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Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Biology A (Salters Nuffield)

Advanced Subsidiary

Paper 1: Lifestyle, Transport, Genes and Health

Thursday 24 May 2018 – Afternoon

Time: 1 hour 30 minutes

Paper Reference **8BN0/01**

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.*
- 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.

Turn over ▶

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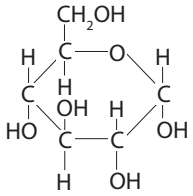
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Answer ALL questions.

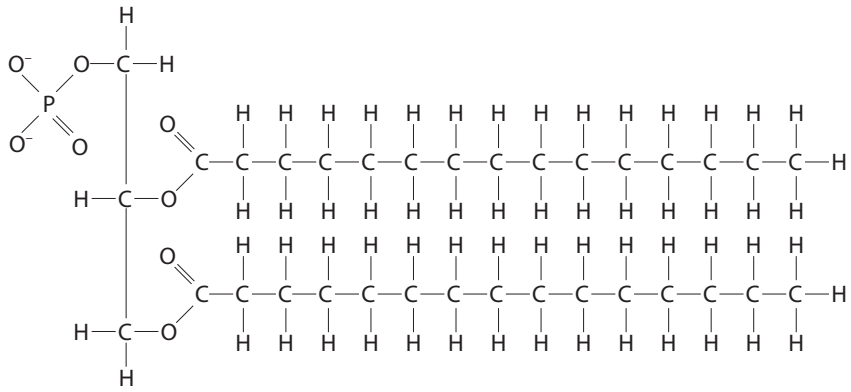
Write your answers in the spaces provided.

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 ☒.

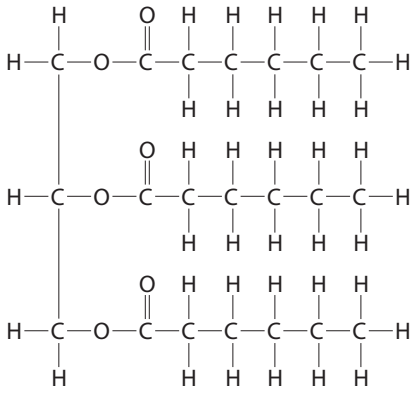
1 The diagram shows four molecules that can be found in living organisms.



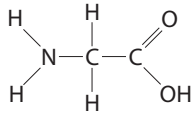
A



B



C



D

(a) (i) How many of these molecules contain three elements only?

(1)

- ☒ **A** one
- ☒ **B** two
- ☒ **C** three
- ☒ **D** four

(ii) State how an unsaturated lipid differs from molecule **C**.

(1)

An unsaturated lipid contains C=C double bonds between carbon atoms in the fatty acid (hydrocarbon) chains; molecule C has only single C–C bonds.

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(iii) Which of these molecules is transported by tRNA?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(iv) Which of these molecules could be joined to another molecule of the same type by a peptide bond?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(v) Which of these molecules is a component of maltose?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

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(b) Diffusion and active transport are mechanisms by which molecules can enter cells.

Compare and contrast these two mechanisms.

(3)

Similarities: both mechanisms move molecules across the cell surface membrane (phospholipid bilayer), and in both the molecules can move through proteins in the membrane (channel or carrier proteins).

Differences: diffusion occurs down a concentration gradient (from high to low concentration), whereas active transport moves molecules against a concentration gradient (from low to high concentration).

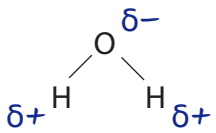
Diffusion is passive and does not require ATP, whereas active transport requires energy from ATP (released by respiration).

(Total for Question 1 = 8 marks)

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2 Water is a polar molecule. The diagram shows a molecule of water.



(a) Complete the diagram to show the dipole nature of this water molecule.

(2)

(b) Name the type of reaction in which a molecule of water is involved in the breaking of a bond in another molecule.

(1)

Hydrolysis (a hydrolysis reaction).

(c) Explain how the properties of water make it an ideal transport medium.

(3)

Water is a good solvent, so polar molecules and ions (e.g. glucose, amino acids, Na^+ and Cl^-) dissolve in it and can be transported.

This is because water is polar: water molecules surround the ions and polar molecules (δ− oxygen attracted to positive ions, δ+ hydrogen to negative ions) and hydrogen bonds form between water molecules and solute molecules, separating them.

