

PEARSON EDEXCEL A-LEVEL BIOLOGY A • 9BN0

BIOLOGY



EXAM QUESTION PACK

TOPIC 1: LIFESTYLE, HEALTH AND RISK

SCORE

/236

PERCENTAGE

%

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Q1.

A study was carried out to determine the incidence of VTE in people of different ages. Those who developed VTE were then tested for the factor V gene mutation.

The results of this study are shown in the table.

Age range	Percentage incidence of VTE in the study group (%)	Percentage of VTE patients with factor V mutation in the study group (%)
less than 20 years of age	1.3	49.3
over 70 years of age	34.0	20.9

Deduce the relative impact of the genotype and environmental factors on the development of VTE.

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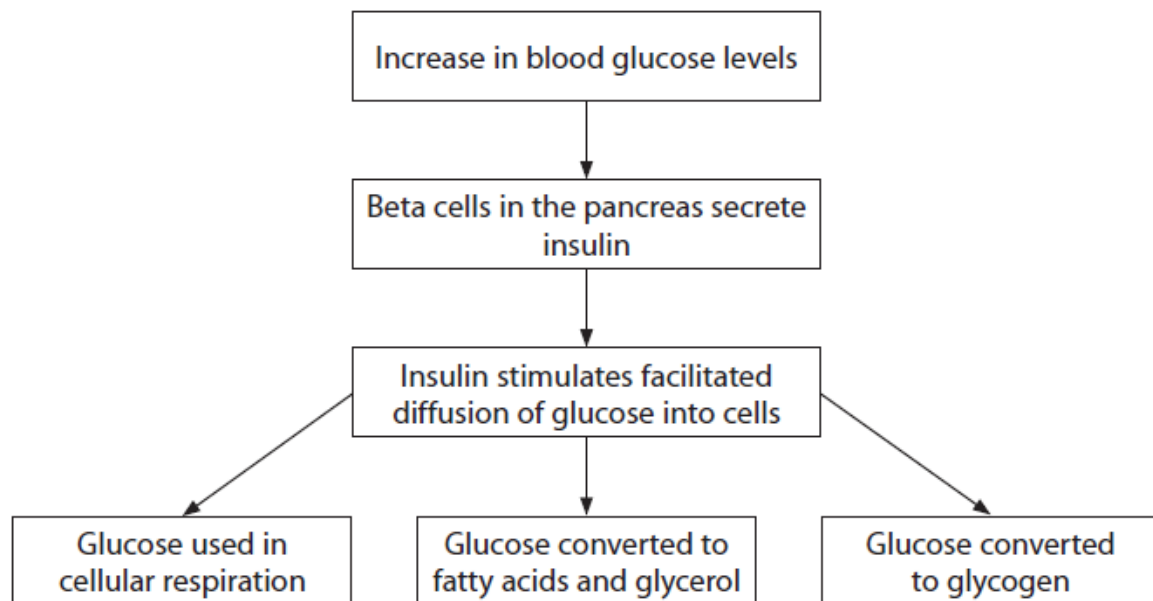
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(Total for question = 4 marks)

Q2.

The internal conditions within the body are maintained by homeostatic mechanisms. The regulation of blood glucose involves homeostatic mechanisms.

The diagram shows part of the sequence of events when there is an increase in blood glucose levels.



(i) Describe how glucose moves into cells by facilitated diffusion.

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(ii) Explain how the structure of glycogen allows it to be an energy store.

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(Total for question = 5 marks)

Q3.

Cardiovascular disease (CVD) is a major cause of death and disability in the UK.

It has been suggested that magnesium ions are involved in regulating the ratio of HDL to LDL in the blood.

(i) Describe the role of LDLs in the development of atherosclerosis.

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(ii) Explain how atherosclerosis can result in damage to heart muscle.

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(Total for question = 6 marks)

Q4.

Thrombophilia is a condition that increases the risk of blood clots forming.

This condition increases the risk of venous thromboembolism (VTE), a condition where a blood clot forms in a vein. Thrombophilia due to the production of overactive factor V can be inherited.

Factor V is involved in the conversion of prothrombin to thrombin.

(i) Describe the role of thrombin in blood clotting.

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(ii) Explain why a mutation in the gene coding for the protein factor V may increase the risk of VTE.

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(Total for question = 6 marks)

Q5.

Sweating is a thermoregulatory mechanism.

A student stated that loss of heat when sweating is related to the dipole nature of water molecules.

Justify this statement.

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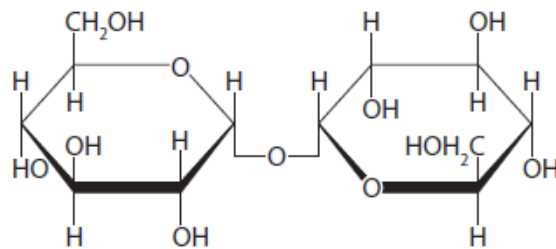
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(Total for question = 3 marks)

Q6.

Maltose and trehalose are disaccharides. Trehalose is formed from two molecules of α -glucose.

The diagram shows a molecule of trehalose.



(i) Describe the reaction that joins two α -glucose molecules to form a disaccharide.

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(ii) Compare and contrast the structures of trehalose and maltose.

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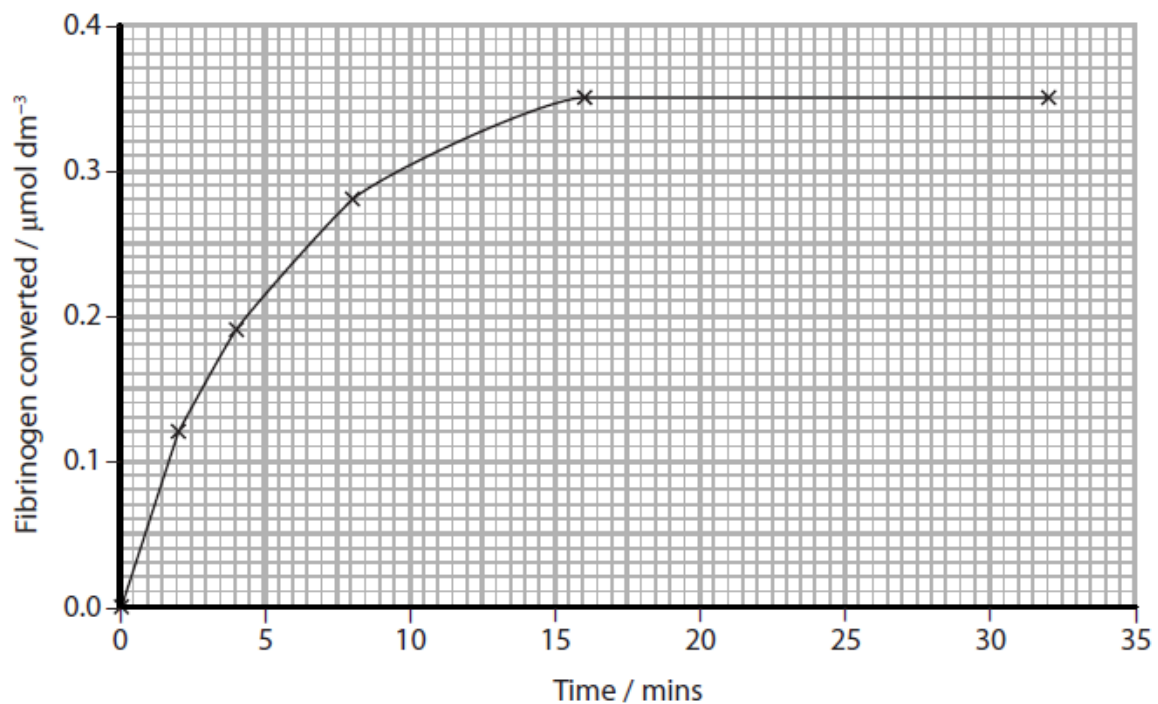
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Q7.

Fibrin is involved in the formation of blood clots.

Thrombin is an enzyme that converts fibrinogen to fibrin.

The graph shows the effect of one concentration of thrombin on the conversion of fibrinogen to fibrin.



(i) Calculate the initial rate of reaction.

(2)

Answer

(ii) On the graph, draw a line to show the effect of halving the concentration of thrombin.

(1)

(iii) Explain the effect of changes in the initial rate of reaction on the time taken for a blood clot to form.

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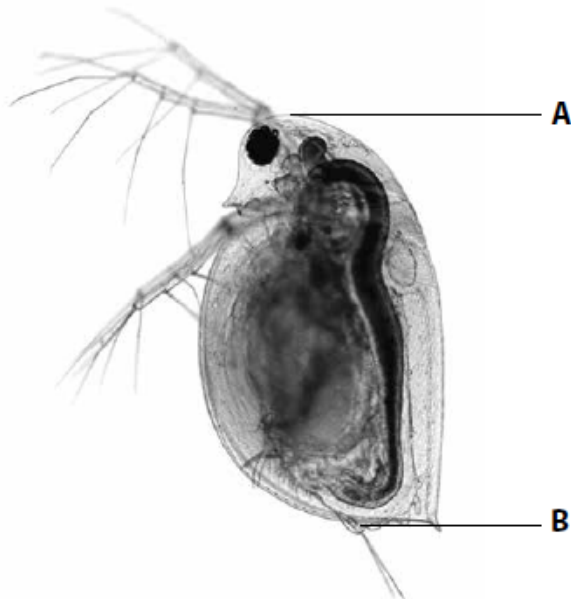
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(Total for question = 5 marks)

Q8.

A student investigated the effect of temperature on the heart rate of *Daphnia*.



Magnification $\times 60$

(Source: <http://www.nature-education.org/water-life.html>)

(a) Use the lines A to B to calculate the actual length of this *Daphnia*.

(2)

Answer

(b) The student used five *Daphnia* in the investigation.

The *Daphnia*'s heartbeats were counted over a 20-second period.

A stopwatch was used and a pencil mark made on a piece of paper while observing the *Daphnia* through a low powered microscope.

The number of heartbeats was counted three times for each *Daphnia*.

This was repeated at five different temperatures using the same *Daphnia* each time.

This was then repeated using the four other *Daphnia*.

The results obtained are shown in the table below.

<i>Daphnia</i>	Heart rate / beats in 20 seconds														
	5 °C			10 °C			15 °C			20 °C			25 °C		
1	20	18	19	30	26	29	36	35	36	42	45	44	53	47	53
2	22	23	19	36	32	29	36	39	34	42	46	42	50	51	63
3	16	18	20	26	30	27	35	33	36	39	41	40	58	52	50
4	19	22	21	30	32	35	38	36	37	45	46	42	62	62	58
5	20	25	21	35	32	34	36	39	38	44	48	42	52	55	59

(i) Explain why the number of heartbeats was measured in 20 seconds rather than in one minute.

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(ii) The mean heart rate at 5 °C is 20.2 beats in 20 seconds. Calculate how many times faster the mean heart rate is at 25 °C than at 5 °C.

(2)

Answer

(iii) The student concluded that temperature increased the heart rate of *Daphnia*.

Analyse the data to explain how this investigation could be modified to improve the validity of this conclusion.

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(c) Discuss the ethical issues that might arise from the use of invertebrates in investigations.

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(Total for question = 13 marks)

Q9.

An investigation was carried out to study the effect of alcohol concentration on heart rate in *Daphnia*.

Give one reason why some people believe that there are fewer ethical issues when using *Daphnia* for this investigation rather than using a species of mammal.

(1)

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(Total for question = 1 mark)

Q10.

The scientific article you have studied is adapted from articles from Nature, Scientific American and the ScienceDaily website.

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) Give the name of the 'simpler molecules' produced by the breakdown of glucose that can enter the mitochondria (paragraph 3).

(1)

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(b) (i) Describe the role of oxygen in the 'last reaction' involved in aerobic respiration in the mitochondria (paragraph 3).

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(ii) Explain how carbon monoxide reduces the production of ATP in the electron transport chain (paragraphs 3 and 4).

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(c) Explain how nitric oxide (NO) released by nerve endings could result in vasoconstriction of blood vessels (paragraphs 7 and 9).

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(d) Explain how free radicals may be involved in the production of P53 in the cell (paragraph 17).

(3)

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(e) Describe **three** structural differences between the inner mitochondrial membrane and the outer mitochondrial membrane (paragraphs 18 and 19).

(3)

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(f) Long wavelengths of light, in the near infrared (NIR) spectrum, appear to be able to modulate cell respiration by affecting cytochrome oxidase (paragraph 30).

Deduce how this may explain why NIR phototherapy has 'shown promise' in reducing cell death caused by myocardial infarction (paragraph 34).

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(g) (i) Describe how scientists could have produced 'genetically modified neurons' described in paragraphs 38 and 39.

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(ii) A light sensitive protein is channelrhodopsin-2. This is a channel protein that spans membranes. When exposed to blue light these channel proteins open and allow sodium ions to flow through.

