

Please check the examination details below before entering your candidate information

Candidate surname <i>StemUp Model Solution</i>		Other names
Centre Number	Candidate Number	

Pearson Edexcel Level 3 GCE

Monday 13 May 2024

Morning (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:
Scientific 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 all your working out** in calculations and **include units** 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.*
- 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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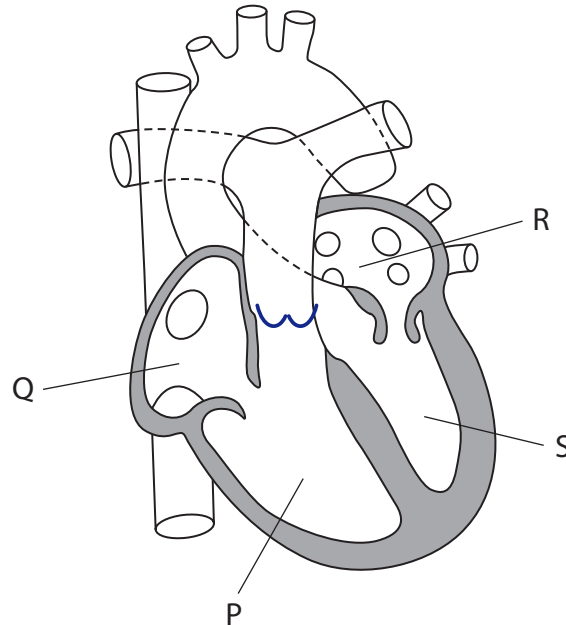



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Answer ALL questions. Write your answers in the spaces provided.

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 part of the internal structure of a human heart.



- (a) (i) How many of the following statements about the human heart are correct?

- structures P and S fill with deoxygenated blood when structures Q and R contract
- structure R receives blood from the pulmonary vein
- when the cardiac muscle walls of P and S undergo diastole, blood leaves the heart and enters the aorta and pulmonary artery

(1)

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

- (ii) Complete the diagram to show the location of the semilunar valve in the pulmonary artery.

(1)



(iii) Describe the role of this semilunar valve in the cardiac cycle.

(3)

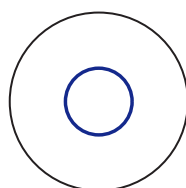
The semilunar valve opens during ventricular systole, when the pressure in the right ventricle is higher than in the pulmonary artery.

This allows blood to be pumped out of the ventricle and enter the pulmonary artery.

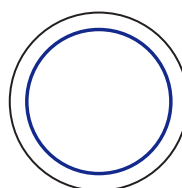
The valve closes during diastole, when the pressure in the pulmonary artery is higher than in the ventricle.

This prevents the backflow of blood from the pulmonary artery into the right ventricle.

(b) The diagrams show a cross-section of an aorta and a vena cava.



aorta



vena cava

(i) Complete the diagrams to show the relative sizes of the lumens.

(1)

(ii) Which of the following would be in contact with the blood in an undamaged vena cava?

(1)

- ☐ A collagen
- ☒ B endothelial cells
- ☐ C epithelial cells
- ☐ D smooth muscle cells

(Total for Question 1 = 7 marks)

2 The photograph shows red, white and pink snapdragon flowers.

Plants with genotype $F^R F^R$ have flowers with red petals.

Plants with genotype $F^W F^W$ have flowers with white petals.



(Source: © Irina Kryvasheina/Alamy Stock Photo)

(a) Deduce why heterozygous snapdragon plants produce flowers with pink petals.

(3)

Snapdragon petal colour shows incomplete dominance (codominance), so neither allele is recessive.

The heterozygous plants have the genotype $F^R F^W$.

Both the allele for red petals (F^R) and the allele for white petals (F^W) are expressed in the phenotype.

Therefore the flowers have a colour that is intermediate between red and white, so the petals are pink.



(b) (i) Two snapdragon plants with genotype $F^R F^W$ were crossed.

Determine the probability of each petal colour in the offspring of this cross, using a genetic diagram. (3)

$F^R F^W \times F^R F^W$

	F^R	F^W
F^R	$F^R F^R$ red	$F^R F^W$ pink
F^W	$F^R F^W$ pink	$F^W F^W$ white

Petal colour	Probability
Pink	0.5
Red	0.25
White	0.25

(ii) There were 416 plants produced from this cross.