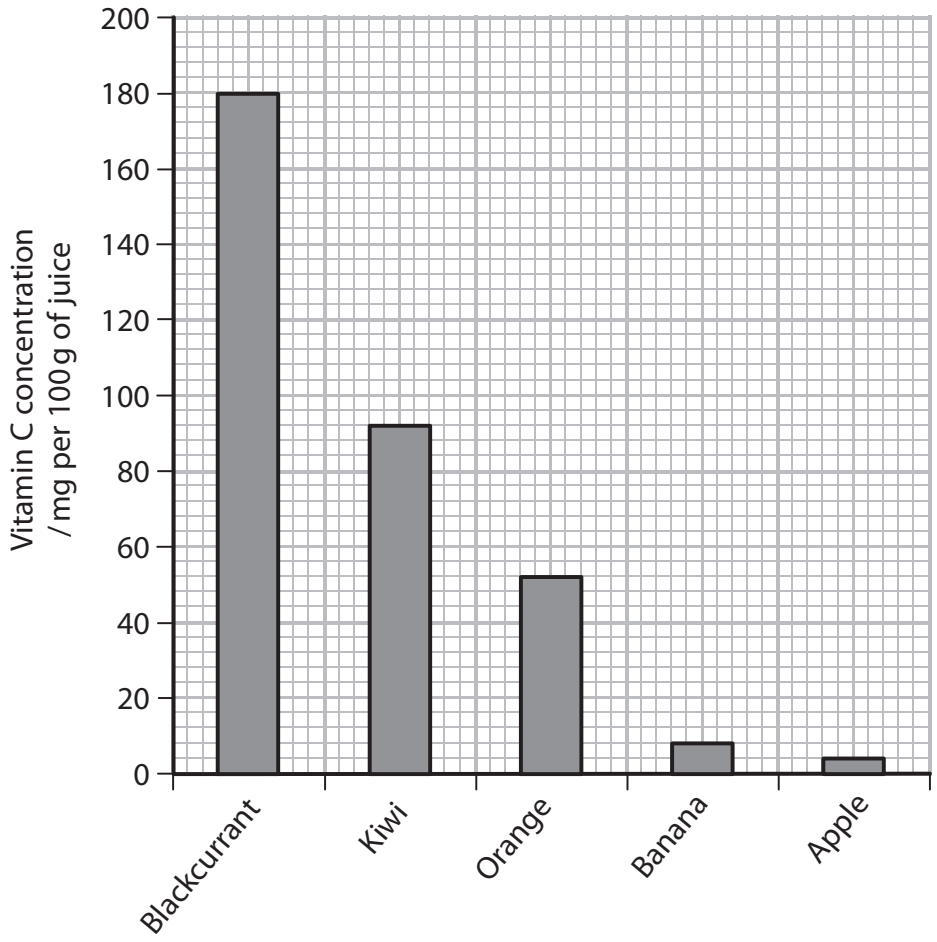
Water is a liquid at body temperature, so it has the ability to flow, and cohesion between water molecules (hydrogen bonding) lets it flow as a continuous column.

(Total for Question 2 = 6 marks)

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3 Fruit juices contain various concentrations of vitamin C.

The graph shows the vitamin C concentration of five fruit juices.



(a) Calculate the mass of orange juice required to provide the same mass of vitamin C that is in 100 g of blackcurrant juice.

(2)

Blackcurrant = 180 mg per 100 g

Orange = 52 mg per 100 g

mass of orange juice = (180 ÷ 52) × 100

= 346 g

Answer ..... *346* ..... g

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(b) Devise an investigation that can be used to collect these data.

(5)

Carry out a titration using DCPIP. Put a known, fixed volume of DCPIP (e.g. 2 cm^3) of the same concentration into a test tube for each juice.

Add the fruit juice drop by drop from a burette (or pipette), shaking after each drop, until the end point is reached, when the blue DCPIP turns colourless. Record the volume of juice needed.

Control other variables: use the same concentration and volume of DCPIP each time, use freshly squeezed juice of the same age, kept at the same temperature, and shake the tube the same way. Repeat three times for each juice and calculate a mean.