Explain how a brief flash of light could cause neurotransmitter to be released by 'the genetically modified neurons' (paragraphs 38 and 39).

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(h) Explain how fMRI allowed Vandewalle to make the observations described in paragraph 50.

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(Total for question = 30 marks)

Q11.

Nandrolone is an anabolic steroid, it is a molecule with a similar shape to testosterone. Nandrolone has been used as a performance-enhancing substance by athletes in the past.

A number of investigations with mice have been carried out to study the effect of nandrolone on the structure and function of the aorta.

In these investigations, all the mice were of one type and were all supplied with the same amount of food and water. These mice were placed into four groups.

Each group was treated differently for eight weeks. The treatments are shown in the table.

Group	Treatment	
	Allowed to exercise	Given nandrolone
P	No	No
Q	No	Yes
R	Yes	No
S	Yes	Yes

After eight weeks, the aorta of each mouse was studied.

(i) In investigation 1, samples of aorta were put under tension to test elastic recoil.

The tension was removed and the mean maximum percentage recoil for each group was found.

The results are shown in the table.

Group	Mean maximum percentage recoil (%)
P	57
Q	38
R	80
S	53

The use of nandrolone has been linked to a variety of cardiovascular conditions.

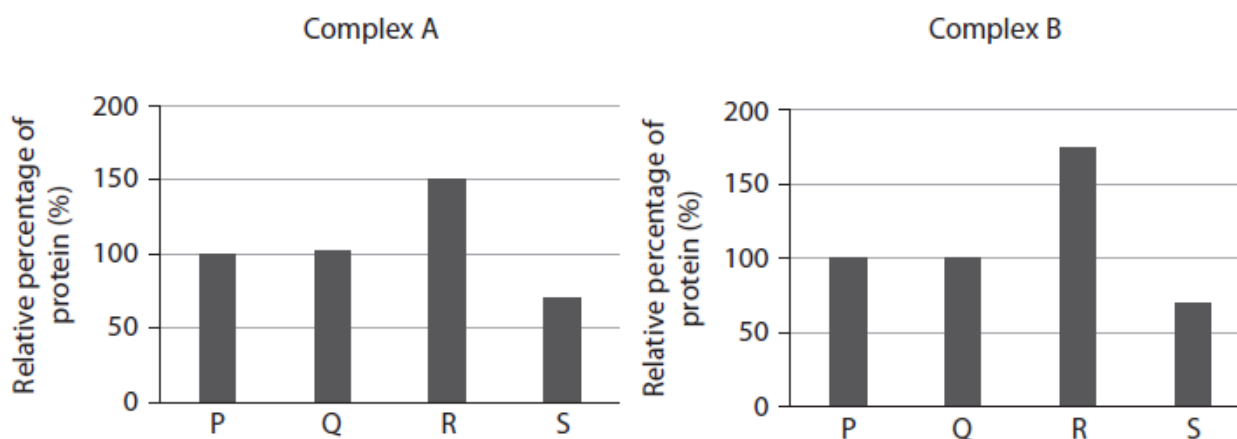
Explain how the use of nandrolone could lead to atherosclerosis.

(3)

(ii) In investigation 2, some of the cells from the middle layer of the aortas of the mice were removed.

Two protein complexes, A and B, are found in the cells of the middle layer. These protein complexes are involved in the electron transport chain.

The graphs show the relative percentage of these two protein complexes in each group of mice.



Comment on the effects of nandrolone on the production of ATP.

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(iii) The transcription factor Tfam is involved in the production of mitochondria.

In investigation 3, some of the cells from the middle layer of the aortas of the mice were removed. The quantity of mRNA per cell coding for Tfam was measured.

The results are shown in the table.

Group	Quantity of mRNA per cell coding for Tfam / a.u.
P	100 ± 20
Q	75 ± 10
R	170 ± 25
S	85 ± 15

A student concluded that nandrolone affects the quantity of mRNA per cell coding for Tfam.

Explain why this conclusion is not valid for all the mice.

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(Total for question = 8 marks)

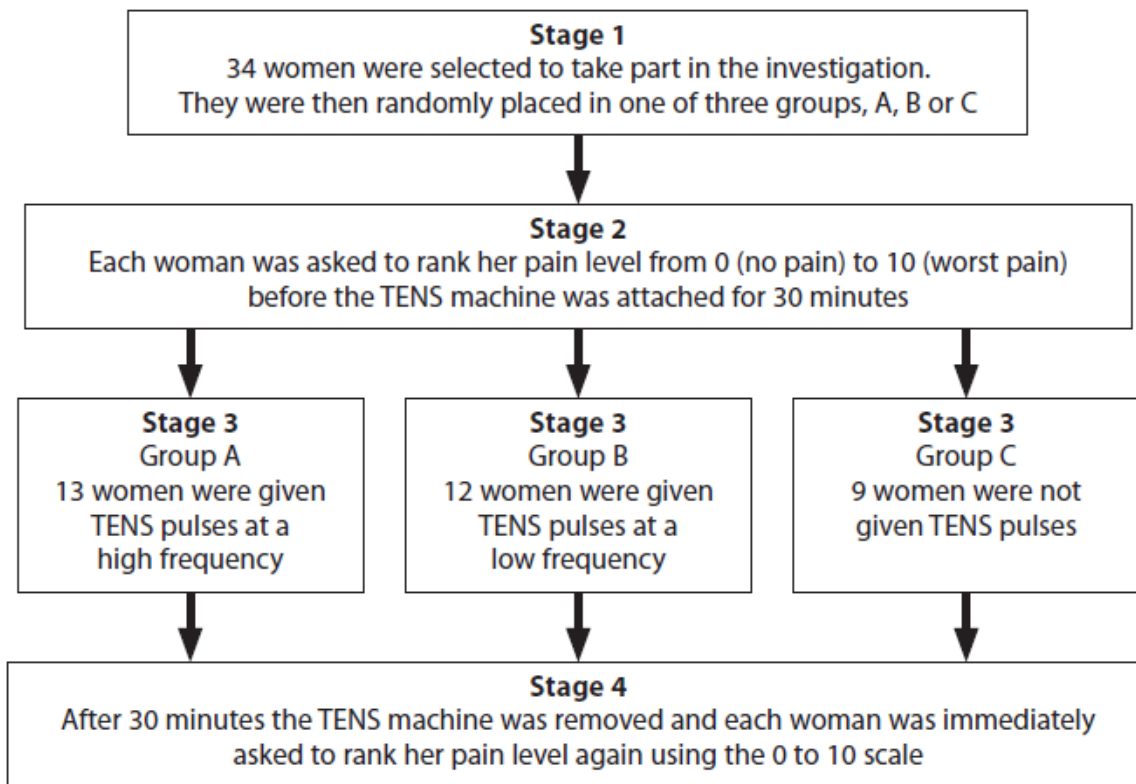
Q12.

Some women need to have surgery to aid childbirth. This can lead to pain after surgery.

A TENS (transcutaneous electrical nerve stimulation) machine releases regular pulses of electricity onto the skin surface and can be used in pain relief.

An investigation was carried out to study whether the frequency of the pulses from a TENS machine could help these women with their pain relief.

The diagram shows how the investigation was carried out.



Explain why group C was included in this investigation.

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(Total for question = 2 marks)

Q13.

Sepsis is a bacterial infection in the bloodstream. Sepsis can cause tissue death in limbs. This may require parts of a limb to be removed (amputation).

Sepsis can cause blood clots to form and block the supply of blood to tissues in the limbs.

Explain why blood clot formation in capillaries could cause tissues to die.

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(Total for question = 2 marks)

Q14.

The largest blood vessels in the body are the aorta and the vena cava.

The wall of the aorta is thicker than the wall of the vena cava.

Explain why there is a difference in the thickness of the walls of the aorta and the vena cava.

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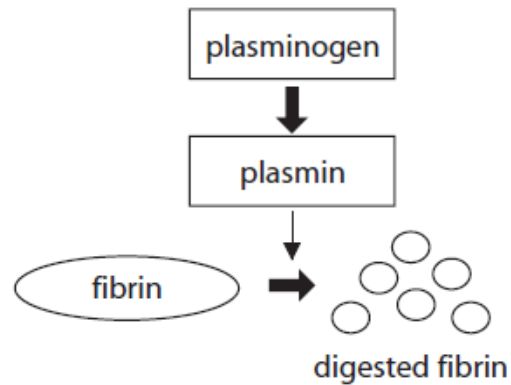
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(Total for question = 2 marks)

Q15.

Plasmin is an enzyme that digests fibrin.

Plasmin is produced, in the blood, from an inactive form of the enzyme called plasminogen.



Pharmaceutical companies have developed drugs that inhibit the activity of plasmin.

One of these drugs, tranexamic acid, is used in surgery to reduce blood loss.

(a) Explain why tranexamic acid will result in reduced blood loss during surgery.

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(Total for question = 3 marks)

Q16.

Fibrin is involved in the formation of blood clots.

Thrombin is an enzyme that converts fibrinogen to fibrin.

The table shows the results of an investigation into the fibrinogen concentrations in the blood of males and females with and without cardiovascular disease (CVD).

Mean fibrinogen concentration / mg 100 cm ⁻³		
	With CVD	Without CVD
Males	333 ± 5.16	322 ± 2.00
Females	336 ± 7.25	319 ± 1.89

(i) Explain how the results of this investigation could be used to identify individuals at risk of CVD.

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(ii) Explain how changes in fibrinogen concentration might be a risk factor for CVD.

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(Total for question = 6 marks)

Q17.

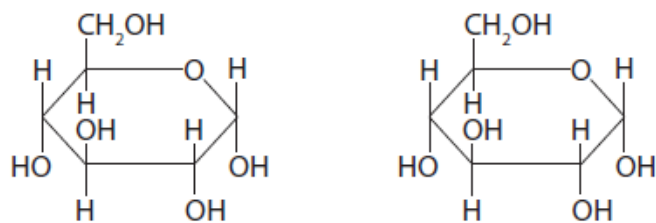
There are a number of reactions that regularly occur in cells.

Condensation reactions can be used to join a number of molecules together.

(i) The diagram shows two substrate molecules.

Draw the products when a condensation reaction occurs between the two substrate molecules.

(2)



(ii) Name the larger product formed in this reaction.

(1)

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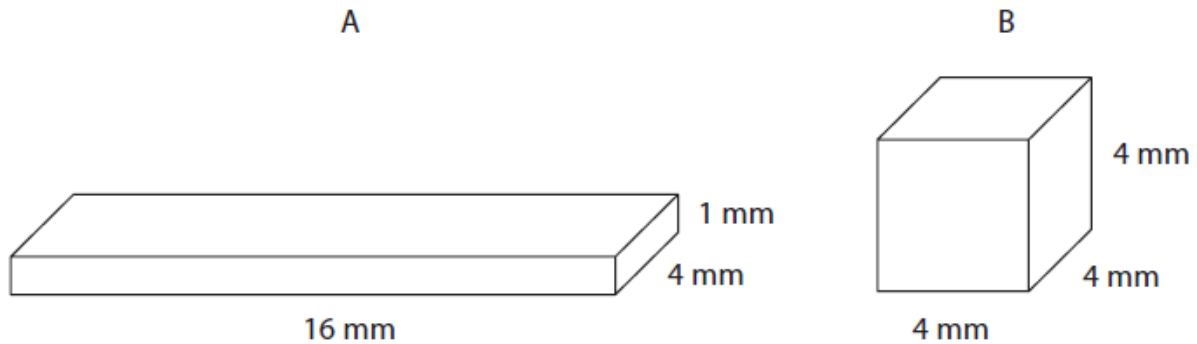
Q18.

Scientists can use models to explain the need for a circulation system in animals.

The shapes in the diagram represent two different animals that live in water.
The figures represent the height, width and breadth of the animals.

Determine why animal A does not need a circulation system but animal B does.

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(Total for question = 4 marks)

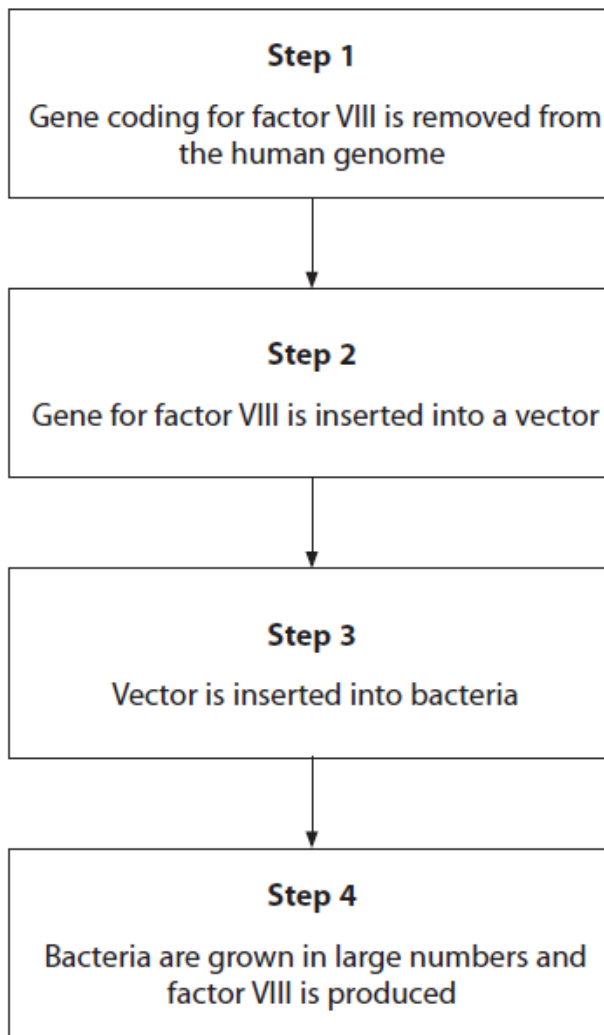
Q19.