Predict how many of these plants will have flowers with white petals. (1)

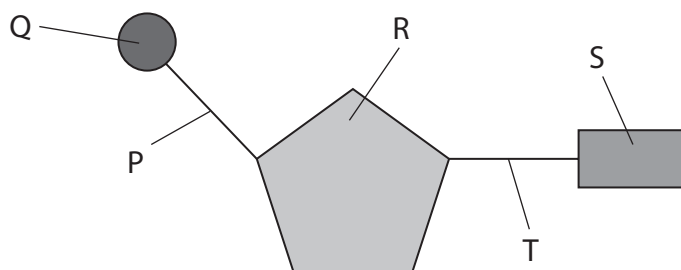
$0.25 \times 416 = 104 \text{ plants}$

(Total for Question 2 = 7 marks)



3 Nucleic acids are involved in protein synthesis.

(a) The diagram shows the structure of a nucleotide.



(i) Which labelled structure would contain the element phosphorus?

(1)

- ☐ A P
- ☒ B Q
- ☐ C R
- ☐ D S

(ii) Structure R is different in a DNA nucleotide compared with an RNA nucleotide.

Name structure R in a DNA nucleotide and in an mRNA nucleotide.

(1)

DNA nucleotide deoxyribose

mRNA nucleotide ribose

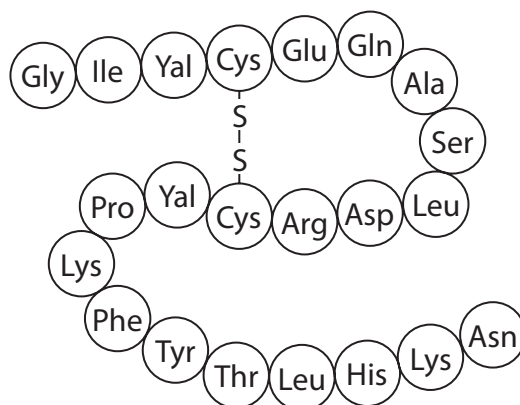
(iii) Which of the following bases would be found in a DNA nucleotide, but not in an RNA nucleotide?

(1)

- ☐ A Adenine
- ☐ B Cytosine
- ☐ C Guanine
- ☒ D Thymine



(b) The diagram shows a polypeptide chain.



(i) Which row shows the correct type of monomer and the type of reaction that joins the monomers together?

(1)

	Monomer	Type of reaction
☒ A	amino acid	condensation
☐ B	amino acid	hydrolysis
☐ C	fatty acid	condensation
☐ D	fatty acid	hydrolysis

(ii) Which of the following types of bond are involved in forming the tertiary structure of a protein?

(1)

- ☐ A disulfide bridge, ester bond and ionic bond
- ☒ B disulfide bridge, hydrogen bond and ionic bond
- ☐ C disulfide bridge, ester bond and hydrogen bond
- ☐ D disulfide bridge, glycosidic bond and hydrogen bond



(iii) Describe the role of RNA in the formation of this polypeptide chain.

(4)

The gene is transcribed into mRNA in the nucleus, and the mRNA leaves the nucleus through a nuclear pore.

The mRNA binds to a ribosome in the cytoplasm.

Each tRNA molecule carries (binds to) a specific amino acid.

The anticodon on each tRNA binds to the complementary codon on the mRNA by complementary base pairing.

So the sequence of bases (codons) on the mRNA determines the sequence of amino acids in the polypeptide chain.

Peptide bonds form between adjacent amino acids as the ribosome moves along the mRNA.

(Total for Question 3 = 9 marks)



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4 Red blood cells contain haemoglobin.

(a) Oxygen molecules enter red blood cells and bind to haemoglobin.

Glucose molecules can also enter red blood cells.

The table gives some information about these molecules.

Molecule	Properties
Glucose	large, polar molecule
Oxygen	small, non-polar molecule

Describe how oxygen and glucose molecules can enter red blood cells.

(2)

Oxygen *Oxygen is small and non-polar, so it diffuses directly through the phospholipid bilayer, from an area of high concentration to an area of low concentration (down the concentration gradient).*

Glucose *Glucose is large and polar, so it cannot pass through the bilayer. It enters by facilitated diffusion through carrier proteins, down its concentration gradient.*



- (b) Collagen and haemoglobin are proteins associated with the cardiovascular system.

Give **three** differences between the structures of collagen and haemoglobin.

(3)

Collagen is a fibrous protein, whereas haemoglobin is a globular protein.

Collagen is made of three polypeptide chains, whereas haemoglobin has four polypeptide chains.

Haemoglobin contains a prosthetic haem group (with an iron ion), whereas collagen does not.

Haemoglobin has hydrophilic R groups on its surface, whereas collagen has hydrophobic R groups on its surface.



- (c) Haemolysis is the breaking open of a red blood cell, causing the release of haemoglobin.

The effect of concentration of three different alcohols on the haemolysis of red blood cells was investigated.

Samples of red blood cells were treated with different concentrations of three alcohols.

