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A Level
Biology A (Salters-Nuffield)

Sample Assessment Materials

Pearson Edexcel Level 3 Advanced GCE in Biology A (Salters-Nuffield) (9BN0)

First teaching from September 2015

First certification from 2017

Issue 1

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Sample Assessment Materials

First certification 2017

Edexcel, BTEC and LCCI qualifications

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Contents

Introduction

The Pearson Edexcel Level 3 Advanced GCE in Biology A (Salters-Nuffield) is designed for use in schools and colleges. It is part of a suite of GCE qualifications offered by Pearson.

These sample assessment materials have been developed to support this qualification and will be used as the benchmark to develop the assessment students will take.

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than be penalised for omissions.
- Examiners should mark according to the mark scheme – not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is given.
- Crossed-out work should be marked **unless** the candidate has replaced it with an alternative response.

Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Biology A (Salters Nuffield)

Advanced

Paper 1: The Natural Environment and Species Survival

Sample Assessment Material for first teaching September 2015

Time: 2 hours

Paper Reference **9BN0/01**

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

Total Marks

Instructions

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

Information

- The total mark for this paper is 100.
- 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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S 4 7 5 6 3 A 0 1 3 6

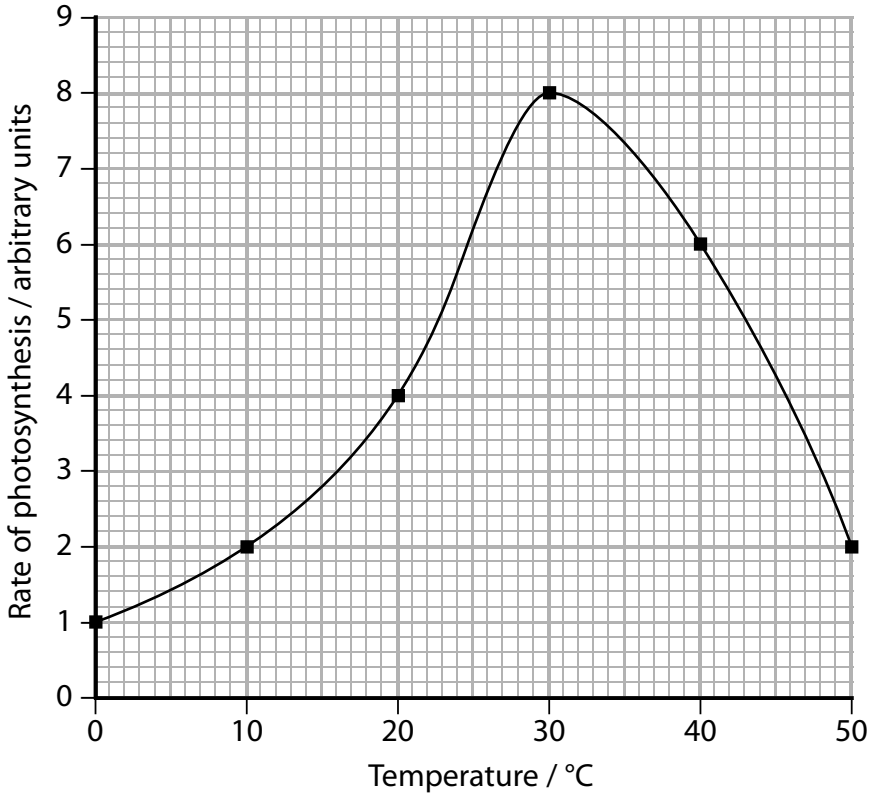
PEARSON

Answer ALL questions.

Write your answers in the spaces provided.

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

1 The reactions involved in photosynthesis are affected by environmental factors.
The graph shows the effect of temperature on the rate of photosynthesis in wheat.



(a) Calculate the Q_{10} for photosynthesis between 20 °C and 30 °C.

(1)

Answer.....

(b) Explain the effect of temperature on the rate of photosynthesis in wheat.

