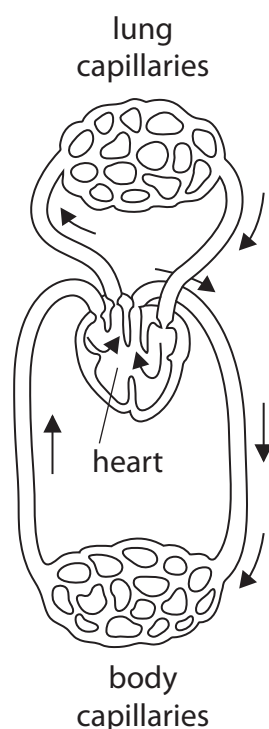
The benefit is an earlier diagnosis, so the result is available earlier in the pregnancy, giving more time to make a decision.

(Total for Question 5 = 9 marks)



6 Many animals have a heart and circulatory system.

The diagram shows the structure of the heart and circulatory system of a snake.



- (a) (i) Compare and contrast the heart and circulatory system of a snake with that of a human. (4)

Similarities: both the snake and the human have a double, closed circulatory system, so blood passes through the heart twice in one complete circuit.

Both have hearts with two atria, and both have arteries, veins and capillaries.

Differences: the snake heart has only one ventricle, whereas the human heart has two ventricles; the snake does not have a complete septum between the ventricles, whereas the human heart does.

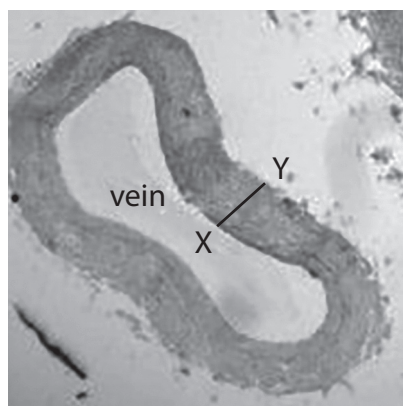
So in the snake heart oxygenated and deoxygenated blood mix in the ventricle, whereas in the human heart they do not mix.

(ii) Explain why a snake needs a heart.

(2)

The snake has a small surface area to volume ratio, so diffusion alone is not fast enough. The heart pumps blood by mass transport to supply oxygen and glucose to body cells and remove carbon dioxide.

- (b) The image shows a cross section of a vein viewed with a light microscope. An eyepiece lens of $\times 10$ magnification and an objective lens of $\times 4$ magnification were used.



(Source from: <https://dissectionconnection.com.au/product/artery-and-vein-40x/>)

- (i) Calculate the actual thickness of the wall of the vein between points X and Y. Give your answer in μm .

(3)

measured X to Y = 8 mm

magnification = $10 \times 4 = 40$

actual thickness = $8 \div 40 = 0.2 \text{ mm}$

$0.2 \text{ mm} \times 1000 = 200 \mu\text{m}$

Answer.....200..... μm

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(ii) Explain how the structure of a vein relates to its function.

(4)

Veins have a large lumen, which reduces resistance to blood flow, so blood returns to the heart easily.

Valves prevent the backflow of blood, keeping blood flowing in one direction, back to the heart.

The wall has only a thin layer of muscular and elastic tissue, because the blood pressure in veins is low, so a thick wall is not needed.

A smooth endothelium lines the lumen, which reduces friction and resistance to blood flow.

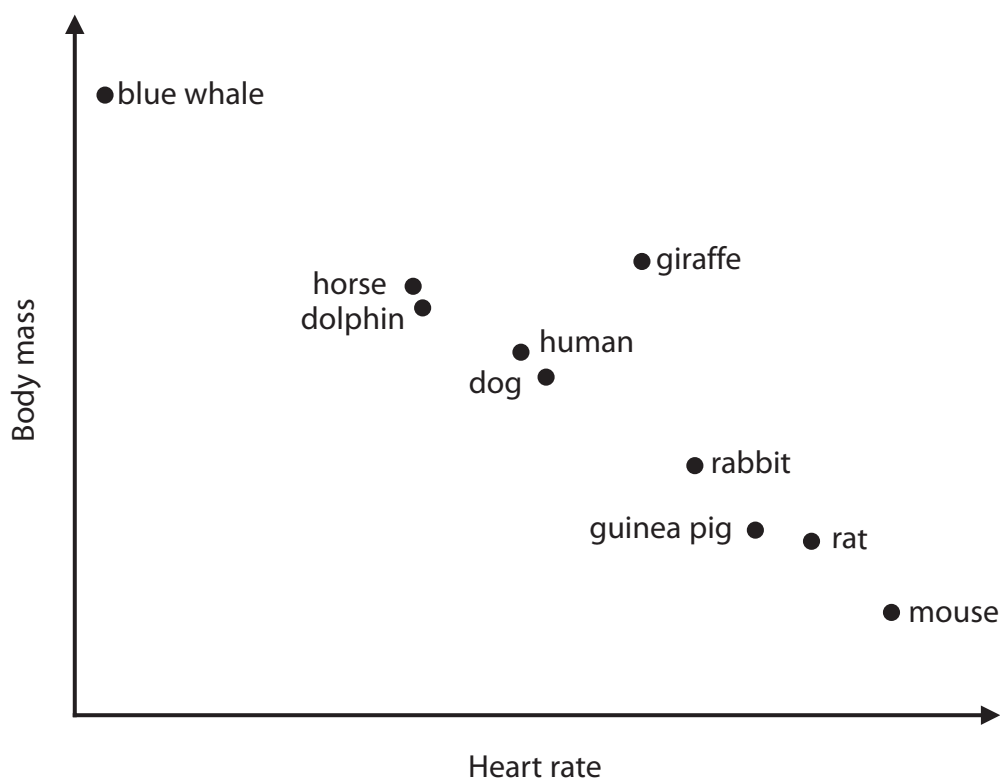
(Total for Question 6 = 13 marks)