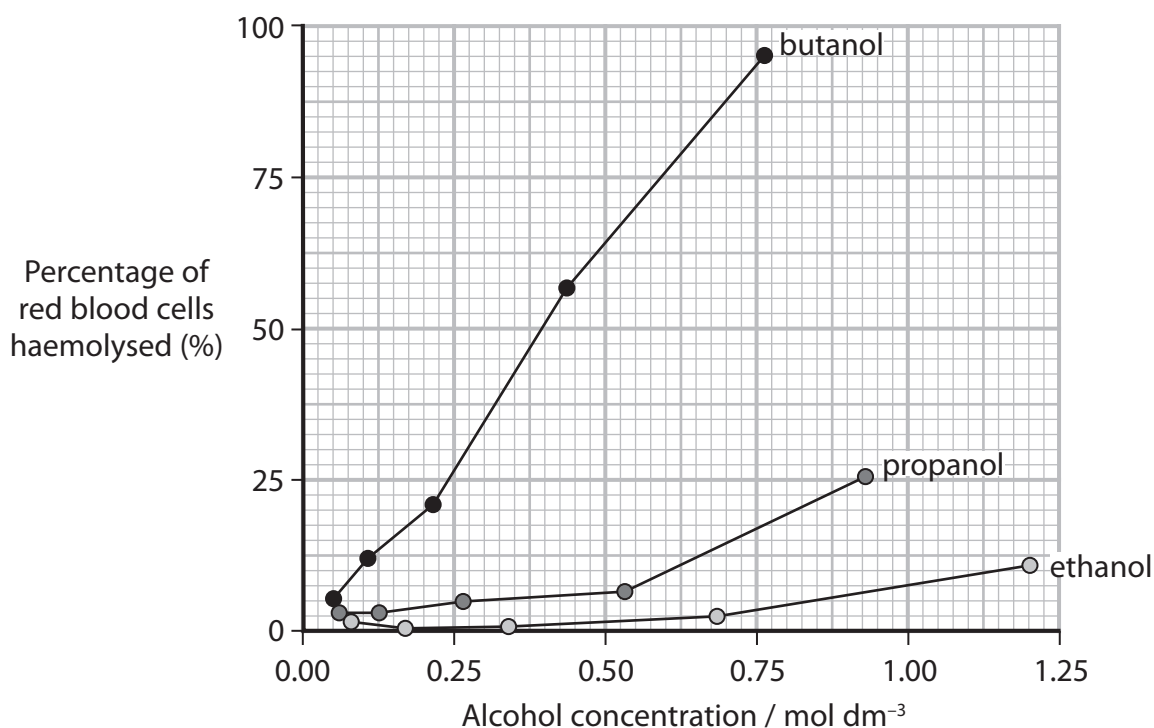
The table shows the formulae of the alcohols.

Alcohol	Formula
Ethanol	$\text{CH}_3\text{CH}_2\text{OH}$
Propanol	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
Butanol	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

A microscope was used to count the number of intact red blood cells.

The investigation was repeated twice.

The mean percentage of red blood cells that had haemolysed was calculated, and the results are shown in the graph.



(i) State and justify a suitable control for this investigation.

(2)

Red blood cells treated with saline (the solvent used to dilute the alcohols) containing no alcohol, i.e. 0.00 mol dm^{-3} .

This shows the percentage of cells that undergo haemolysis without alcohol present, giving a baseline to compare with the alcohol solutions.

(ii) Evaluate the effect of concentration of the three alcohols on the haemolysis of red blood cells.

(4)

As the concentration of each alcohol increases, the percentage of red blood cells haemolysed increases (positive correlation).

Butanol causes the most haemolysis, about 95% at 0.75 mol dm^{-3} , while ethanol causes the least, only about 11% at 1.2 mol dm^{-3} .

This is because the alcohol dissolves the lipids and disrupts the cell membranes, increasing membrane permeability.

The more carbon atoms (the longer the chain) in the alcohol, the greater the percentage of cells haemolysed.

However, it was only repeated twice and there is no information about controlled variables such as the volume of alcohol, so the conclusions are limited.

(Total for Question 4 = 11 marks)

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5 Scientists have investigated the functions of DNA polymerase.

(a) (i) Describe the function of DNA polymerase in producing a polynucleotide.

(2)

DNA polymerase catalyses condensation reactions that join DNA nucleotides together.

This forms phosphodiester bonds between the phosphate group of one nucleotide and the deoxyribose sugar of the next.

(ii) Scientists have discovered a property of DNA polymerase that detects and corrects errors in DNA replication.

Discuss the possible benefits of this property of DNA polymerase.

(4)

Errors in DNA replication cause mutations (changes in the base sequence), so this property reduces the number of mutations and faulty alleles.