Haemophilia is a genetic disorder where blood does not clot normally.

It can be treated by injecting factor VIII, a protein involved in the blood-clotting process that is not produced by people with haemophilia type A.

Bacteria can be genetically modified to produce factor VIII.

(a) The diagram shows some of the steps involved in genetically modifying bacteria to produce factor VIII.



(i) Describe the difference between a gene and the genome

(2)

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(ii) Give the name of the type of enzyme that would be used to insert the gene into the DNA of the vector at Step 2.

(1)

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(iii) Give an example of a suitable vector that would be used in Step 2 or 3.

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(iv) Describe how the genetically modified bacteria would use the gene from the human genome to produced factor VIII in Step 4.

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(b) Factor VIII is required for the activation of prothrombin.

Explain why the blood-clotting process does not take place normally when a person with haemophilia type A cuts their hand.

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(Total for question = 9 marks)

Q20.

The scientific article you have studied is adapted from several sources.

Use the information from the scientific article and your own knowledge to answer the following questions.

Give two reasons why doctors want to prevent people gaining excess weight (paragraph 28).

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(Total for question = 1 mark)

Q21.

Some people have a disorder that reduces their ability to produce an enzyme required to break down glycogen. This enzyme is glycogen phosphorylase.

The symptoms of this disorder include muscle weakness and lack of stamina when exercising.

(i) Explain why a low concentration of this enzyme would cause the symptoms described.

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(ii) Devise an experiment to investigate the effect of glycogen phosphorylase concentration on the breakdown of glycogen.

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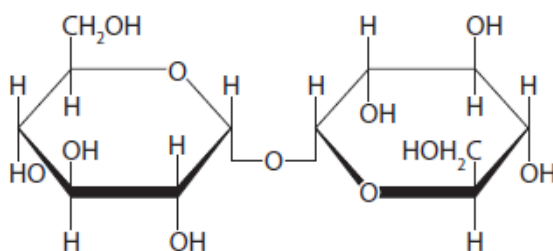
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Q22.

Maltose and trehalose are disaccharides. Trehalose is formed from two molecules of α -glucose.

The diagram shows a molecule of trehalose.



Some flying insects store trehalose and glycogen in their wing muscles.

(i) Trehalose is broken down to glucose by the enzyme trehalase.

Which of the following describes how glucose is produced from trehalose?

(1)

☒ **A** anabolism

☒ **B** catalysis

☐ **C** glycolysis

☐ **D** hydrolysis

(ii) Insect flight uses a lot of energy. Explain the advantage of insects storing both trehalose and glycogen.

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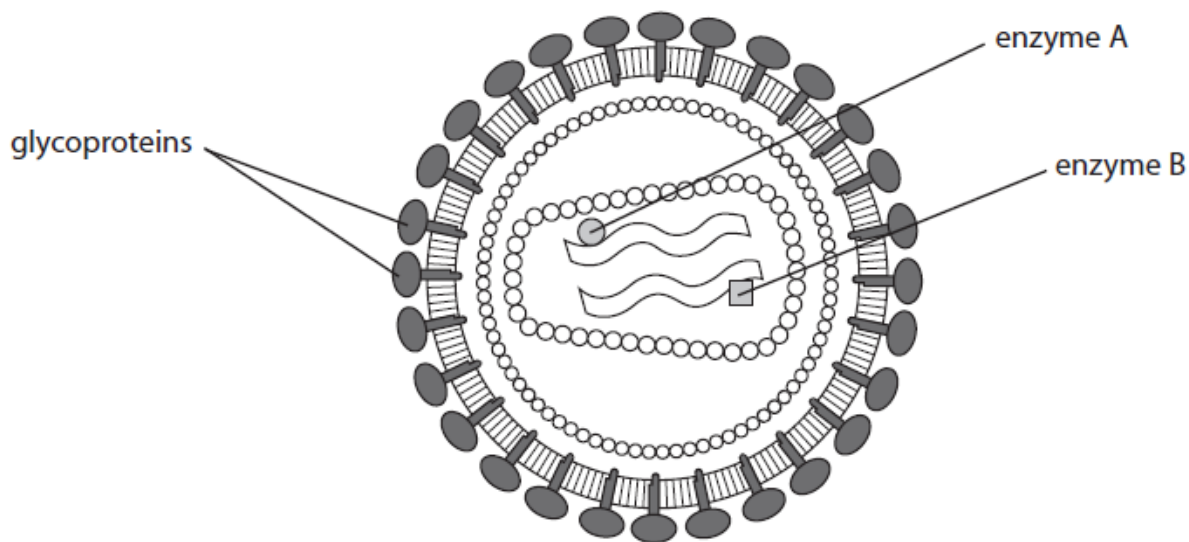
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(Total for question = 5 marks)

Q23.

Anti-viral drugs have been developed to treat patients infected with Human Immunodeficiency Virus (HIV).

The diagram below shows the structure of HIV.



(a) A glycoprotein has a carbohydrate attached to a protein molecule.
Describe the three-dimensional structure of a glycoprotein.

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(b) Some anti-viral drugs prevent HIV entering the host cells.

Suggest how these anti-viral drugs could prevent HIV entering the host cells.

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*(c) Describe how the enzymes shown in the diagram are involved in HIV infection.

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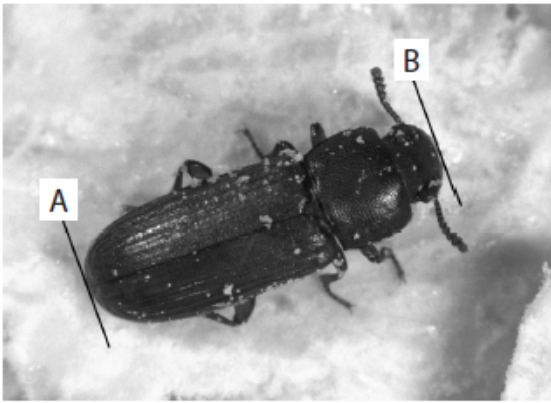
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(Total for question = 11 marks)

Q24.

The red flour beetle (*Tribolium castaneum*) is a food pest found in flour.

The photograph shows a red flour beetle.



(Source: © Nigel Cattlin/Alamy Stock Photo)

magnification $\times 15$

The main food source for adult red flour beetles is starch.

Red flour beetles lay eggs that contain all the nutrients required for the development of the embryo.

The main food source in the eggs is glycogen.

Describe how starch can be used to make glycogen.

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(Total for question = 3 marks)

Q25.

Glucagon is a hormone that is usually released when the level of blood glucose falls too low.

Glucagon stimulates the liver to break down glycogen into glucose.

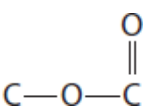
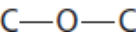
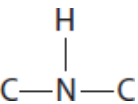
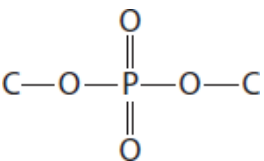
(i) Which of the following processes breaks down glycogen into glucose?

(1)

- ☐ **A** condensation
- ☐ **B** hydrolysis
- ☐ **C** methylation
- ☐ **D** phosphorylation

(ii) Which arrangement shows the structure of the bond that is broken in this process?

(1)

- ☐ **A** 
- ☐ **B** 
- ☐ **C** 
- ☐ **D** 

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
	An answer that makes reference to the following: - percentage incidence (of VTE) higher in {older people /people older than 70 } (1) - in younger people larger percentage (of VTE patients) have the factor V mutation (1) (therefore) genotype has a greater influence on incidence (of VTE) in younger people (1) (therefore) greater incidence (of VTE) in older people probably a result of environmental factors (1)	ALLOW converse – incidence of VTE lower in {younger people/ people under 20} ALLOW converse - lower percentage of older people have the factor V mutation ALLOW converse – genotype has less influence on incidence of VTE in older people	(4)

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to two of the following: - carrier protein (in cell surface membrane) (glucose moves from) high to low concentration - glucose binds to (carrier) protein / (carrier) protein changes shape to move glucose (across the membrane) (1)	IGNORE channel protein ALLOW 'down a concentration gradient'	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: - polymer of glucose - to provide glucose for respiration {branched / contains 1,6-glycosidic bonds / has many terminal ends} for rapid hydrolysis - compact to allow large amount (of glucose / energy) to be stored in a small space / insoluble therefore no osmotic effect on cells	ALLOW polysaccharide /made of many glucose monomers DO NOT ALLOW β- glucose IGNORE 'easy to hydrolyse' ALLOW break down instead of hydrolyse	(3)

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to the following: • (LDL / lipoproteins carry) cholesterol in the blood • (cholesterol) is deposited to form atheroma (1) • in the endothelium of an artery	ALLOW LDLs increase blood cholesterol ALLOW plaque formation ALLOW artery wall	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • narrowing of (lumen of) coronary arteries • which reduces {blood flow / oxygen} to the cardiac muscle • which reduces aerobic respiration	ALLOW coronary arteries blocked ALLOW heart muscle ALLOW more anaerobic respiration / build- up of lactic acid	(3)

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	A description that makes reference to the following: • thrombin is an enzyme (1) • (which catalyses) the conversion of fibrinogen into fibrin (1) • a mesh of fibrin traps { platelets / red blood cells } to form a clot (1)	IGNORE 'platelet plug'	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following: • (mutation in the gene) changes the sequence of the amino acids (in the factor V molecule) (1) • (overactive factor V will) increase the production of thrombin (1) • increases blood clotting (1)	ALLOW the mutation results in a change to the {primary structure/ polypeptide chain} ALLOW increased risk of blood clotting	(3)

Q5.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to three of the following: • the water has an uneven distribution of charge (making it a dipole) (1) • so water forms hydrogen bonds with other water molecules (1) • (and) it requires a lot of { heat / thermal } energy to break these bonds (1) • and allow water to evaporate (taking the heat energy with it) / high latent heat of evaporation (1)	ALLOW description of dipole ALLOW – a lot of heat energy is required to evaporate water	(3)

Q6.

Question number	Answer	Additional guidance	Mark
(i)	A description that makes reference to the following: - condensation (1) - involving OH groups (on both molecules) / water is formed (1)		(2)

Question number	Answer	Additional guidance	Mark
(ii)	An answer that makes reference to the following: - both are formed from two molecules of (α)glucose / both contain a glycosidic bond (1) - maltose has (α-)1,4 linkage and trehalose has (α-)1,1 linkage / in trehalose one of the glucose monomers is inverted (1)	ALLOW both are disaccharides of glucose DO NOT ALLOW β - glucose	(2)

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	- correct values taken from the graph (1) - correct answer with correct units (1)	<u>Example of calculation</u> $0.12 \div 2 =$ $= 0.06 \text{ } \mu\text{mol dm}^{-3} \text{ min}^{-1}$ $= 0.06 \text{ } \mu\text{mol per dm}^3 \text{ per minute}$ or $= 0.001 \text{ } \mu\text{mol dm}^{-3} \text{ s}^{-1}$ $= 0.001 \text{ } \mu\text{mol per dm}^3 \text{ per second}$ Correct answer with no units gains one mark Correct answer with correct units but no working gains full marks	2

Question Number	Answer	Additional Guidance	Mark
(ii)	curve that is less steep but reaches the same plateau (1)	e.g.	1

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: - the slower the initial rate of reaction the longer it will take for a clot to form (1) - because fibrin will be produced more slowly (1)	Allow converse arguments	2

Q8.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	Measurement in 5.5 cm / 55 mm correct (1) $55 \div 60 = 0.92$ mm (1)	need to measure on paper	(2)

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(i)	An explanation that makes reference to the following: - very high heart rate makes it difficult to count (1) - so greater chance of error (1)		(2)

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(ii)	Calculation of mean = 55 (1) Answer = $55 \div 20.2 = 2.72$ (1)		(2)

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(iii)	An explanation that makes reference to three of the following: • control of variables (1) • returning fleas to ambient temperature for specified time (1) • acclimatisation (1) • use smaller intervals (1)		(3)