Repeat the titration with vitamin C solutions of known concentration to produce a calibration curve (volume needed to decolourise DCPIP against vitamin C concentration), or compare with a standardised vitamin C solution.

Use the calibration curve to determine the concentration of vitamin C in each juice (mg per cm^3).

Calculate the mass of vitamin C per 100 g of juice from this concentration, using the mass of a known volume of juice (its density), e.g. mg per cm^3 × volume of 100 g of juice.

(Total for Question 3 = 7 marks)

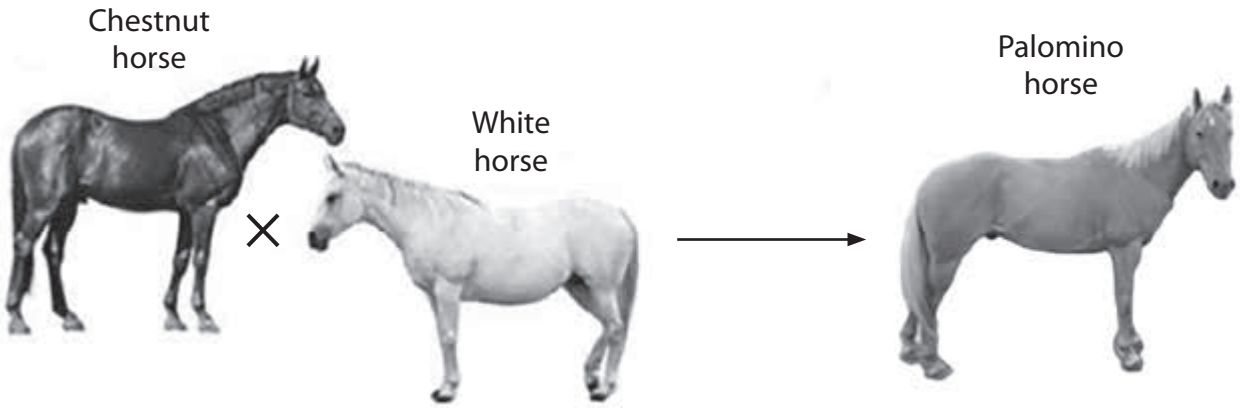
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4 The phenotype of organisms is affected by genotype.

(a) Chestnut horses are homozygous for the allele H^C. White horses are homozygous for the allele H^W.

If a chestnut horse is mated with a white horse, the offspring will be palomino.

Palomino horses have coats with a colour intermediate between chestnut and white.



(i) State what is meant by the term **allele**.

(2)

An alternative form (different version) of a gene,
found at the same locus (same position) on a chromosome.

(ii) Explain why the offspring have the palomino coat colour.

(3)

Each offspring inherits one allele from each parent, so the palomino offspring are heterozygous, with the genotype H^CH^W.
The alleles show codominance (incomplete dominance): neither allele is dominant over the other.
So both alleles are expressed in the phenotype, producing a coat colour intermediate between chestnut and white.

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(b) Achondroplasia is a genetic condition that causes dwarfism in humans.

Genetic screening can be used to identify achondroplasia in embryos.

Individuals that are heterozygous for achondroplasia have shortened limbs.

Individuals homozygous for achondroplasia will not usually survive for more than one year.

(i) Deduce if achondroplasia is caused by a dominant or recessive allele.

(1)

Dominant, as heterozygous individuals (with one copy) have the condition.

(ii) Use a genetic diagram to determine the probability that a child of parents with achondroplasia will be homozygous for this condition.

(3)

A = achondroplasia allele, a = normal allele

Parents: Aa × Aa (both heterozygous)

Gametes: A, a and A, a

	A	a
A	AA	Aa
a	Aa	aa

Offspring: AA, Aa, Aa, aa

AA = homozygous achondroplasia

Answer *0.25 (25%)*

(iii) An embryo, created by IVF, can be screened before it is placed in the mother's uterus.

Name this type of genetic screening.

(1)

Pre-implantation genetic diagnosis (PGD).

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(iv) Explain **one** ethical issue relating to the use of prenatal genetic screening.

(2)

If the embryo or fetus is found to have the condition, the parents may choose an abortion (or embryos may be discarded).

Many people believe it is unethical to cause the death of a fetus, as it destroys a potential human being with a right to life.