Faulty bases are replaced, so the correct base sequence is produced and the allele is not changed, so the mRNA sequence is also correct.

Therefore the correct amino acid sequence is produced, so the protein has the correct primary structure and is functional, e.g. an enzyme keeps the shape of its active site.

This reduces the chance of cancer (uncontrolled cell division) and genetic disease.

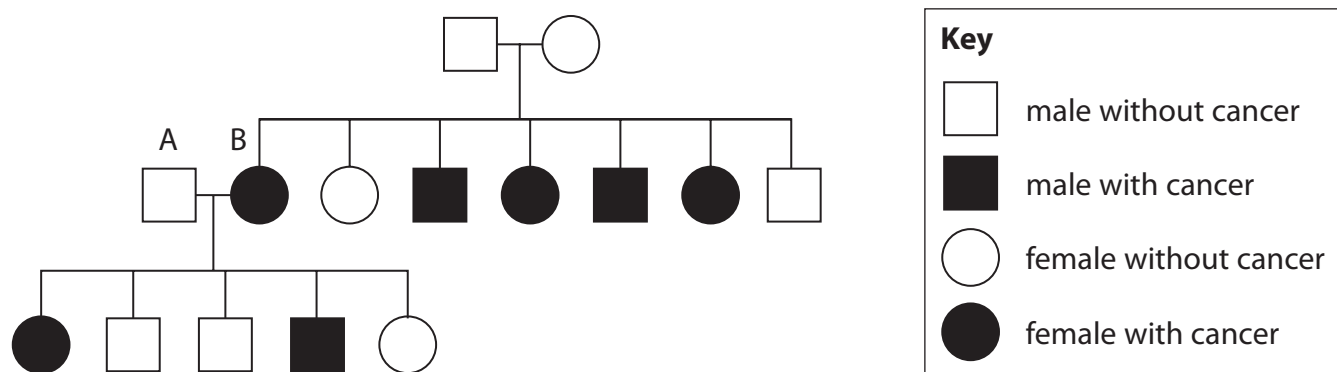


- (b) Some people have DNA polymerase that cannot detect and correct errors in DNA replication.

These people have an increased risk of developing cancer.

The increased risk of cancer occurs when a person inherits two faulty recessive alleles of the DNA polymerase gene.

The pedigree diagram shows the development of cancer in one family.



Individuals A and B wish to have another child.

Explain why they may choose pre-implantation genetic diagnosis (PGD).

(2)

Parent A must be a carrier (heterozygous), as some of their children have cancer, and parent B has cancer so is homozygous for the faulty allele.

PGD allows them to select an embryo that is not homozygous for the faulty allele, so the child will produce functioning DNA polymerase and has a reduced risk of cancer.

PGD also has no risk of miscarriage, unlike prenatal testing.

(Total for Question 5 = 8 marks)

6 The effect of enzyme concentration on the rate of reaction was investigated.

Starch is a polysaccharide.

(a) Which of the following statements about polysaccharides is correct?

(1)

- ☐ **A** starch contains amylose, a straight chain containing 1,6 glycosidic bonds
- ☐ **B** glycogen contains amylopectin, a branched chain containing both 1,4 and 1,6 glycosidic bonds
- ☒ **C** polysaccharides containing both 1,4 and 1,6 glycosidic bonds allow a rapid release of energy
- ☐ **D** starch and glycogen are both soluble in water



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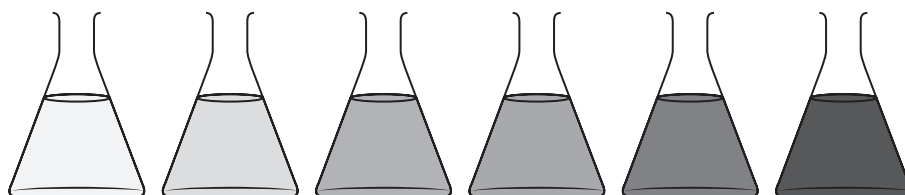
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(b) Amylase breaks down starch into maltose.

The diagram shows the effect of adding iodine to flasks containing different concentrations of starch.



increasing concentration of starch present

no starch

high starch concentration

yellow-brown colour

blue-black colour

The effect of amylase concentration on the rate of reaction, at two different temperatures, was investigated.

The table shows the results of this investigation.

Enzyme concentration / mmol dm^{-3}	Rate of reaction at 30°C / a.u.	Rate of reaction at 45°C / a.u.
0	0	0
1	31	16
2	41	25
3	69	36
4	82	42
5	92	47
6	98	54
7	100	62
8	100	70

*(i) Explain how to carry out a valid investigation to collect the data shown in the table.

(6)

Make up amylase solutions of 0, 1, 2, 3, 4, 5, 6, 7 and 8 mmol dm⁻³ by diluting a stock solution with distilled water.