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	An answer that makes reference to the following: • undeveloped nervous system so don't feel pain and there aren't ethical issues (1) • unethical to use any living organism in an experimental procedure (1) • relativism would state that it is acceptable under certain circumstances to use invertebrates (i.e. if there is potential benefit to human health) (1) • absolutism promotes use of invertebrates under any circumstance or under no circumstance (1)		(4)

Q9.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • simpler nervous system / does not feel pain (1)	ALLOW – feels less pain	(1)

Q10.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	pyruvate and { reduced coenzyme / reduced NAD }		(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(i)	A description that makes reference to the following: • Final electron acceptor		(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(ii)	An explanation that makes reference to the following: • carbon monoxide binds to cytochrome oxidase (1) • prevents oxygen binding to the enzyme (1) • blocks the electron transport chain / prevents oxidation of reduced electron carriers (1)		(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
(c)	An explanation that makes reference to the following: • NO binds to cytochrome oxidase in endothelium (of blood vessels) (1) • diverts oxygen to smooth muscle cells (1) • contraction of muscle cells causes vasoconstriction in arterioles (1)		(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
(d)	An answer that makes reference to three of the following: • free radicals interact with transcription factors (1) • activation of gene for P53 (1) • production of mRNA from activated gene (1)		

Question Number	Acceptable Answer	Additional Guidance	Mark
	translation of mRNA resulting in synthesis of P53 on ribosomes	(1)	(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
(e)	A description that makes reference to three of the following: - inner membrane { is folded / has a larger surface area / has cristae } (1) - outer membrane is impermeable to H^+ ions (1) - only inner membrane contains { ETC (proteins) / ATP synthase / stalked particles } (1) - only inner membrane contains H^+ pump (1)		(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
(f)	An answer that makes reference to the following: - myocardial infarction causes cell death in the heart (1) - due to lack of oxygenated blood reaching cardiac muscle cells (1) - NIR affects cytochrome oxidase involved in aerobic respiration (1) - diversion of oxygen to cardiac muscle cells would reduce death of these cells (1)		(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
(g)(i)	A description that makes reference to the following: • restriction endonuclease enzyme (1) • extraction of gene that codes for light-sensitive protein (1) • use of a suitable vector (1) • insertion of gene into the { genome / DNA } in the nucleus of the neurone (1)		(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
(g)(ii)	An explanation that makes reference to the following: • { depolarisation / action potential } occurs (1) • (nerve) impulse reaches { synapse / presynaptic membrane } (1) • calcium ion channels open causing calcium ions to enter presynaptic neurone (1) • vesicles containing neurotransmitter fuses with presynaptic membrane (1) • neurotransmitter released (1)		(5)

Question Number	Acceptable Answer	Additional Guidance	Mark
(h)	An explanation that makes reference to three of the following: • fMRI detects changes in blood flow in the brain (1) • MRI signal reflects state of haemoglobin / magnetic fields repelled by oxygen rich blood / deoxygenated haemoglobin more magnetic than oxygenated haemoglobin (1) • allows areas of greater brain activity to be detected as an image created by magnetic resonance (1) • areas of the brain that are involved in an auditory memory task { were using more oxygen / had an increased flow of blood } (1)		(3)

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to following: - the use of nandrolone reduces the (mean maximum percentage) recoil of the { aorta / artery } (1) and two from: - increased risk of damage to the endothelium of arteries (1) - inflammatory response / white blood cells accumulate (1) - build-up of { cholesterol / calcium salts / fibrous tissue } leads to formation of { atheroma / plaque } (1)		(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to three of the following: - nandrolone reduces the production of (both) proteins when exercise is allowed (1) - these proteins are involved in { ATP production / oxidative phosphorylation } (1) - nandrolone has no effect on ATP production if there is no exercise (1) - nandrolone reduces ATP production if exercise takes place (1)	ALLOW nandrolone has no effect on the production of the proteins in absence of exercise	(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: - without exercise the values for mRNA for Tfam overlap for groups with and without nandrolone (1) - as when exercise is carried out and nandrolone taken, the values for mRNA for Tfam overlap with no exercise and no nandrolone (1)	ALLOW overlap between groups P and Q ALLOW overlap between groups P and S	(2)

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • {control / placebo} (1) • to allow a comparison with {A and B / the other groups} (1)		(2)

Q13.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • lumen of capillaries blocked • preventing supply of {oxygen / glucose} (to tissues or cells) • therefore respiration stops (and tissues die) / anaerobic respiration causes build-up of lactic acid	ALLOW build-up of carbon dioxide	(2)

Q14.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to two of the following: • more elastic tissue to allow recoil (1) • more collagen to withstand high pressure (1) • more muscle tissue to maintain pressure in the aorta (1)	ALLOW converse argument for vena cava ALLOW 'to withstand high pressure' ALLOW converse argument for vena cava	(2)

Q15.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: - fibrin forms a mesh that collects {platelets / red blood cells} (tranexamic acid) { prevents plasmin digesting fibrin / stops the breakdown of fibrin } - allowing clots to remain in place	ALLOW fibrin is involved in forming blood clots	(3)

Q16.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: - fibrinogen concentration is higher in individuals with CVD (1) - compare an individual's fibrinogen concentration with values in the table (1) - no overlap between fibrinogen concentrations for those with CVD compared with those without CVD (1)	ALLOW females above 321 and males above 324 or females above 328 and males above 329 are identified as being at risk ALLOW values above mean without CVD + SD or mean with CVD -SD identified as at risk	3

Question Number	Acceptable answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - increased concentrations of fibrinogen leading to increased fibrin (1) - increase the risk of blood clotting / more frequent and extensive clotting (1) - blocking lumen of {arteries / capillaries} (1)		3

Q17.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: - water (1) - glycosidic bond drawn correctly (1)		(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	maltose		(1)

Q18.

Question Number	Answer	Additional guidance	Mark
	An answer the makes reference to four of the following: • both have same volume (1) • animal A has a larger surface area (1) • animal A has a larger surface area to volume ratio (1) • so sufficient (surface area in animal A) for diffusion (1) • distance to cells in centre of A is shorter than for B allowing {quicker/sufficient} diffusion / shorter diffusion distance (in A) (1)	ALLOW both have a volume of 64 mm^3 ALLOW converse ALLOW figures given (e.g. 168 mm^2 v 96 mm^2) or difference given as 72 mm^2 ALLOW {168:64 / 2.6:1} compared to {96:64 / 1.5:1} ALLOW converse ALLOW converse	(4)

Q19.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(i)	A description that makes reference to the following: - gene is a length of DNA that codes for a { polypeptide / protein } (1) - genome is a complete set of { DNA / introns and exons } (1)		(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(ii)	ligase / integrase		(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(iii)	plasmid / virus		(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(iv)	A description that makes reference to the following: - transcription of DNA to mRNA (1) { translation of mRNA / protein synthesis } on ribosomes (1)		(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)	An explanation that makes reference to the following: • no prothrombin activated so thrombin not produced (1) • thrombin needed to convert fibrinogen to fibrin (1) • fibrin needed to trap { platelets / blood cells } to form the (blood) clot (1)		(3)

Q20.

Question Number	Answer	Additional Guidance	Mark
	• two obesity-related conditions given (1)	e.g. diabetes / wear and tear on joints / sleep apnoea / increased risk of cancer / {increased blood pressure /hypertension} / {CVD / CHD} / atherosclerosis / stroke / {heart attack / myocardial infarction } ALLOW one obesity-related condition and a relevant idea of a negative effect on the NHS	(1)

Q21.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: - low blood glucose levels (1) - less glucose for respiration (1) - less { energy / ATP } in muscle tissue (1)		(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: - range of enzyme concentration (1) - control of other named variables (1) - measurement of rate of glucose production (1)	e.g. temperature, pH, concentration of substrate	(3)

Q22.

Question number	Answer	Mark
(i)	The only correct answer is D – hydrolysis A is not correct because anabolism is associated with forming more complex molecules B is not correct because catalysis is a general term for enzyme controlled reactions C is not correct because glycolysis is a sequence of reactions in respiration	(1)

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following: - glucose used in respiration to provide { energy / ATP } (1) - glycogen is a polymer of glucose (1) - glycogen has lots of { branches / terminal ends } so it can release glucose rapidly (1) - breakdown of trehalose { makes two molecules of glucose available / provides a more immediate source of glucose } (1)	ALLOW glycogen contains lots of glucose ALLOW quickly hydrolysed	(4)

Q23.

Question Number	Answer	Additional Guidance	Mark
(a)	1. proteins consist of amino acids joined together by peptide bonds; 2. credit reference to named bonds (between R groups) involved in holding {3D structure / eq} ; 3. carbohydrates consist of {monosaccharides / glucose / eq} ; 4. reference to glycosidic {bonds / eq} between (adjacent) {glucose / eq} molecules ;		(3)

Question Number	Answer	Additional Guidance	Mark
(b)	1. idea that the drugs could {bind to / alter shape of} {glycoproteins / gp120} ; 2. idea that drugs bind to {receptors / antigens} on membrane / eq ; 3. called CD4 (antigen / molecules) ; 4. preventing virus attaching to T (helper / CD4⁺) cells / eq ;		(3)

Question Number	Answer	Additional Guidance	Mark
*(c)	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. reference to reverse transcriptase ; 2. idea of formation of (viral) DNA ; 3. from (viral) RNA ; 4. reference to integrase ; 5. idea of integration of (viral) DNA into (host) DNA ; 6. idea that {T helper cells / eq} would be {destroyed / killed / burst / eq} (by virus particles leaving cell) ; 7. idea that more T (helper) cells would become infected ;	QWC focussing on clarity of expression 2. reject idea that RNA is {turned into / converted into} DNA 5. ACCEPT idea of {latency / formation of provirus / eq}	(5)

Q24.

Question number	Answer	Additional guidance	Mark
	A description that makes reference to the following: • starch can be {broken down / hydrolysed} into glucose (1) • by hydrolysis of the glycosidic bonds (1) • glycogen is formed by condensation reaction forming glycosidic bonds (between glucose molecules) (1)		Expert (3)

Q25.

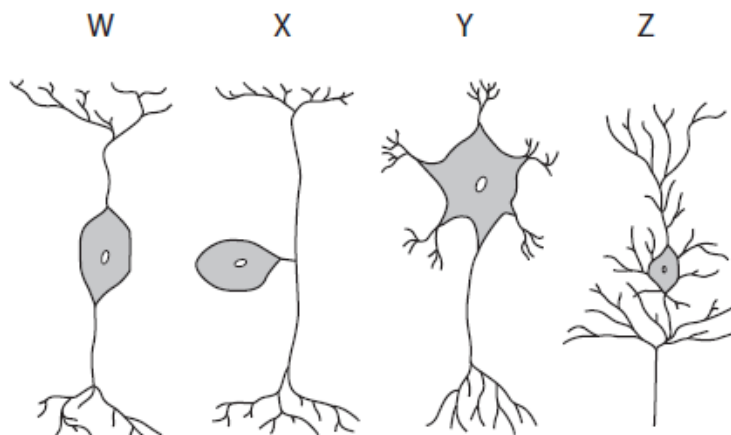
Question Number	Answer	Additional Guidance	Mark
(i)	B (hydrolysis)		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	B (C - O - C)		(1)

Q1.

People with Guillain-Barré syndrome (GBS) suffer from a rapid onset of muscle weakness. It is thought that GBS is caused by damage to the peripheral nervous system.

The diagram shows some typical neurones.



(i) Which of these is a sensory neurone?

(1)

- ☐ **A** W
- ☐ **B** X
- ☐ **C** Y
- ☐ **D** Z

(ii) The axons of some neurones are surrounded by a myelin sheath.

The main component of myelin is a glycolipid.

Glycolipids are formed from lipids attached to a chain of

(1)

- ☐ **A** amino acids which are joined by glycosidic links
- ☐ **B** amino acids which are joined by peptide bonds
- ☐ **C** sugar molecules which are joined by ester bonds
- ☐ **D** sugar molecules which are joined by glycosidic links

(iii) Describe the role of the dendrites in a neurone.

(3)

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(Total for question = 5 marks)

Q2.

Obesity can be affected by both genetic and environmental factors. An indicator of obesity is the body mass index (BMI).

The effects of a gene called FTO, saturated fats and physical exercise on BMI were investigated.

There are two alleles (FTO^T and FTO^C) at the FTO locus.

(i) Which of the following describes what is meant by the term locus?

(1)

- ☐ **A** genetic code for a protein
- ☐ **B** holds together sister chromatids
- ☐ **C** location of a gene on a chromosome
- ☐ **D** paternal part of a genome

(ii) Compare and contrast the structures of a saturated fatty acid and an unsaturated fatty acid.

(3)

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(Total for question = 4 marks)

Q3.

An investigation was carried out to study the effect of alcohol concentration on heart rate in *Daphnia*.