Also, there is a risk of an incorrect result (a false positive), so a healthy fetus could be aborted.

(Total for Question 4 = 12 marks)

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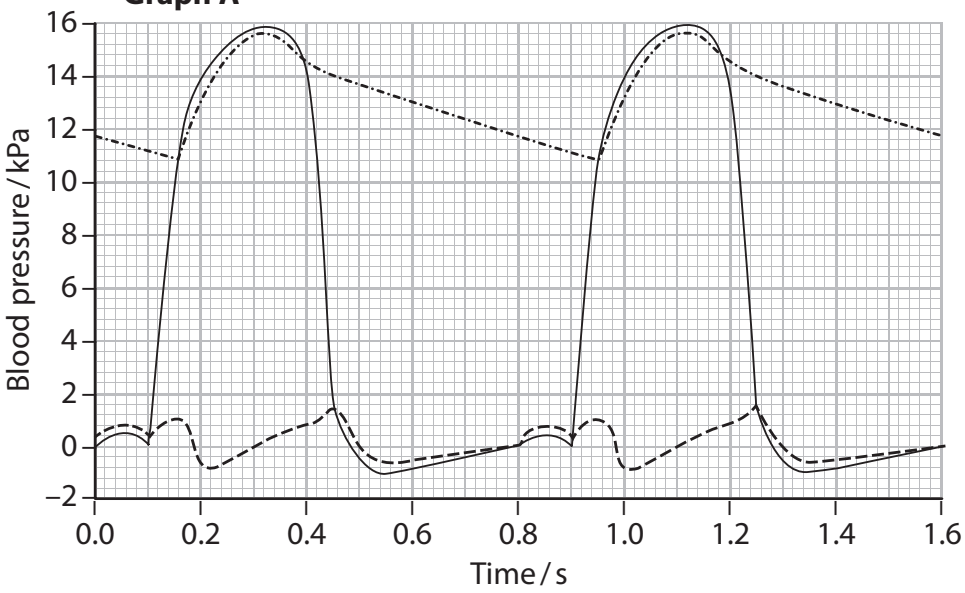
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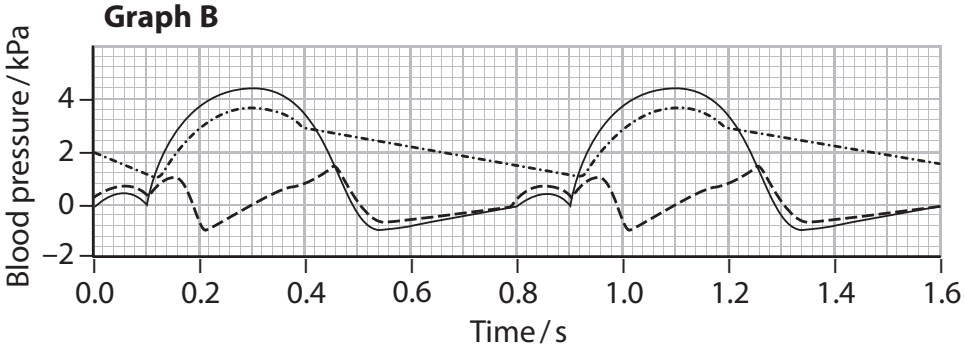
5 The pressure of the blood passing through the heart can vary.

Graph A shows the changes in blood pressure in one side of the heart. Graph B shows the changes in blood pressure in the other side of the heart over the same time period.

Graph A



Graph B



(a) (i) Calculate the heart rate.

(2)

One cardiac cycle = 0.8 s (two cycles in 1.6 s)

heart rate = 60 ÷ 0.8

Answer *75 bpm*

(ii) Increased heart rate is often associated with high blood pressure.

Which of the following will reduce blood pressure?

(1)

- ☒ **A** anticoagulants
- ☒ **B** antihypertensives
- ☒ **C** cholesterol
- ☒ **D** platelet inhibitors

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(b) (i) Explain which side of the human heart is represented by graph B.

(2)

The right side, because the pressure is lower: blood is transported from the heart to the lungs, so only a low pressure is needed.

(ii) In graph A, which blood vessel carries the blood leaving the heart?

(1)

- ☒ **A** aorta
- ☐ **B** pulmonary artery
- ☐ **C** pulmonary vein
- ☐ **D** vena cava

(iii) In graph A, the blood pressure inside the ventricle changes between 0.0 and 0.45 seconds.