Use the same volume (e.g. 5 cm³) and concentration (e.g. 1%) of starch solution, and the same volume (e.g. 5 cm³) of each amylase solution, measured with a syringe.

Add the same volume of buffer solution (e.g. pH 7) to each tube to keep the pH constant.

Place the starch and amylase tubes separately in a thermostatically controlled water bath at 30 °C for 5 minutes to equilibrate, then mix them and start a stop clock.

Put a drop of iodine solution in each well of a spotting tile. Every 30 seconds, remove a drop of the mixture with a pipette and add it to a fresh drop of iodine.

Record the time taken for the iodine to remain yellow-brown (no blue-black colour), showing all the starch has been broken down. Colour standards or a colorimeter can be used to judge the end point.

Calculate the rate of reaction as $1 \div \text{time taken (s}^{-1}\text{)}$.

Repeat three times at each enzyme concentration and calculate a mean, ignoring anomalies.

Repeat the whole investigation with the water bath at 45 °C.

Safety: wear eye protection and gloves, as iodine is an irritant and amylase can cause allergic reactions.

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P 7 4 4 7 2 A 0 1 9 3 2

- (ii) Comment on the effects of enzyme concentration and temperature in this investigation.

(4)

At both temperatures the rate of reaction increases as the enzyme concentration increases, as there are more active sites, so more enzyme-substrate complexes form.

The rate is higher at 30 °C than at 45 °C at every concentration, e.g. 100 a.u. compared with 70 a.u. at 8 mmol dm⁻³.

This is because 45 °C is above the optimum temperature for amylase, so some of the enzyme has denatured: the active site changes shape and fewer enzyme-substrate complexes form.

At 30 °C the rate plateaus at 100 a.u. from 7 mmol dm⁻³, because the substrate (starch) concentration becomes the limiting factor.

(Total for Question 6 = 11 marks)

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- 7 Obesity indicators, such as body mass index (BMI), can be used to assess the risk of a person developing coronary heart disease (CHD).

(a) The table shows categories of BMI.

BMI	Classification
Less than 20	underweight
20–24.9	normal
25–29.9	overweight
30–40	obese
Greater than 40	severely obese

A man has a body mass of 65 kg.

He has a normal BMI.

Calculate the minimum and maximum possible heights for this man in metres.

Use the formula

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

$$\text{height} = \sqrt{(\text{mass} \div \text{BMI})} \quad (2)$$

$$\text{minimum: } \sqrt{(65 \div 24.9)} = 1.616$$

$$\text{maximum: } \sqrt{(65 \div 20)} = 1.803$$

minimum height 1.62 m

maximum height 1.80 m



- (b) One risk factor for coronary heart disease (CHD) is obesity.

The table shows the incidence of CHD for people with a differing number of risk factors.

Number of risk factors	Incidence of CHD per 100 000 people
0	60
1	130
2	210
3	615

- (i) Describe the relationship between the number of additional risk factors and the incidence of CHD.

(2)

As the number of risk factors increases, the incidence of CHD increases (positive correlation).

The increase is not linear: it gets steeper with each additional risk factor, e.g. a rise of 405 per 100 000 from 2 to 3 risk factors, compared with 70 from 0 to 1.

- (ii) State **one** risk factor for CHD other than obesity.

(1)

Smoking.