In this investigation, *Daphnia* were placed into three groups of 10. Each group was placed in alcohol of a different concentration for five minutes.

After five minutes, each *Daphnia* was removed from the alcohol and its heart rate recorded every 15 seconds for one minute. A mean for each concentration was calculated.

The results are shown in the table.

Alcohol concentration / mol dm ⁻³	Mean <i>Daphnia</i> heart rate / beats per minute
0.00	221
0.17	176
0.34	97

(i) Give one reason why 10 *Daphnia* were used for each alcohol concentration.

(1)

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(ii) Explain why the *Daphnia* were left for five minutes in the alcohol before the heart rate was

recorded.

(2)

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(Total for question = 3 marks)

Q4.

An investigation was carried out to study the effect of alcohol concentration on heart rate in *Daphnia*.

Devise an investigation to find the lowest concentration of alcohol that has an effect on the heart rate of *Daphnia*.

(5)

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(Total for question = 5 marks)

Q5.

Devise a procedure that can be used to investigate the effect of cooking on the vitamin C content of cauliflower.

(4)

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(Total for question = 4 marks)

Q6.

Cells use ions in many different processes.

Explain why ions can dissolve in blood.

(2)

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(Total for question = 2 marks)

Q7.

Some lipoproteins may reduce fertility in mammals.

An investigation was carried out using mice of the same breed.

Female mice were divided into three groups, P, Q and R. Each group was given a different treatment.

The table shows the treatment given to the three groups of female mice.

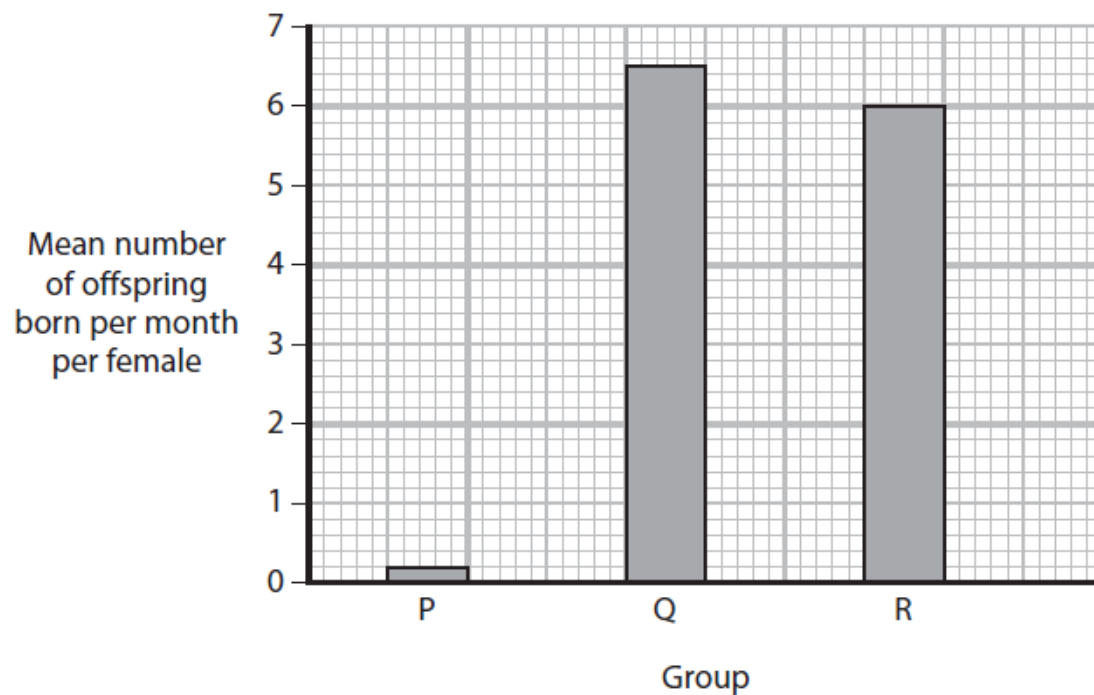
Group	Treatment
P	Genetically modified (GM) only
Q	Genetically modified and supplied with drug K
R	Supplied with drug K only

The GM mice have an increased concentration of high-density lipoproteins (HDLs) in their blood plasma.

Drug K was used to lower the blood plasma HDL levels.

The mice in each group were allowed to breed with non-genetically modified male mice and the number of offspring born was recorded.

The graph shows the results.



(i) The mice were all of one breed to improve data

(1)

- ☒ **A** accuracy
- ☒ **B** precision
- ☒ **C** quantity
- ☒ **D** validity

(ii) State a null hypothesis for this investigation.

(1)

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(iii) Comment on the effect of blood plasma HDL levels on the fertility of these female mice.

(4)

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(Total for question = 6 marks)

Q8.

As levels of activity increase, the heart can respond to the changing demand for oxygen.

During the cardiac cycle there are pressure changes in the chambers of the heart.

Explain how pressure differences in the heart ensure efficient pumping of the blood into the arteries.

(3)

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Q9.

Studies have provided evidence for a link between heart rate when a person is at rest and various medical conditions.

In one study, the relationships between resting heart rate and the percentage incidence of coronary heart disease and cancer were investigated.

The results are shown in the table.

Range of resting heart rate / beats per min	Number of individuals in each range	Percentage incidence of condition (%)	
		Coronary heart disease	Cancer
< 59	961	4.2	1.0
60–69	2277	6.0	1.5
70–79	2120	7.5	2.0
80–89	1202	8.0	2.5
90–99	576	8.2	4.0
> 99	379	7.9	3.8

(i) Comment on the evidence for a link between resting heart rate and the percentage incidence of coronary heart disease and cancer.

(5)

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(ii) Give two reasons why there were different numbers of people in each resting heart rate group.

(2)

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(iii) Give two reasons why the number of people in each resting heart rate group did not affect the validity of this investigation.

(2)

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(Total for question = 9 marks)

Q10.

Trypsin is an enzyme found in many groups of living organisms.

Trypsin specifically acts on a polypeptide to form amino acids.

State the type of chemical reaction catalysed by trypsin.

(1)

(Total for question = 1 mark)

Q11.

Doctors sometimes prescribe beta-blockers for their patients.

Beta-blockers are a type of drug with antihypertensive properties.

Explain why beta-blockers are prescribed for some people.

(2)

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(Total for question = 2 marks)

Q12.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The cardiac cycle is the sequence of events in one heartbeat.
In humans, the cardiac cycle can be divided into three stages.

In the ventricular systole stage of the cardiac cycle, the

(1)

☒ **A** ventricles contract, atrioventricular valves close and semilunar valves open

- ☐ **B** ventricles contract, atrioventricular valves open and semilunar valves close
- ☐ **C** ventricles relax, atrioventricular valves close and semilunar valves open
- ☐ **D** ventricles relax, atrioventricular valves open and semilunar valves close

(Total for question = 1 mark)

Q13.

The cardiac output of the heart changes during exercise.

(a) During exercise, a person had a pulse rate of 140 beats per minute and a cardiac output of $17.0 \text{ dm}^3 \text{ min}^{-1}$.

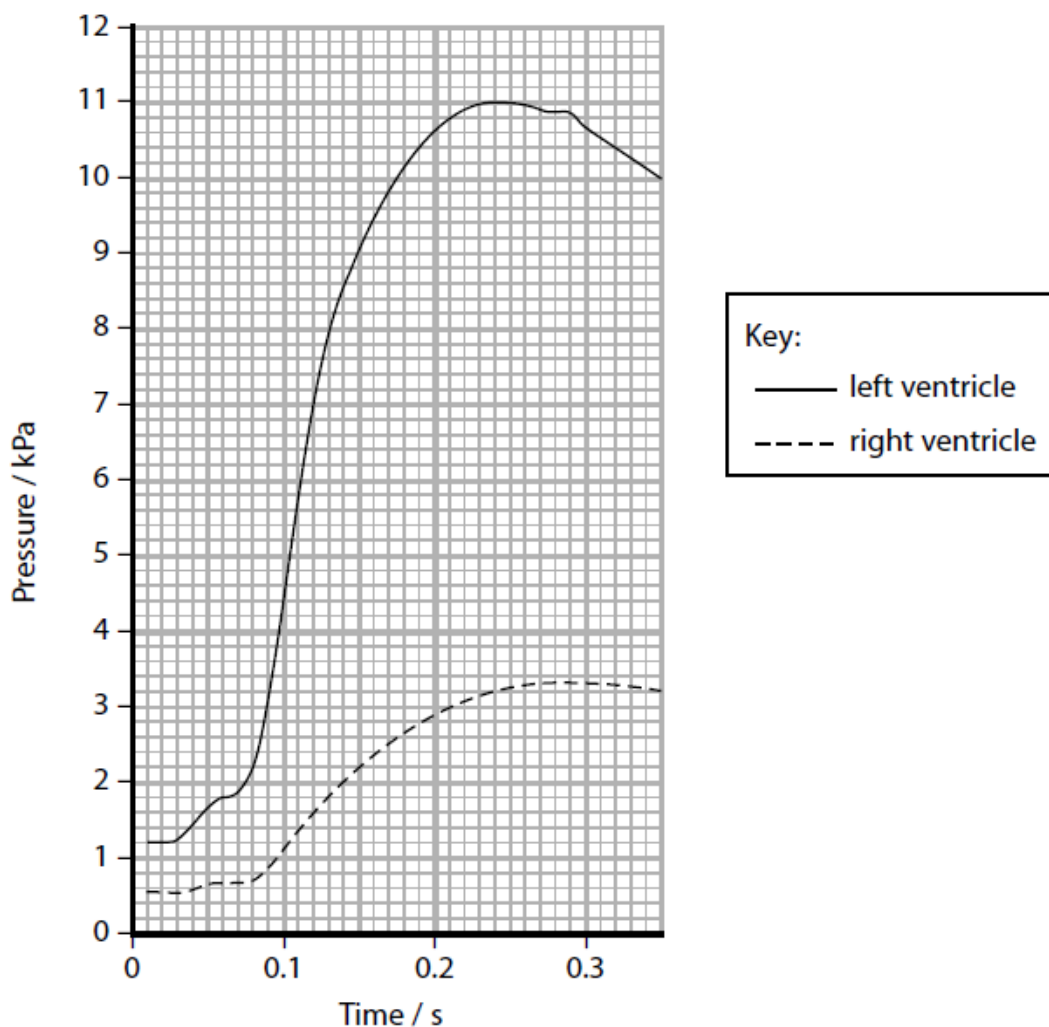
Calculate the stroke volume of the heart of this person.

(2)

Answer

(b) The maximum pressure in the left ventricle is 11.0 kPa and in the right ventricle 3.3 kPa.

The graph below shows the pressure changes in the two ventricles of the heart during part of the cardiac cycle.



(i) Explain why there is a difference in pressure in these two ventricles.

(3)

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(ii) Which row of the table shows the correct stage in the part of the cardiac cycle shown at 0.25 s in the graph?

(1)

Stage in cardiac cycle		
	left ventricle	right ventricle
☒ A	diastole	diastole
☒ B	diastole	systole
☒ C	systole	diastole
☒ D	systole	systole

(Total for question = 6 marks)

Q14.

Nicotine is a drug found in the smoke of cigarettes.

The effect of inhaling nicotine on the circulatory system of rats was investigated.

In this investigation, three variables were considered:

- the concentration of nicotine in blood plasma
- the diameter of the lumen of one artery
- blood pressure

Two groups of rats were treated as shown in the table.

Group	Number of rats in group	Nicotine dose / mg
A	6	1.0
B	6	0.1

(i) The concentration of nicotine in the blood plasma of the group A rats was recorded at different times and

the means calculated.

The means are shown in the table along with the range of data for each mean.

Time of sampling / minutes	Mean concentration of nicotine in blood plasma / ng cm^{-3}
0 (immediately after inhalation)	35.0 ± 9.3
30 (after inhalation)	24.1 ± 5.6

Determine the maximum rate of decrease in the concentration of nicotine in the blood plasma per minute after being given the nicotine.

(2)

Answer $\text{ng cm}^{-3} \text{ min}^{-1}$

(ii) The diameter of the lumen of one artery, in each of the 12 rats, was measured when the rats were resting. The blood pressure of each rat was also measured and the mean blood pressure calculated.

The diameter of the lumen of the artery and the blood pressure of each rat were then recorded at intervals, for a total of 30 minutes. The rats inhaled nicotine for the first minute (0.0 to 1.0).

The table shows the results for the mean diameter of the lumen of the artery.

Time / minutes	Mean diameter of lumen / μm	
	Group A (1.0 mg nicotine)	Group B (0.1 mg nicotine)
0.0	48	48
0.5	44	44
1.0	49	45
2.0	52	48
5.0	57	52
10.0	55	48
15.0	49	48
30.0	49	48

Determine the effect of nicotine concentration on the percentage change in lumen diameter in the first minute.