P 6 2 3 0 2 R A 0 1 7 2 4

7 The heart rate of an animal often depends on its body mass.

The graph shows the mean heart rate of some animals and their mean body mass.



(Adapted from: <http://www.cardio-research.com/quick-facts/animals>)

- (a) State the relationship between the average heart rate and the average body mass of these animals.

(1)

There is a negative correlation: animals with a higher body mass have a lower heart rate.



(b) Some chemicals can affect the heart rate of animals.

The effects of dopamine and caffeine on the heart rate of *Daphnia* were investigated.

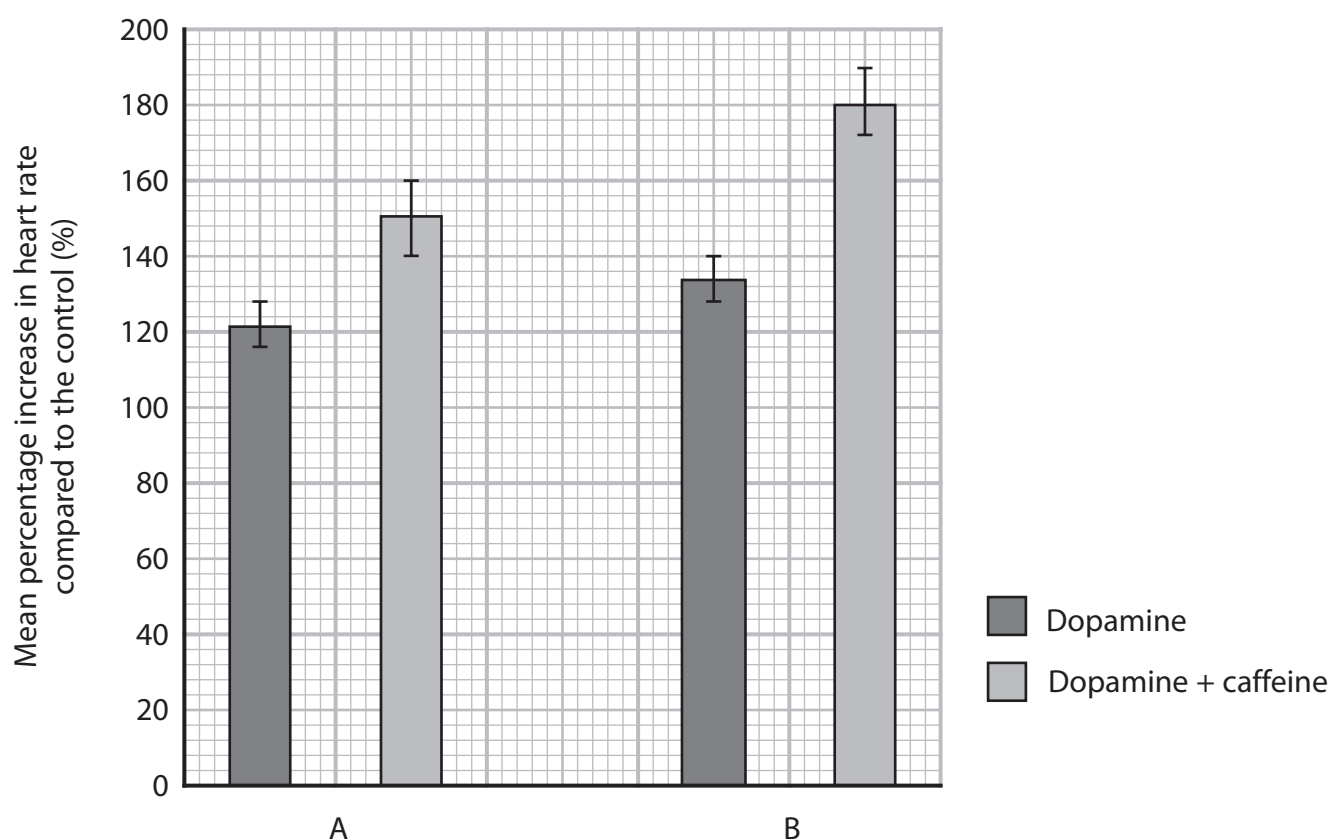
Investigation A used three different solutions:

- a control solution
- a solution containing 0.8 mg cm^{-3} dopamine
- a solution containing $80 \mu\text{g cm}^{-3}$ caffeine and 0.8 mg cm^{-3} dopamine

Investigation B used three different solutions:

- a control solution
- a solution containing 1.6 mg cm^{-3} dopamine
- a solution containing $80 \mu\text{g cm}^{-3}$ caffeine and 1.6 mg cm^{-3} dopamine

The graph shows the percentage increase in heart rate compared with the controls, for both investigations.



(Source from: <https://f1000research.com/articles/7-254/v1>)

- (i) Comment on the effects of dopamine alone and dopamine with caffeine on the heart rate of *Daphnia* in this investigation.

(4)

Dopamine alone increases the heart rate: by about 121% at 0.8 mg cm^{-3} (A) and about 134% at 1.6 mg cm^{-3} (B), so increasing the concentration of dopamine increases the heart rate.

Adding caffeine to dopamine increases the heart rate even more: by about 150% in A and 180% in B. The largest increase is when both are used together at the higher dopamine concentration.

The error bars for dopamine and for dopamine with caffeine do not overlap, so there is a significant difference between them. The error bars for the two dopamine concentrations overlap, so there is no significant difference between them.

There was no caffeine-only solution, so the effect of caffeine alone cannot be judged.

- (ii) State and justify a suitable control for these investigations.

(2)

Distilled (pond) water, the solvent used to make the dopamine and caffeine solutions, with no dopamine or caffeine added.

To show that the solvent did not have an effect, giving the heart rate in the absence of the added chemicals.



(iii) Devise a procedure that could have been used to produce the results shown in the graph.

(5)

Use *Daphnia* of the same species, age, sex and size, taken from the same culture.

Place a *Daphnia* in a small volume of the control solution on a cavity slide, with cotton wool fibres to immobilise it, and view the heart under a microscope at low power.

Leave the *Daphnia* in the solution for 5 minutes to acclimatise, keeping the temperature constant.

Count the heart beats in 20 seconds, for example by making a dot on paper for each beat or filming and counting at slow speed, then multiply by 3 to give beats per minute.

Repeat with 0.8 mg cm^{-3} dopamine, $80 \text{ } \mu\text{g cm}^{-3}$ caffeine with 0.8 mg cm^{-3} dopamine, 1.6 mg cm^{-3} dopamine, and $80 \text{ } \mu\text{g cm}^{-3}$ caffeine with 1.6 mg cm^{-3} dopamine, using a fresh *Daphnia* each time.

Repeat at least 10 times for each solution, calculate the mean and standard deviation, and calculate the percentage increase: $(\text{mean rate in solution} - \text{mean control rate}) \div \text{mean control rate} \times 100$.

(Total for Question 7 = 12 marks)



8 Cystic fibrosis is inherited as a recessive condition. It is caused by a mutation in the CFTR gene.

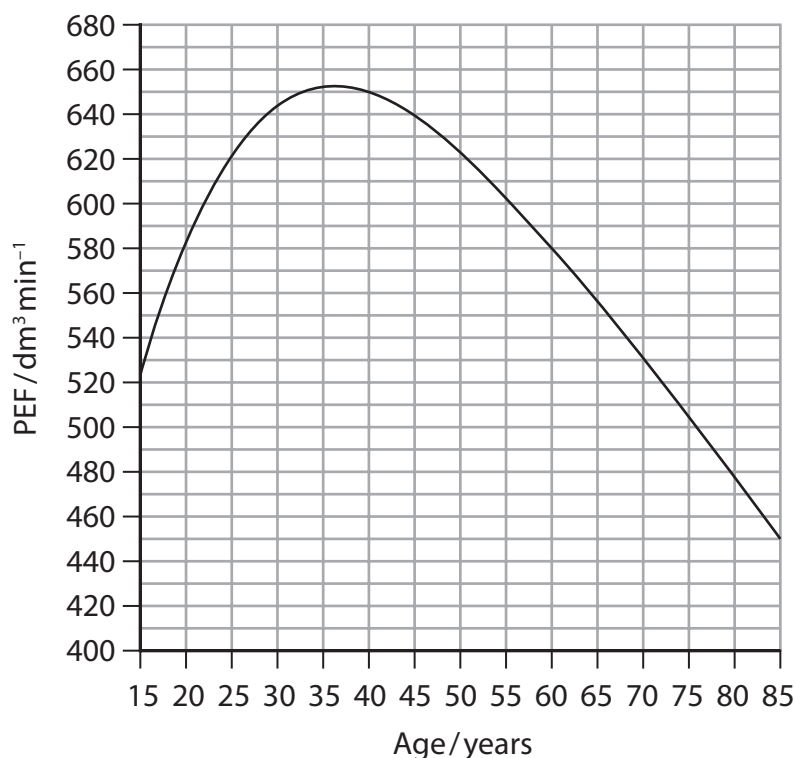
(a) The CFTR gene codes for

(1)