Explain how these changes in blood pressure occur in this part of the cardiac cycle.

(4)

From 0 s to 0.05 s the ventricular pressure increases slightly due to atrial systole: the muscular walls of the atria contract and the ventricle fills with blood from the atrium. After atrial systole finishes (0.05 s to 0.1 s) there is a fall in ventricular pressure. From 0.1 s to 0.32 s the pressure increases rapidly due to ventricular systole: the muscular walls of the ventricle contract, the AV valve closes and the semilunar valve opens when ventricular pressure exceeds the pressure in the aorta. From 0.32 s the ventricular pressure decreases (to 0.45 s) due to ventricular diastole, as the muscular walls of the ventricle relax.

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(c) Explain how the structure of the walls of the blood vessels carrying blood away from the heart in graph A and graph B are different.

(3)

The aorta (graph A) has a thicker wall than the pulmonary artery (graph B), with a thicker layer of (more) collagen, elastic tissue and smooth muscle tissue.

More collagen in the walls of the aorta enables it to withstand the higher blood pressure.

More muscular tissue in the walls of the aorta helps to maintain the higher blood pressure.

More elastic tissue in the aorta allows elastic recoil, which maintains blood pressure and smooths the flow between heartbeats.

The pulmonary artery has thinner walls with less collagen, elastic and muscular tissue because the blood pressure is lower.

(Total for Question 5 = 13 marks)

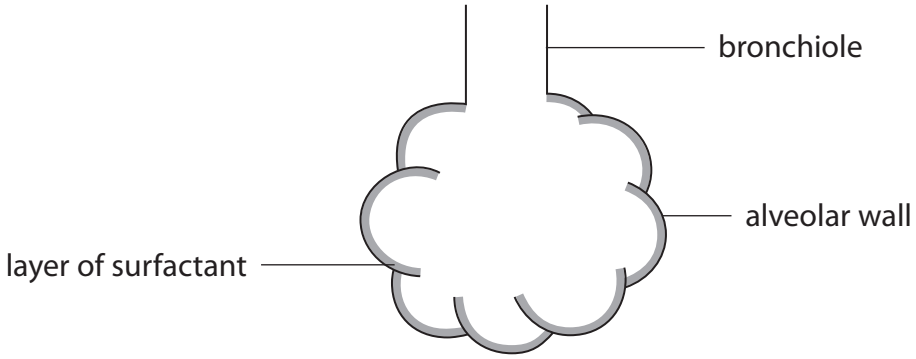
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6 Cells in the walls of the alveoli secrete a fluid.

This fluid, containing proteins and lipoproteins, acts as a surfactant.

The layer of surfactant, shown in the diagram, prevents the alveoli collapsing.



Alveolar cells undergoing protein synthesis were investigated.

Cells containing amino acids labelled with a fluorescent marker were monitored for 30 minutes.

The percentage of fluorescence inside and outside the cells was measured.

The results are shown in the table.

Time / min	Fluorescence (%)	
	Inside the cells	Outside the cells
0	100	0
5	87	13
10	80	20
15	68	32
20	56	44
25	47	53
30	38	62

(a) During which period of time did the fluorescence inside the cells decrease at the fastest rate?

(1)

☒ **A** 0 to 5 minutes

☒ **B** 0 to 10 minutes

☒ **C** 10 to 15 minutes

☒ **D** 10 to 20 minutes

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(b) The percentage of fluorescence inside and outside these alveolar cells changed.

Explain why these changes occurred.

(4)

The fluorescence inside the cells decreases (from 100% to 38%) while the fluorescence outside the cells increases (from 0% to 62%).

This is because the labelled amino acids were used to synthesise proteins and lipoproteins (translation on the ribosomes of the rough ER).

The proteins are modified in the Golgi apparatus and packaged into secretory vesicles.

The vesicles move to and fuse with the cell surface membrane, so the proteins are secreted (leave the cell) by exocytosis, as the surfactant.

Some fluorescence remains inside the cells because some labelled amino acids are used to make cellular proteins that stay in the cell (e.g. enzymes, membrane proteins).

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(c) Explain how these labelled amino acids would be incorporated into a surfactant protein.