(2)

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*(iii) The graph shows the results for the mean blood pressure for the two groups of rats. Nicotine was inhaled for the first minute.

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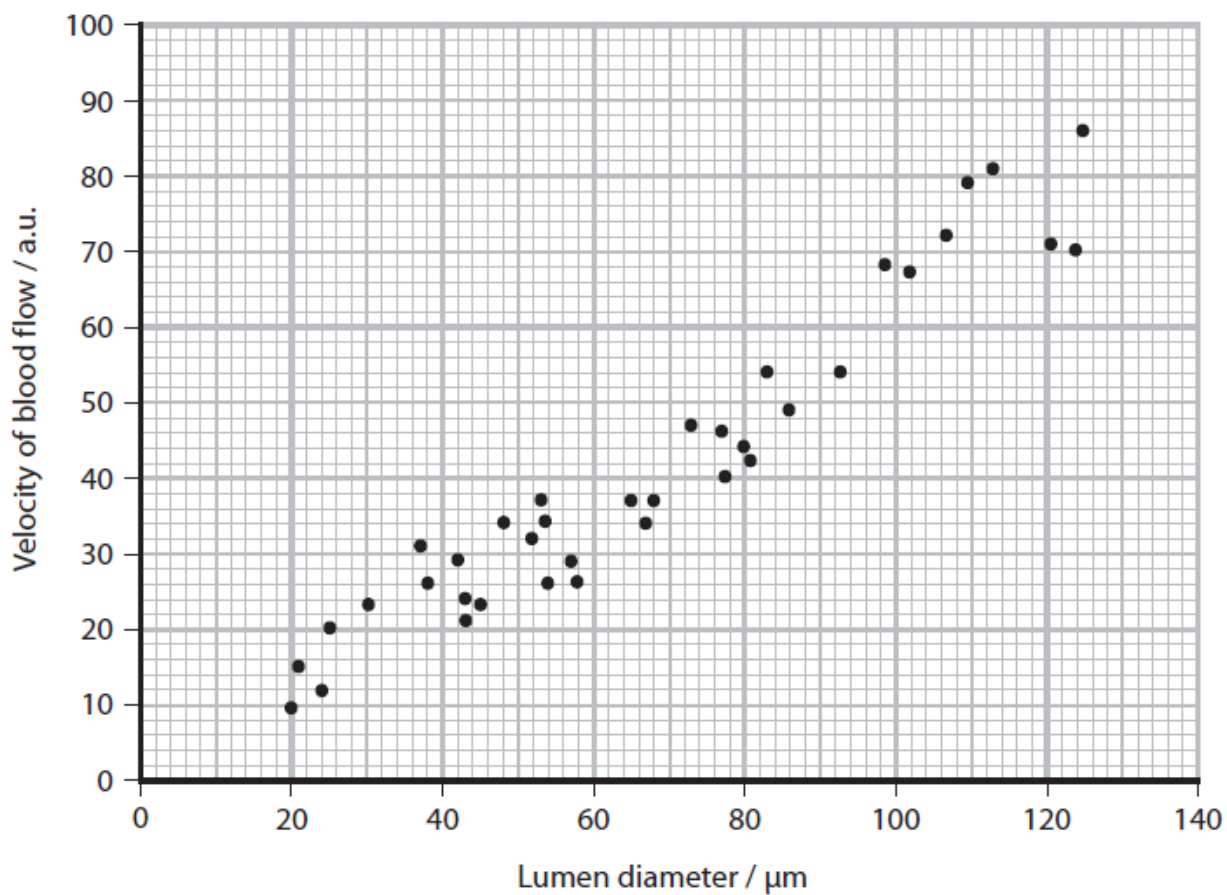
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(Total for question = 10 marks)

Q15.

The diameter of the inside of a blood vessel (lumen diameter) affects the speed of blood flow.

The graph shows the relationship between the lumen diameter of blood vessels and the velocity of blood flow.



State the relationship shown in the graph.

(1)

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(Total for question = 1 mark)

Q16.

Blood clotting is a process that is affected by genes.

Some people are at an increased risk of a condition called deep vein thrombosis (DVT). Blood clots form in the veins of people with DVT.

There are two alleles in a population, a wild type allele and G20210A.

The table shows the risk of DVT for people with different genotypes in this population.

Genotype	Risk of DVT / number of people with DVT per 1000 individuals
Homozygous wild type	1.0
Heterozygous for G20210A	2.5
Homozygous for G20210A	20.0

(i) Determine the effect of the allele G20210A on the risk of an individual developing DVT in this population.

(2)

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(ii) The frequency of the G20210A allele in a population of 10 000 individuals was investigated. In this population, 50 individuals were homozygous for G20210A.

Calculate the number of individuals in the population who were heterozygous for the G20210A allele, using the Hardy-Weinberg equation:

$$p^2 + 2pq + q^2 = 1.0$$

(3)

Answer

(Total for question = 5 marks)

Q17.

Mucopolysaccharides are complex molecules found in the human body.

Mucopolysaccharides can be broken down by enzymes.

Describe how an enzyme could break down the polysaccharide component of mucopolysaccharides.

(2)

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(Total for question = 2 marks)

Q18.

Mucopolysaccharides are complex molecules found in the human body.

Mucopolysaccharides are large molecules containing unbranched polysaccharides.

Describe the structure of an unbranched polysaccharide.

(2)

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(Total for question = 2 marks)

Q19.

Blood from the lungs returns to the left side of the heart in the pulmonary vein. The pulmonary vein does not have valves.

(i) Describe how the atrioventricular (AV) valves work during one cardiac cycle.

(2)

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(ii) The structure of the pulmonary vein is different from the structure of the pulmonary artery. Explain how this difference is related to the function of the pulmonary vein.

(2)

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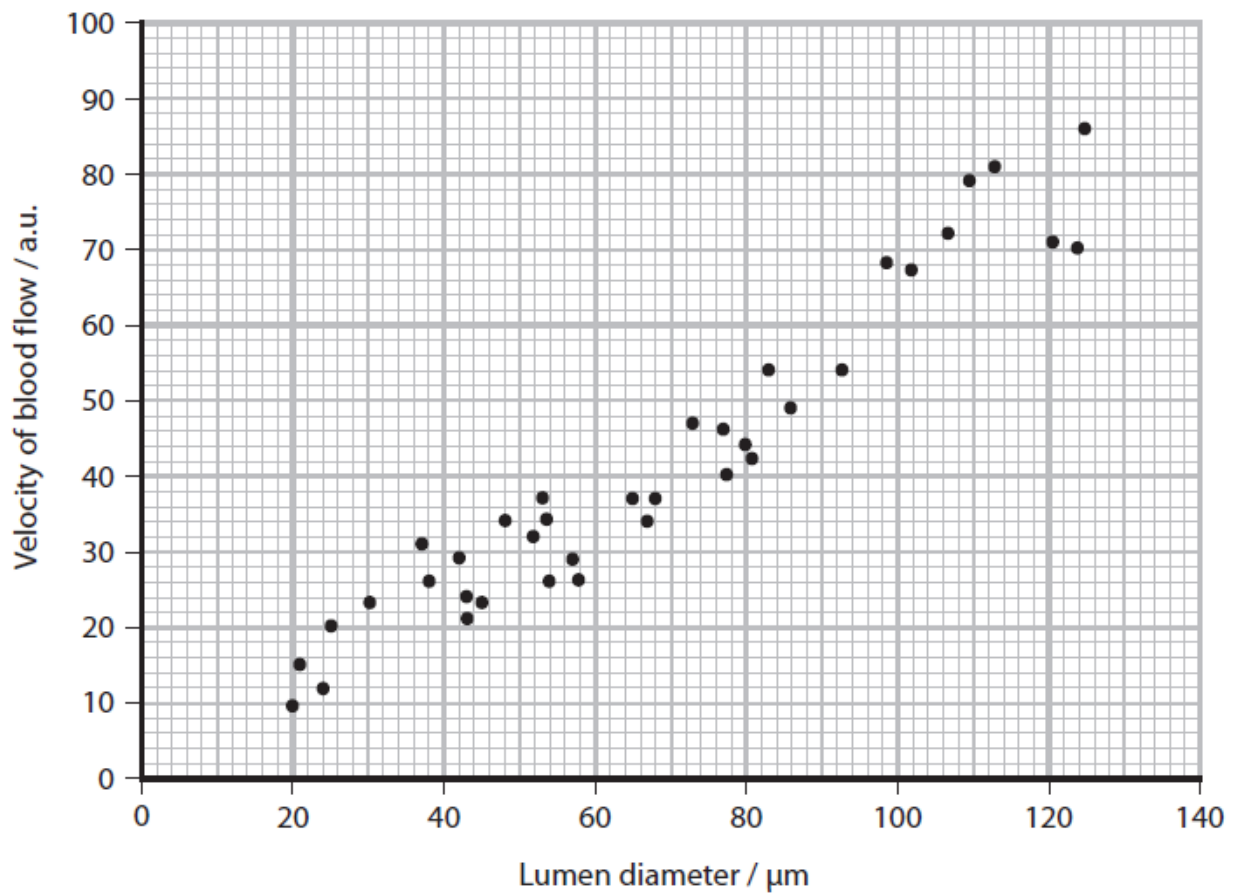
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(Total for question = 4 marks)

Q20.

The diameter of the inside of a blood vessel (lumen diameter) affects the speed of blood flow.

The graph shows the relationship between the lumen diameter of blood vessels and the velocity of blood flow.



(i) Explain how the development of cardiovascular disease (CVD) could affect the velocity of blood flow.

(2)

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(ii) Explain why a change in the velocity of blood flow will affect the function of the heart muscle.

(2)

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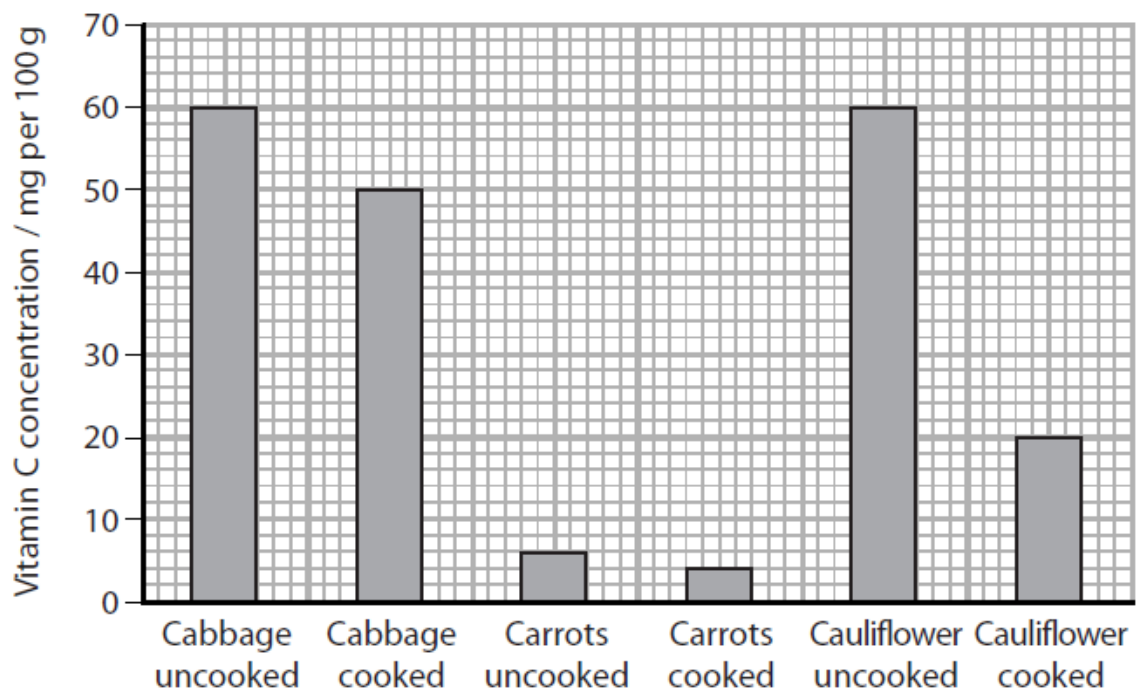
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Q21.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

Vitamin C has antioxidant properties. The human body cannot make or store vitamin C. A healthy diet must contain vitamin C.

The graph shows the concentration of vitamin C in a variety of cooked and uncooked vegetables.



(i) How many of the following conclusions are valid for these results?

- cooking destroys all of the vitamin C
- each vegetable contains less vitamin C when it is cooked than when it is uncooked
- cabbage contains the most vitamin C

(1)

☐ A 0

☐ B 1

☐ C 2

☐ D 3

(ii) The recommended daily value (DV) of vitamin C for men is 90 mg.

Calculate the mass of cooked cauliflower that would provide 90 mg of vitamin C.