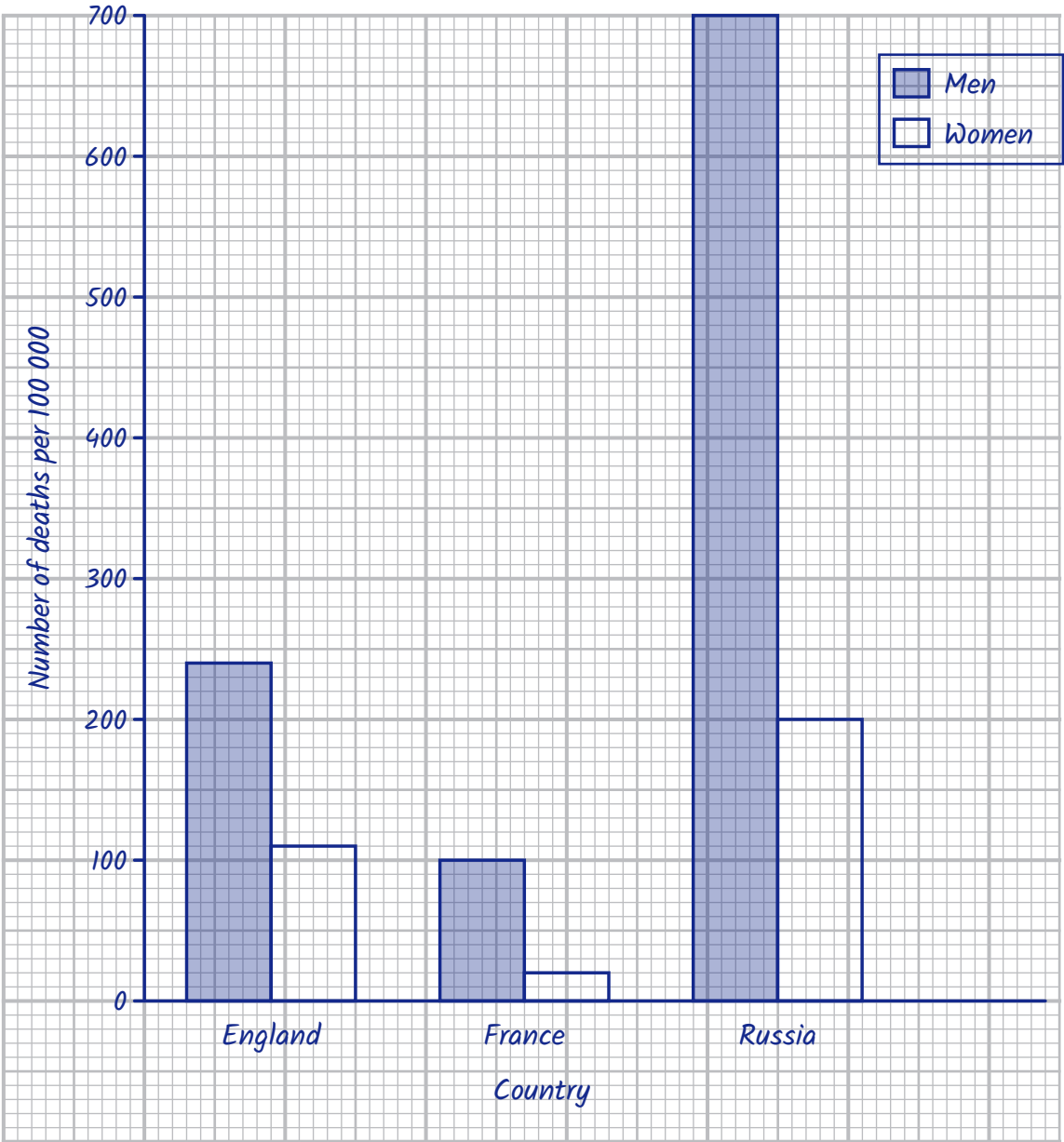


(c) The table shows the number of deaths due to CHD in three countries.

Country	Number of deaths per 100 000	
	Men	Women
England	240	110
France	100	20
Russia	700	200

Plot these data in a suitable graphical form.

(4)



(d) Atherosclerosis is a type of cardiovascular disease (CVD) that causes the narrowing of coronary arteries.

(i) How many of the following types of medication would reduce the risk of CVD?

(1)

- anticoagulants
- antihypertensives
- statins

☐ **A** none

☐ **B** one

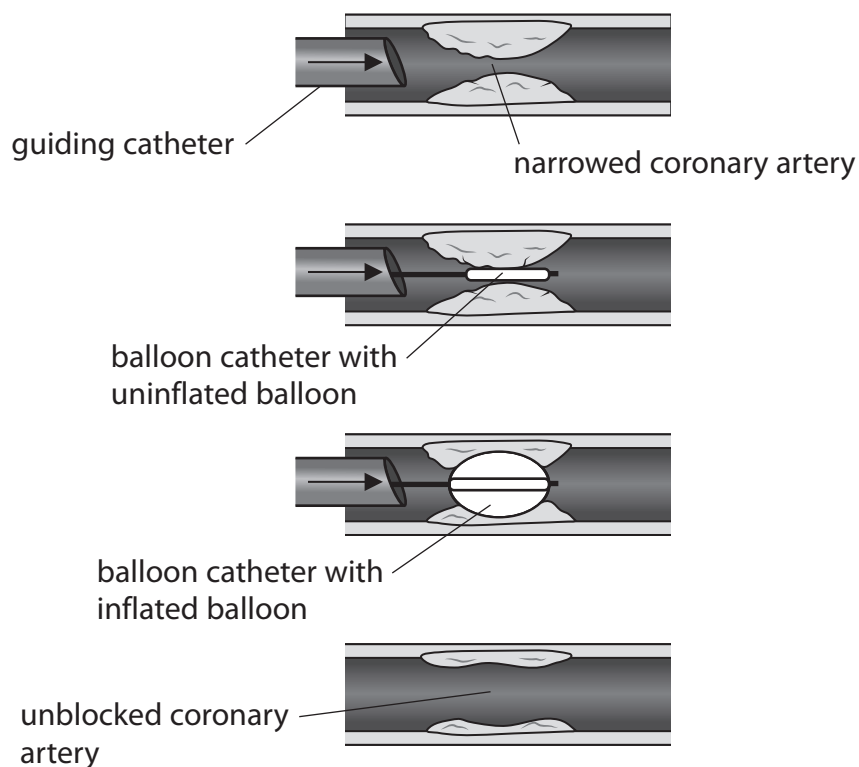
☐ **C** two

☒ **D** three

The diagram shows a procedure called balloon angioplasty.