(4)

The mRNA for the surfactant protein leaves the nucleus and attaches to a ribosome (on the rough ER), where it is translated.

The labelled amino acids are carried to the ribosome by tRNA molecules, each tRNA carrying a specific amino acid.

There is complementary base pairing between the codons on the mRNA and the anticodons on the tRNA, so the amino acids are placed in the correct sequence.

Adjacent amino acids are joined by peptide bonds in condensation reactions, forming the polypeptide (primary structure).

The polypeptide then folds to form its secondary structure (alpha helix or beta pleated sheet, held by hydrogen bonds) and its tertiary structure, producing the surfactant protein.

(Total for Question 6 = 9 marks)

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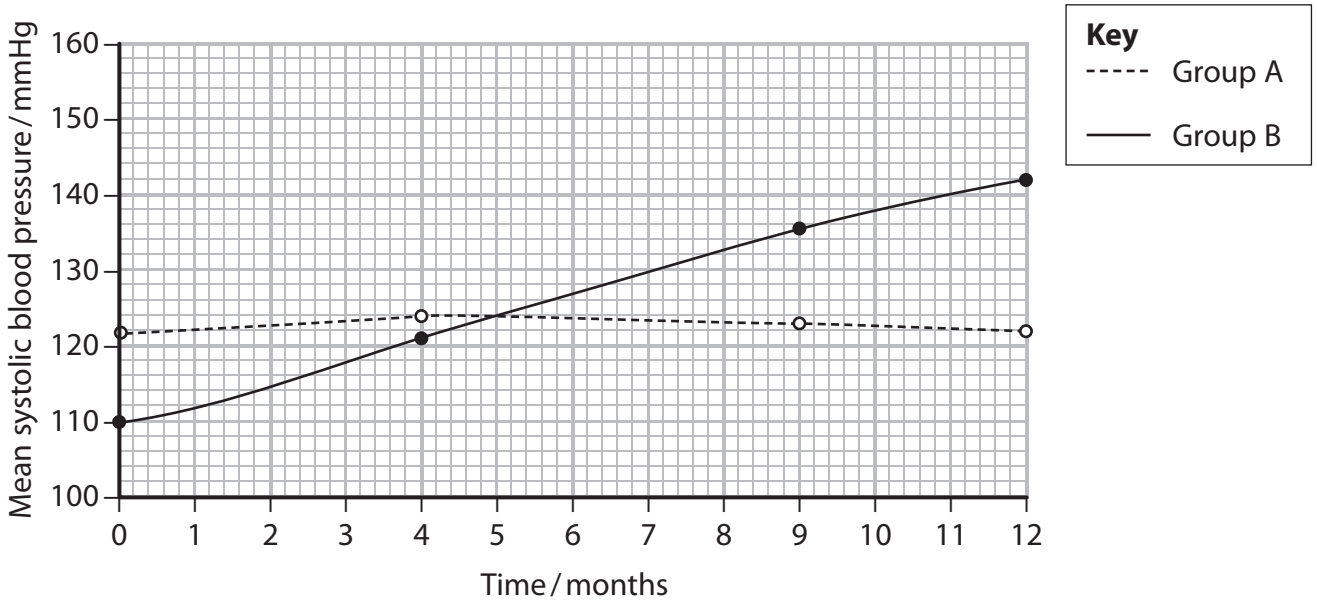
7 The effect of salt in the diet on blood pressure was investigated.

This investigation involved 15 males and 5 females, all between 20 and 30 years old. They were split into two groups, A and B, each of 10 people.

Group A had a diet containing 3 g of salt per day. Group B had a diet containing 9 g of salt per day.

The systolic blood pressures, measured in mmHg, were recorded during one year.

The results are shown in the graph.



(a) (i) Determine the effects of salt in the diet on systolic blood pressure in this investigation.

(3)

In group A (3 g salt per day, low salt diet) there is little change (no increase) in blood pressure, staying at about 121 to 124 mmHg.

In group B (9 g salt per day, high salt diet) the blood pressure increased, from 110 mmHg to 142 mmHg.

This is an overall increase of 32 mmHg (a 29% increase) for B, and after 12 months B is 20 mmHg higher than A.

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(ii) Explain the effect that a diet high in salt could have on a person's risk of developing cardiovascular disease.