(2)

Answer

(Total for question = 3 marks)

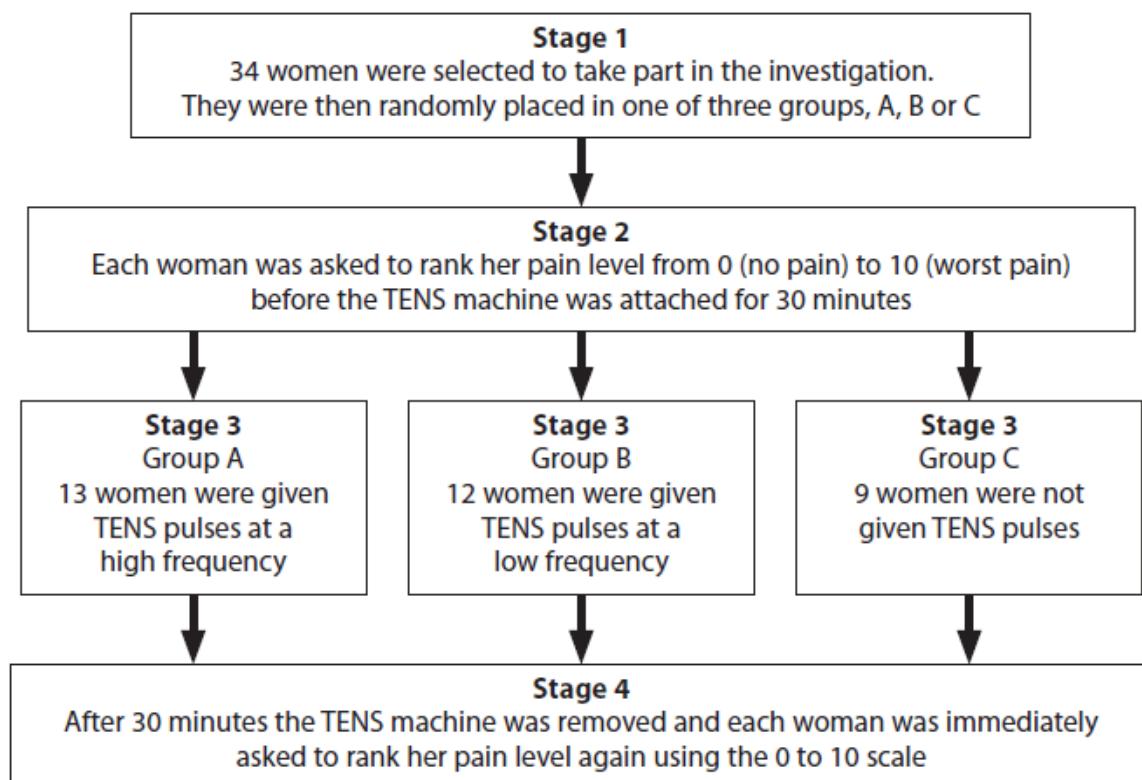
Q22.

Some women need to have surgery to aid childbirth. This can lead to pain after surgery.

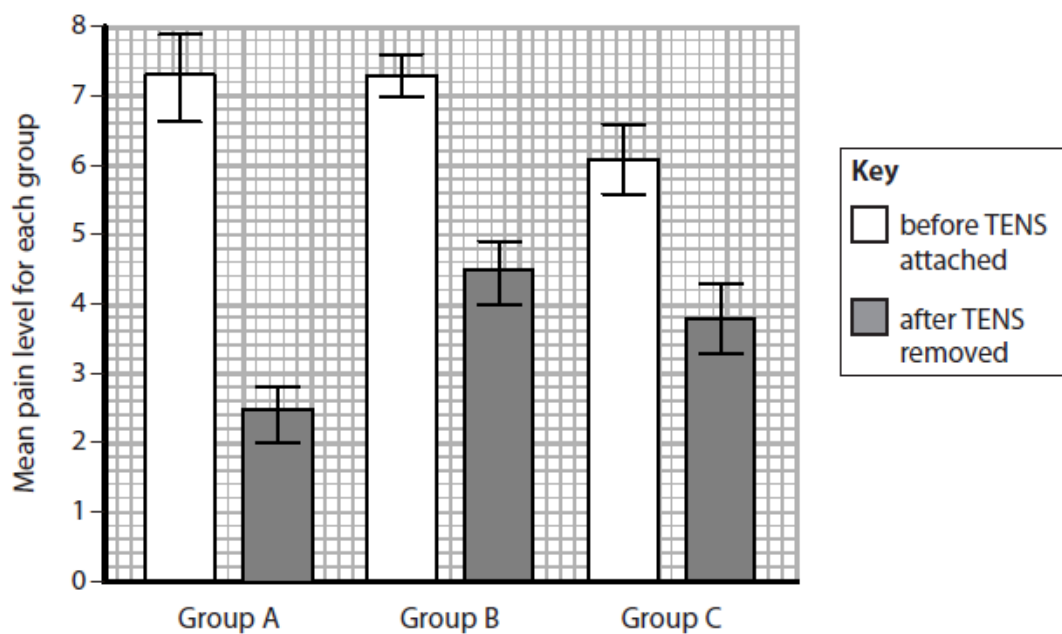
A TENS (transcutaneous electrical nerve stimulation) machine releases regular pulses of electricity onto the skin surface and can be used in pain relief.

An investigation was carried out to study whether the frequency of the pulses from a TENS machine could help these women with their pain relief.

The diagram shows how the investigation was carried out.



The results and range of data for the investigation are shown in the graph.



Determine the effectiveness of the use of a TENS machine in relieving pain following surgery.

(4)

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(Total for question = 4 marks)

Q23.

Changes in diet are affecting the health of people in the UK.

The table shows mean data for adult males in the UK in 1967 and 50 years later in 2017.

Year	Mean mass / kg	Mean height / cm	Mean BMI
1967	73	172	24.7
2017	84	178	

The National Health Service (NHS) states that BMI can be used to assess the weight category of an adult male. The table shows these categories.

Category	BMI range
Underweight	≤ 18.4
Healthy weight	18.5 – 24.9
Overweight	25.0 – 29.9
Obese	≥ 30.0

The mean BMI for adult males in 1967 indicates that they were in the healthy weight category.

Use the BMI formula to determine the mean weight category for adult males in 2017.

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

(2)

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(Total for question = 2 marks)

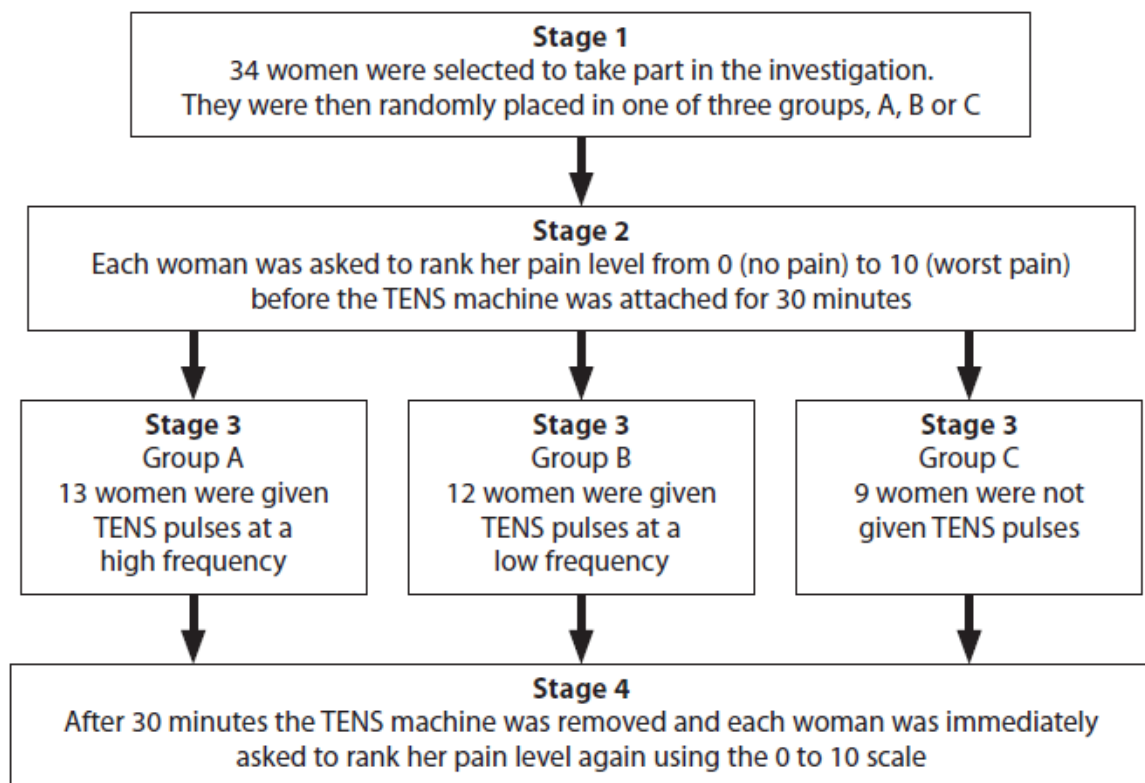
Q24.

Some women need to have surgery to aid childbirth. This can lead to pain after surgery.

A TENS (transcutaneous electrical nerve stimulation) machine releases regular pulses of electricity onto the skin surface and can be used in pain relief.

An investigation was carried out to study whether the frequency of the pulses from a TENS machine could help these women with their pain relief.

The diagram shows how the investigation was carried out.



Describe how the 34 women were selected in stage 1 to ensure that this investigation was valid.

(2)

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(Total for question = 2 marks)

Q25.

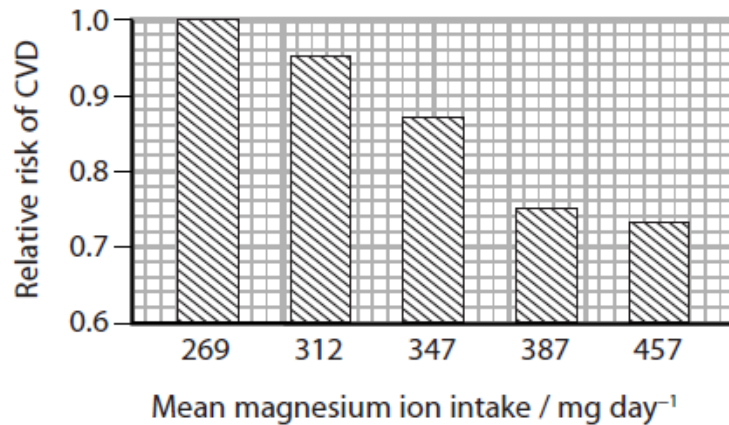
Cardiovascular disease (CVD) is a major cause of death and disability in the UK.

The relationship between magnesium ions in the diet and CVD has been studied.

In one study, magnesium ions were added to the diets of a group of men. The effect of this on the relative risk of CVD was recorded.

The mean normal dietary intake of magnesium ions is 269 mg day^{-1} .

The results of the study are shown in the graph.



(i) Which of the following statements can be made about the relationship between an increased magnesium ion intake and the risk of CVD in this study?

(1)

An increased magnesium ion intake

- ☐ **A** causes an increase in CVD
- ☐ **B** causes a reduction in CVD
- ☐ **C** is correlated with an increase in CVD
- ☐ **D** is correlated with a reduction in CVD

(ii) What is the daily increase in magnesium ion intake that reduces the relative risk of CVD by 0.13?

(1)

- ☐ **A** 43 mg day^{-1}
- ☐ **B** 78 mg day^{-1}
- ☐ **C** 118 mg day^{-1}
- ☐ **D** 347 mg day^{-1}

(Total for question = 2 marks)

Mark Scheme

Q1.

Question Number	Answer	Mark
(i)	B - X <i>The only correct answer is B</i> <i>A is incorrect because W is a relay neurone</i> <i>C is incorrect because Y is a motor neurone</i> <i>D is incorrect because Z is a multipolar neurone</i>	(1)

Question Number	Answer	Mark
(ii)	D - sugar molecules which are joined by glycosidic links <i>The only correct answer is D</i> <i>A is incorrect because glycolipids are not made of amino acids</i> <i>B is incorrect because glycolipids are not made of amino acids</i> <i>C is incorrect because sugar molecules are not joined by ester bonds</i>	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to three of the following: • { form synapses / connections } with other neurones (1) • { integrate / receive } impulses from other neurones (1) • involved in summation • { propagate a signal / initiate an action potential } to the { cell body / axon }		(3)

Q2.