- ☐ A a carrier protein
- ☒ B a channel protein
- ☐ C an enzyme
- ☐ D a glycoprotein

(b) A peak flow meter is used to measure the maximum rate at which air can be exhaled. This is called the peak expiratory flow (PEF).

The graph shows the normal PEF for men. The PEF values for men with cystic fibrosis would be 45% lower.



(Source from: <https://www.activ8rlives.com/support/data-collected/cardiovascular-and-respiratory/normal-peak-expiratory-flow-pef/>)

Calculate the PEF for a 25-year-old man with cystic fibrosis compared with a man of the same age without cystic fibrosis.

(2)

PEF at 25 years without cystic fibrosis = 620 dm³ min⁻¹

with cystic fibrosis = 100% - 45% = 55% of 620

0.55 × 620 = 341

Answer *341 dm³ min⁻¹*



(c) Explain the effect of a reduced PEF on gas exchange.

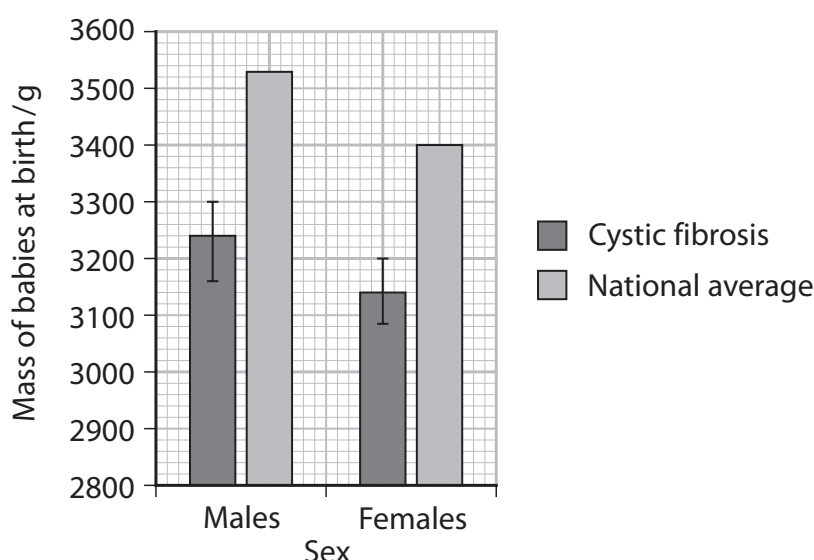
(3)

A reduced PEF means a reduced rate (and volume) of air entering and leaving the lungs.

So there is a lower concentration of oxygen in the alveoli, giving a lower concentration gradient between the alveoli and the capillaries.

This reduces the rate of diffusion, so the rate of gas exchange is reduced.

(d) The graph shows the mean mass of newborn babies with cystic fibrosis and of newborn babies without cystic fibrosis.



(i) How many of the following statements are correct?

- male babies always have a larger birth weight compared to female babies
- there is a significant difference between the birth weight for males and females born with cystic fibrosis
- on average female babies born with cystic fibrosis have a birth weight 260g less than the national average

(1)

- ☐ A none
- ☒ B one
- ☐ C two
- ☐ D three

- (ii) Doctors give dietary supplements and digestive enzymes to children with cystic fibrosis.

Dietary supplements include carbohydrates, proteins and lipids, as well as vitamin and mineral supplements.

Explain why these children would be given dietary supplements and digestive enzymes.

(5)

Cystic fibrosis causes the production of thick, sticky mucus, which blocks the pancreatic duct, so pancreatic enzymes cannot reach the small intestine.

This reduces the digestion of carbohydrates, proteins and lipids by enzymes such as amylase, protease and lipase in the intestine.

So there is reduced absorption of the products of digestion, such as glucose, amino acids, fatty acids and glycerol, and of vitamins and minerals, into the blood (and lymph).

Fewer amino acids, vitamins and minerals are available, so there is less protein synthesis and a slower growth rate.

Digestive enzymes allow the food to be digested and the supplements provide extra nutrients, so more products of digestion are absorbed, increasing the growth rate.

(Total for Question 8 = 12 marks)

TOTAL FOR PAPER = 80 MARKS