(3)

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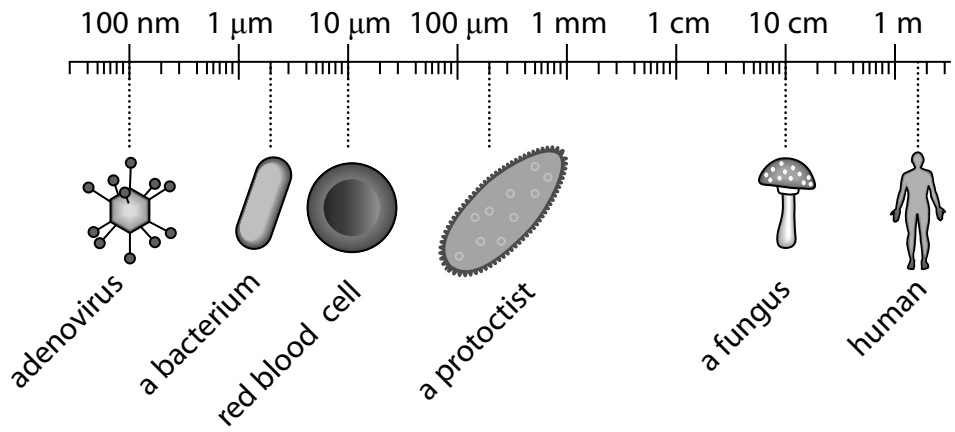
(Total for Question 1 = 4 marks)

2 The diagram compares the size of some microbes with that of a human and a human cell.



(a) Which of the following belong to the domain Eukaryota?

(1)

☒ **A** adenovirus, bacterium and protoctist

☒ **B** human, bacterium and red blood cell

☒ **C** human, red blood cell and protoctist

☒ **D** adenovirus, fungus and human

(b) Which of the following do **not** have a nucleus?

(1)

☒ **A** bacterium and protoctist

☒ **B** bacterium and red blood cell

☒ **C** fungus and adenovirus

☒ **D** protoctist and adenovirus

(c) Which of the following shows how many times bigger the bacterium is than the adenovirus?

(1)

☒ **A** 45 times

☒ **B** 22 times

☒ **C** 2 times

☒ **D** 10 times

(d) State **one** way in which the structure of a virus is different from that of a bacterium.

(1)

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.....

(Total for Question 2 = 4 marks)

3 A new species of mosquito has evolved in the tunnels of the London Underground. These mosquitoes are believed to be the descendants of bird-biting mosquitoes which colonised the tunnels 100 hundred years ago. The mosquitoes now feed on rats, mice and human beings instead of birds.

(a) Place a cross in the box next to the best definition of a species.

(1)

☒ **A** individuals can interbreed to produce fertile offspring

☒ **B** individuals can interbreed to produce hybrid offspring

☒ **C** individuals can interbreed to produce sterile offspring

☒ **D** individuals can interbreed to produce offspring

(b) Explain how this species of mosquito may have evolved.

(5)

(Total for Question 3 = 6 marks)

4 In the 18th century, William Withering trialled the use of an extract of foxglove plants to treat a heart condition.

(a) Give **four** reasons why a contemporary drug testing protocol is an improvement on the trial used by William Withering.

(4)

(b) In a drug trial, people with a heart condition were given one of three drug treatments. The table shows the recorded improvement in their condition for each of the three treatments.

Treatment	Concentration of drug / mg	Recorded improvement / arbitrary units
1	0	18.8
2	400	24.8
3	600	30.9

It was concluded that the drug treatment improved the condition of the patients.

Analyse the data to comment on this conclusion.