(5)

A diet high in salt increases the risk of cardiovascular disease (CVD), such as a heart attack or stroke.

High salt intake lowers the water potential of the blood, so more water is retained in the blood, increasing blood volume and causing higher blood pressure (hypertension).

High blood pressure increases the risk of damage to the endothelium of the arteries, leading to atherosclerosis.

The damage triggers an inflammatory response; white blood cells and cholesterol (LDLs) accumulate under the endothelium.

This leads to atheroma (plaque) formation, with calcium salts and fibrous tissue, so the arteries narrow and lose elasticity.

Narrowing of the arteries increases the risk of blood clots forming at the plaque, further increases blood pressure, and reduces blood flow to the cardiac muscle (coronary arteries), so less oxygen reaches the heart muscle.

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(b) Explain how the validity of this investigation could be improved.

(3)

Use equal numbers of males and females in each group (the 15 males and 5 females may not be evenly split), as sex can affect blood pressure.

Use a larger sample size than 10 people per group, so the results are more reliable and representative.

Control other variables: select people with the same starting blood pressure and body mass, and keep the rest of the diet and exercise level the same.

(c) A variety of drugs can be used to reduce blood pressure. These drugs may cause side effects in some people.

State **two** possible side effects of taking drugs to reduce blood pressure.

(2)

Dizziness or fainting (due to low blood pressure, hypotension).

Nausea (vomiting) and muscle cramps.

(Total for Question 7 = 13 marks)

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8 Mutations in genetic material such as DNA often result in the formation of new alleles.

(a) DNA consists of mononucleotides joined together by bonds between

(1)

☒ **A** deoxyribose and a phosphate group

☒ **B** ribose and a phosphate group

☒ **C** two pentose sugars

☒ **D** two phosphate groups

(b) More than 1500 mutations have been found for the gene that codes for the production of the CFTR channel protein.

Some of these mutations cause cystic fibrosis by affecting the production or functioning of the CFTR channel protein.

If the functioning of the CFTR channel protein is impaired, thicker mucus is produced in the lungs.

Explain why thicker mucus is produced if the functioning of the CFTR channel protein is impaired.

(2)

Chloride ions cannot leave the cell and enter the mucus through the CFTR channel protein, so sodium ions do not move out of the cells into the mucus either. Therefore the water potential of the mucus is not lowered, so water does not move into the mucus by osmosis (water moves into the cells), making the mucus thicker.

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(c) In 2013, in the UK, a sample of 10 500 people with cystic fibrosis was studied.

The numbers of people with the three most common mutations of the CFTR gene are shown in the table.

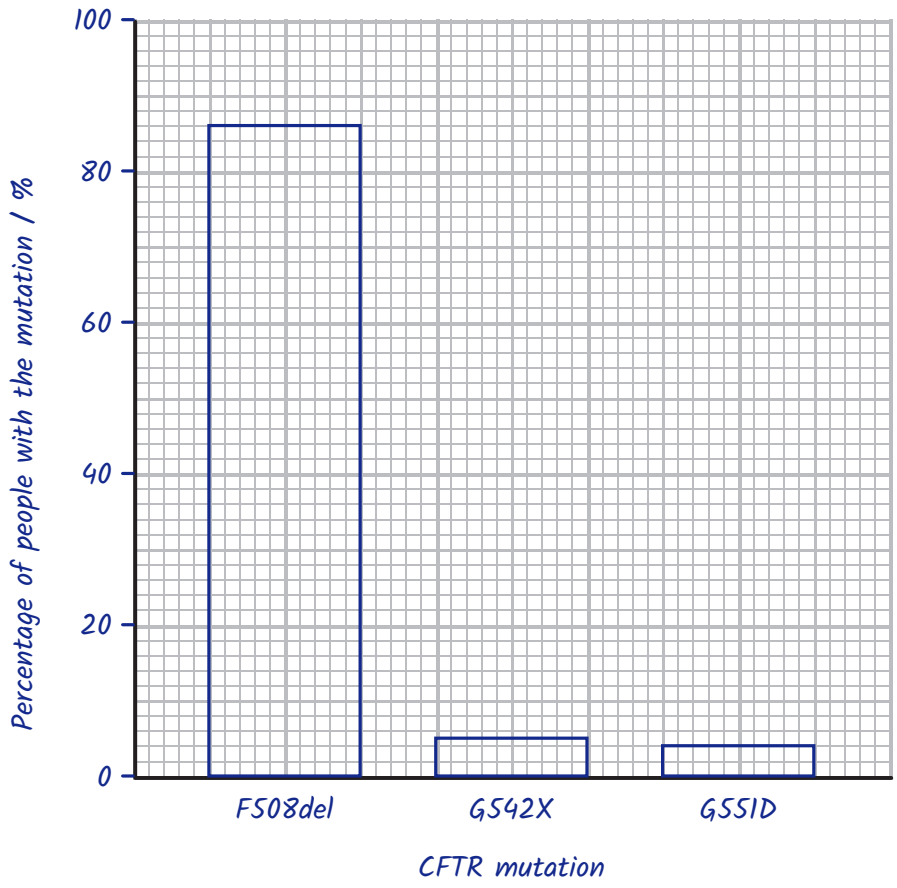
Mutation	Number of people with the mutation	Percentage of people with the mutation (%)
F508del	9030	86
G542X	525	5
G551D	420	4