Balloon angioplasty can reduce the immediate risk of a person having a heart attack.

It will not prevent further narrowing of coronary arteries due to atherosclerosis.



- (ii) Explain why balloon angioplasty could reduce the immediate risk of a person having a heart attack.

(4)

Inflating the balloon widens the lumen of the narrowed coronary artery, so it is no longer narrowed.

This increases blood flow through the coronary artery.

It also reduces the blood pressure and the risk of a blood clot forming and blocking the artery.

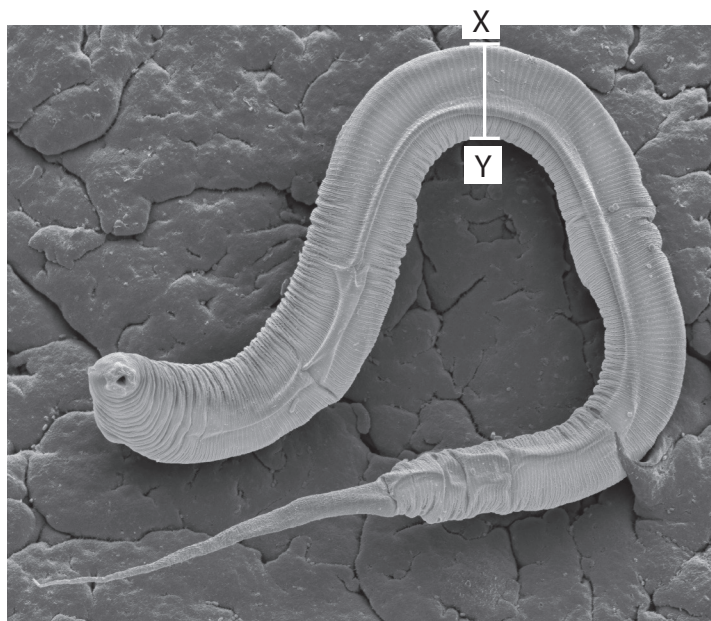
So more oxygenated blood is supplied to the cardiac muscle cells.

This allows aerobic respiration, releasing ATP for muscle contraction, so the heart muscle cells do not die, which reduces the immediate risk of a heart attack.

(Total for Question 7 = 14 marks)

8 Some organisms do not have a circulatory system.

The photograph shows the nematode *Caenorhabditis elegans*, as seen using an electron microscope.



Magnification $\times 1300$

(Source: © Science Photo Library/Alamy Stock Photo)

- (a) (i) Calculate the actual width of the nematode from X to Y.

(2)

$$XY \text{ on photograph} = 13 \text{ mm} = 13\,000 \mu\text{m}$$

$$\text{actual width} = \text{image size} \div \text{magnification}$$

$$= 13\,000 \div 1300 = 10 \mu\text{m}$$

Answer 10..... μm

- (ii) Explain why this nematode does not need a circulatory system.

(2)