Question Number	Answer	Mark
(i)	C – location of a gene on a chromosome <i>The only correct answer is C</i> A is incorrect because locus is not the genetic code for a protein B is incorrect because a centromere holds together sister chromatids and not a locus D is incorrect because a locus is not the paternal part of a genome	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to three of the following: Similarities - both have a carboxylic acid group - both have { hydrocarbon chains / chains formed from only hydrogen and carbon } Differences - saturated fatty acids have { no carbon to carbon double bonds / only have carbon to carbon single bonds } - saturated fatty acids are straight chains and unsaturated fatty acids have { bent chains / a kink in the chain }	ALLOW annotated diagrams used show similarities and differences ALLOW COOH ALLOW description of hydrocarbon chains ALLOW converse for unsaturated fatty acids	(3)

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to one of the following: { identify / remove } any anomalies (1) - to calculate a mean / can make valid comparisons (1)	ALLOW to gain more repeatable data ALLOW outliers for anomalies ALLOW produce / form for calculate	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • (because time is required) for the alcohol to be absorbed (1) • (because time is required) for acclimatisation (1)	ALLOW getting used to the new conditions / overcoming stress of being moved	(2)

Q4.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • alcohol concentrations between 0.00 and 0.17 mol dm⁻³ (1) • controlling one biotic variable (1) • controlling one abiotic variable (1) • determine the concentration at which the <i>Daphnia</i> show a decrease in heart rate (1) • use of microscope to count heart beats of <i>Daphnia</i> (1)	e.g. age, size, sex, species of <i>Daphnia</i>, e.g. temperature, volume of alcohol ALLOW the concentration at which the mean heart rate drops below 221 beats per minute	(5)

Q5.

Question Number	Answer	Additional guidance	Mark
	An answer that makes reference to the following: - cauliflower extract from same mass (of cooked and uncooked cauliflower) (1) - description of titration of cauliflower extract with DCPIP (1) - using same {volume / concentration} of DCPIP (1) - determine the vitamin C content in cooked and uncooked cauliflower by comparing with solution of known vitamin C concentration (1)	ALLOW cauliflower extracts of the same concentration produced e.g. volume of cauliflower extract taken to decolourise the DCPIP ALLOW volume of DCPIP added to cauliflower extract until the DCPIP is no longer decolourised e.g. by using a vitamin C calibration curve	(4)

Q6.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to two of the following: - water is a component of blood (1) - ions are charged (1) - dipole nature of water allows it to {surround / bond to / interact with} ions (1)	IGNORE water and ions form hydrogen bonds	(2)

Q7.

Question Number	Answer	Mark
(i)	D validity <i>The answer is not A as controlling the variety of mice does not improve data accuracy</i> <i>The answer is not B as controlling the variety of mice does not improve data precision</i> <i>The answer is not C as controlling the variety of mice does not improve data reliability</i>	(1) Comp

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: there is no difference in { the number of offspring born / fertility } { if genetically modified or not / if supplied drug K or not / between the treatments }	IGNORE 'significant' ALLOW between the groups	(1) Exp

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following: { the GM mice / group P } had very few offspring (1) - therefore raised HDL levels lead to reduced fertility (1) { non-GM mice / group R } had fewer offspring than { group Q / GM mice given drug K } (1) - suggesting that HDL levels below a certain concentration reduce fertility (1)	ALLOW GM mice had fewest offspring ALLOW converse ALLOW converse ALLOW – some HDL required for fertility	(4) Exp

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following points: • pressure increases in the ventricles (1) • greater pressure (in the ventricles) than in the { atria / arteries } (1) • causing atrioventricular valves to close (1) • causing the semilunar valves to open / forcing blood into the arteries (1)	IGNORE reference to events during atrial systole	(3)

Q9.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: • as heart rate increases, so does incidence of {both conditions / CHD and cancer } (1) • relationship between heart rate and CHD quantified (1) • relationship between heart rate and cancer quantified (1) • greater increase in incidence of cancer with increased heart rate (1) • at a heart rate >99bpm there is a reduction in incidence of both conditions / plateaus / little difference (1)	ALLOW converse e.g. 1.95x increase up to 99 bpm / 1.88x increase at >99 e.g. 4.0x increase up to 99 bpm / 3.8x increase at >99 ALLOW converse	(5)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: • mid heart beat rate is more common in the (general) population / heart rate is normally distributed in the population (1) • fewer people available at low and high heart rate because of other health risks (1)	ALLOW high and low heart rates are less common	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to two of the following: • still (statistically) a large sample size (1) • wide range of heart rates considered (1) • percentage incidence used (rather than number) (1)		(2)

Q10.

Question Number	Answer	Additional Guidance	Mark
	• hydrolysis		(1)

Q11.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • beta-blockers reduce blood pressure (1) • therefore reducing the risk of {atherosclerosis / heart disease /CVD} (1)	ALLOW prescribed to people with {high blood pressure / irregular heart beat / anxiety} ALLOW because high blood pressure can {cause atherosclerosis / damage the endothelium} ALLOW heart attack	(2)

Q12.

Question Number	Answer	Mark
	The only correct answer is A - the ventricles contract, atrioventricular valves close and semilunar valves open <i>B is incorrect because the AV valves do not open</i> <i>C is incorrect because the ventricles do not relax</i> <i>D is incorrect because the semilunar valves do not close</i>	(1)

Q13.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	$17.0 \div 140$ (1) $=121.43 \text{ cm}^3$ (1)		(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(i)	An explanation that shows elements of reasoning /justification in the form of a linked response from the following points: - the higher pressure is in the left ventricle / lower pressure is in the right ventricle (1) - because the left ventricle has more muscle (1) - because it needs a higher pressure to get blood through the aorta to the body (except lungs) (1)	Allow appropriate structural consequential comments for right ventricle.	(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(ii)	D		(1)

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	- calculation of { largest difference in concentration / largest value at 0 minutes and smallest value at 30 minutes } (1) - calculation of rate of decrease in nicotine concentration per minute (1)	Example of calculation $(35.0 + 9.3) / 44.3$ and $(24.1 - 5.6) / 18.5$	(2)
		$25.8 \div 30$ $= 0.86$ Correct answer without working gains full marks	

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to two of the following: - percentage change greater for {the lower concentration of / 0.1 mg } nicotine (1) - a higher concentration causes a positive (percentage) change whilst the lower concentration leads to a negative (percentage) change (1) - correct calculation of percentage change for both rat groups (1)	2.08% for { 1.0 mg nicotine / group A } and 6.25% for { 0.1mg nicotine / group B }	(2)

Question Number	Indicative content
*(iii)	Answers will be credited according to candidates' deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is relevant. Additional content included in the response must be scientific and relevant. Give examples of relevant biological knowledge and understanding: <u>Validating the statement</u> - Investigation involved rats inhaling nicotine which humans do during smoking - Rats are mammals so can extrapolate to humans <u>Not validating the statement</u> - Nicotine inhaled (for both nicotine concentrations) leads to vasoconstriction and then vasodilation and then returns to original diameter - Blood pressure for 1mg nicotine concentration increases and decreases but drops below original value - Presence of nicotine leads to noradrenaline release which increases heart rate - Blood pressure (for both nicotine concentrations) increases and decreases - No reference to rats inhaling smoke, only nicotine - Rats are not the same as humans - Sample size too small to make a valid statement <u>Comment</u> - whether agree or disagree with statement

			Additional guidance
Level 0	Marks	No awardable content	
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	An answer that refers to just one piece of evidence – either lumen size or blood pressure Simple conclusion drawn from the evidence
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	An answer that refers to evidence concerning both lumen size and blood pressure Links made between lumen size, vasoconstriction and blood pressure
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	An answer that refers to data about vasoconstriction and vasodilation and links it to effect of nicotine on the release of noradrenaline and therefore on blood pressure Conclusion made considering validity of data collected from rats and how it can be applied to humans

Q15.

Question number	Answer	Additional guidance	Mark
	An answer that makes reference to the following: (strong) positive correlation	ALLOW velocity of blood flow is (directly) proportional to the lumen diameter ALLOW description of relationship e.g. as lumen diameter increases velocity of blood flow increases	(1)

Q16.

Question number	Answer	Additional guidance	Mark
(i)	A description that makes reference to the following: - the allele (G20210A) increases the risk of suffering a deep vein thrombosis / two copies of the allele (G20210A) increases risk (1) - there is a { 2.5 fold increase in risk with one allele / 20 fold increase in risk with two alleles / 8-fold increase in risk with two alleles compared to one allele} (1)	ALLOW abbreviations for G20210A ALLOW DVT IGNORE 1.5 x, 17.5 x and 19 x as these come from incorrect subtractions of risk factors	(2)

Question number	Answer	Additional guidance	Mark
(ii)	Choose an item. - correct proportion of homozygous individuals calculated (1) - correct probabilities (p and q) determined for Hardy-Weinberg equation (1) - correct number of heterozygotes determined (1)	Example of calculation P^2 or $q^2 = 0.005$ $p = 0.0707$ $q = 0.9293$ or $2pq = 0.1314$ $= 10\,000 \times 0.1314 = 1314$ ALLOW $p = 0.071$ and $q = 0.929$ or $2pq = 0.1319$ $= 10\,000 \times 0.1319 = 1319$ ALLOW three marks for 1302 ALLOW two marks for 1300 Correct answer with no working gains full marks	(3)

Q17.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following: - hydrolysis / description of hydrolysis (1) - of glycosidic bonds (1)		(2)

Q18.

Question Number	Answer	Additional guidance	Mark
	A description that makes reference to two of the following: - polysaccharide made up of many monosaccharide components (1) - joined together by {condensation reactions / glycosidic bonds} (1) (only)1-4 glycosidic bonds present / no 1-6 glycosidic bonds present(1)	ALLOW chain of glucose molecules	(2)

Q19.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to two of the following: - the valves are open { when atria contract / atrial systole / when blood pressure greater in atria (than ventricles) } (1) - the valves close { when ventricles contract / during ventricular systole/when pressure greater in ventricles (than atria) } (1) - valves prevent backflow of blood into the atria during ventricular systole (1)	ALLOW valves open to allow blood to flow from atria to ventricles ALLOW tendons prevent valves from inverting during ventricular systole	(2) Exp

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: { larger lumen / less muscle (in walls) / thinner walls } (1) - explanation { larger lumen as blood pressure lower / less muscle because contraction not needed to push blood back to the heart } (1)	IGNORE valves ALLOW thinner walls linked to lower blood pressure	(2) Exp

Q20.

Question number	Answer	Additional guidance	Mark
(i)	An explanation that makes reference to the following: • atheroma {reduces the diameter of / narrows} the lumen of arteries (1) • therefore reducing (the velocity of) blood flow (1)	ALLOW {atherosclerosis / plaques} reduce the diameter of the lumen of arteries ALLOW {atheroma / atherosclerosis / plaques} partially block the arteries	(2)

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to two of the following: • reduce supply of oxygen to the heart muscle (1) • resulting in reduced aerobic respiration (1) • resulting in {weaker heart muscle contraction / death of heart tissue} (1)	ALLOW less oxygen for respiration ALLOW more anaerobic respiration ALLOW causing heart muscle to contract more frequently ALLOW heart muscle contracts more slowly	(2)

Q21.

Question Number	Answer	Mark
(i)	The only correct answer is B 1 The only conclusion that can be valid for these results is that 'each vegetable contains less vitamin C when it is cooked than uncooked' <i>A is incorrect because there is one valid conclusion</i> <i>B is incorrect because there is only one valid conclusion</i> <i>C is incorrect because there is only one valid conclusion</i>	(1)

Question Number	Answer	Additional guidance	Mark
(ii)	- recommended daily value divided by concentration in cooked cauliflower (1) - correct mass of cauliflower calculated (1)	<u>Example of calculation</u> $(90 \div 20) = 4.5$ 450g ALLOW 450000 mg Correct answer with no working gains full marks	(2)

Q22.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: - TENS provides pain relief (1) - high frequency {most effective / more effective than low frequency} (1) - quantified difference between before TENS and after TENS to show that A was the largest (1) - there was overlap between the {low frequency TENS / B} and {TENS with no pulses / placebo / control / C} (1)	ALLOW TENS is effective {4.8 / 65.8%} pain relief reduction for group A but only {2.8 / 38.4% for group B} / {2.3 / 37.7% for group C}	(4)

Q23.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: - BMI calculation for 2017 (1) - interpretation of data for BMI (1)	26.51 / 26.5 ALLOW if written in the table (just) in overweight category	(2)

Q24.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: - women requiring {pain relief / surgical intervention} (when they gave birth) (1) - condition of mothers (1)	e.g. same age / same number of babies / no pre-existing pain medication / same gestation period	(2)

Q25.

Question Number	Answer	Mark
(i)	D – is correlated with a reduction in CVD <i>The only correct answer is D</i> A is not correct because the incidence of CVD decreases with increasing magnesium ion intake and it is not possible to infer causation from the data B is not correct because it is not possible to infer causation from the data in graph C is not correct because the incidence of CVD decreases with increasing magnesium ion intake	(1)

Question Number	Answer	Mark
(ii)	B – 78 mg day⁻¹ <i>The only correct answer is B</i> A is not correct because 43 is the increase required to achieve a 0.05 reduction in relative risk C is not correct because 118 is the Mg²⁺ intake that is associated with a 0.25 reduction in relative risk D is not correct because 347 is the correct column chosen with no subtraction	(1)