(i) Complete the table to show the percentage of people with each mutation.

(1)

(ii) Plot a suitable graph to show the percentage of people with these mutations.

(2)

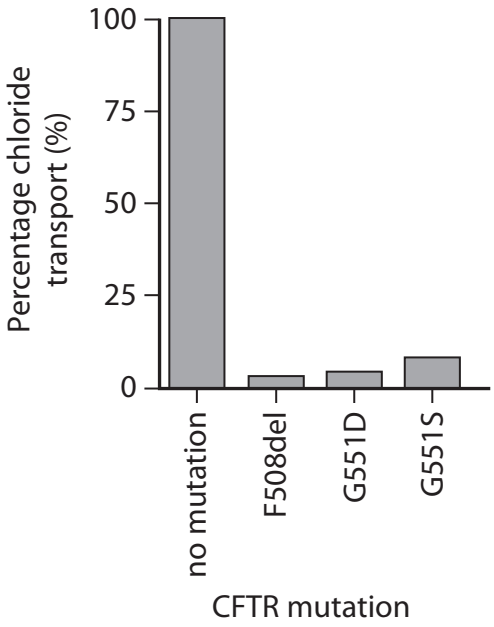


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*(d) The graph gives information about chloride transport in the human respiratory system with the normal allele for the CFTR protein and with the three mutated CFTR alleles.



The table gives information about the CFTR protein produced by cystic fibrosis (CF) sufferers with mutated alleles.

Mutation	Estimated percentage of CF sufferers who have one or more alleles with this mutation	Problem with CFTR protein channel
F508del	90	Reduced quantity / no CFTR protein
G551D	4	Reduced function
G551S	<1	Reduced function

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Assess the effect that these mutations have on the human respiratory system.

(6)

Without a mutation there is 100% chloride transport, but all three mutations reduce chloride transport. F508del results in the lowest chloride transport (about 3%), lower than G551D (about 5%) and G551S (about 8%), so the G551S mutation is less severe than G551D.

The F508del mutation results in no or fewer CFTR protein channels being produced, so there are fewer channels to transport chloride ions out of the cells.

G551D and G551S have higher chloride transport than F508del because the CFTR protein is present (channels are produced) but its function is reduced. These mutations change the amino acid sequence, so the protein folds into a different tertiary structure and the channel has an incorrect shape (e.g. the positioning of the hydrophilic parts of the channel), so fewer chloride ions pass through.

In G551S a different amino acid is substituted, so a different part of the protein structure is affected, which interferes less with chloride transport than G551D.

With less chloride ion transport, less sodium and less water move into the mucus by osmosis, so the mucus is thick and sticky. Cilia struggle to move the mucus out of the lungs, so bacteria are trapped and there is an increased risk of lung infections.

Thick mucus also blocks bronchioles and alveoli, reducing the surface area for gas exchange and increasing the diffusion distance, and reduces the concentration gradient as ventilation is reduced, so less oxygen diffuses into the blood. As F508del affects about 90% of sufferers, most CF sufferers have severe effects on the respiratory system.

(Total for Question 8 = 12 marks)

TOTAL FOR PAPER = 80 MARKS

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