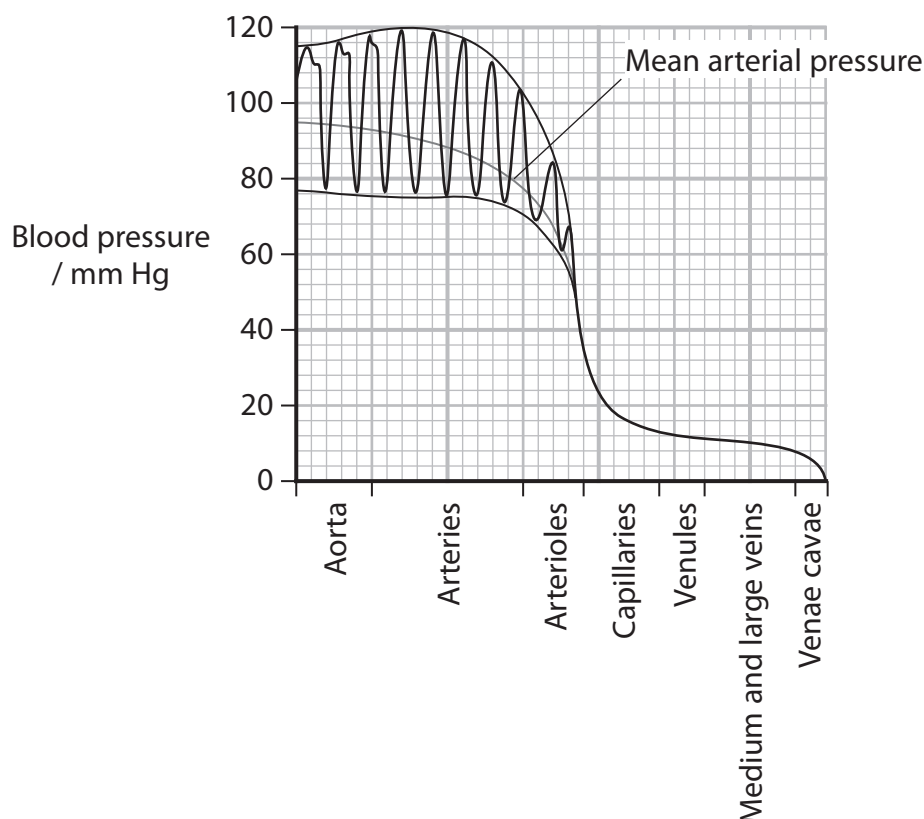
The nematode is small and thin, so it has a large surface area to volume ratio.

All its cells are a short distance from the body surface, so diffusion through the surface can supply the needs of all the cells and their metabolic reactions.



(b) Humans have a circulatory system.

The graph shows the change in blood pressure in different human blood vessels.



(i) Explain why the blood pressure increases and decreases in the aorta.

(2)

The pressure increases during ventricular systole, as the left ventricle contracts and pumps blood into the aorta.

The pressure decreases during ventricular diastole, as no blood is entering the aorta from the heart (elastic recoil of the aorta wall maintains some pressure).

(ii) Calculate the percentage decrease in blood pressure as blood travels through the capillaries.

Give your answer to two significant figures.

(2)

$$36 - 13 = 23 \text{ mm Hg}$$

$$(23 \div 36) \times 100 = 63.9\%$$

Answer 64 %

(c) The squid is an invertebrate animal that lives in the sea.

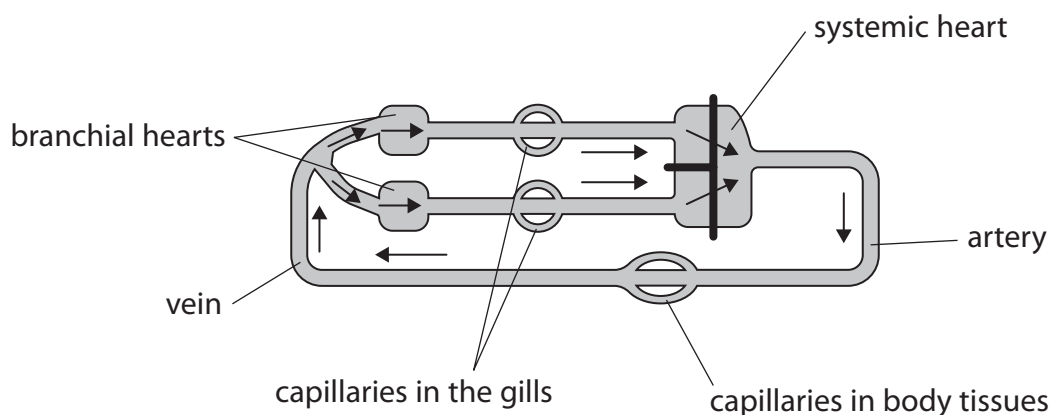
The photograph shows a squid.



(Source: © bonchan/Shutterstock)

The diagram shows the circulatory system of a squid.

The gills contain gas exchange surfaces.



(i) Compare and contrast the circulatory systems of a squid and a human.

(3)

Similarities: both have a heart and blood vessels (arteries, veins and capillaries), and both have a closed circulatory system.

Differences: the squid has three hearts (two branchial hearts and one systemic heart), whereas humans have one heart.

The squid has a single circulatory system, whereas humans have a double circulatory system in which blood passes through the heart twice in each complete circuit.

- (ii) A student wished to investigate the effect of caffeine on the heart rate of some vertebrate and invertebrate organisms.

Describe two potential ethical issues which should be considered before the selection of organisms to include in this investigation.

(2)

Vertebrates have a more developed nervous system, so they may feel pain and be harmed or die, and no organism can give consent. A non-invasive method should be used, e.g. transparent organisms so the heart can be seen, for minimal time.

Select organisms that are abundant and not endangered, and return them to their habitat after the investigation.

(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 80 MARKS

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