(3)

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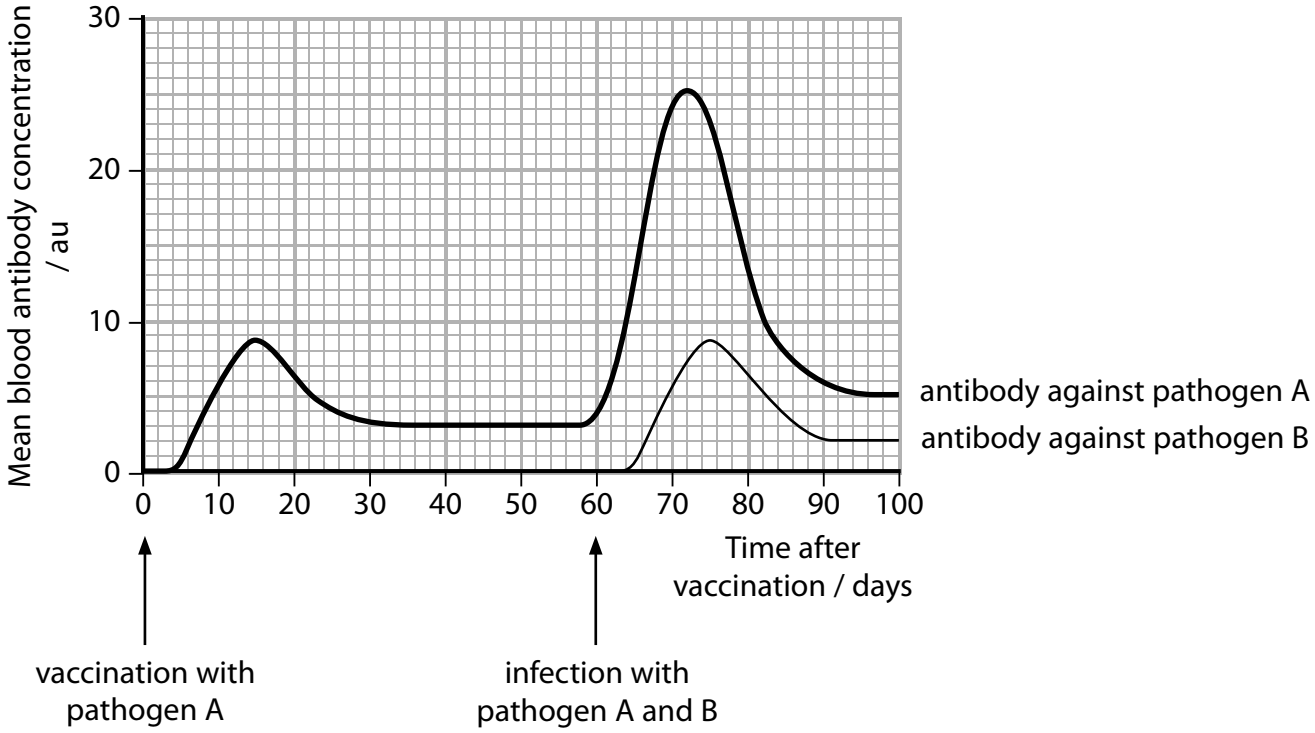
(Total for Question 4 = 7 marks)

5 Many people have a vaccination before visiting some countries for the first time.

A person was vaccinated with a weakened form of pathogen six weeks before travelling to a particular country. The person was infected by two different pathogens, A and B, when in this country.

The graph shows what happened to different blood antibody concentrations of the person after vaccination and after infection by the two different pathogens.



(a) The changes to blood antibody concentration occur because vaccination produces

(1)

☒ **A** active artificial immunity

☒ **B** active natural immunity

☒ **C** passive artificial immunity

☒ **D** passive active immunity

*(b) Explain why this person did not become ill from pathogen A but did become ill from pathogen B when visiting this country.

(6)

(Total for Question 5 = 7 marks)

6 The photograph shows heather, *Calluna vulgaris*, a plant that grows on moorland.

In an investigation into the net primary productivity of heather, all the vegetation on an area of two different moorlands, A and B, was removed by burning. The dry biomass, in g m^{-2}, was then measured each year for a period of 20 years.

(a) Give an equation that shows the relationship between gross primary productivity, net primary productivity and respiration.

(1)

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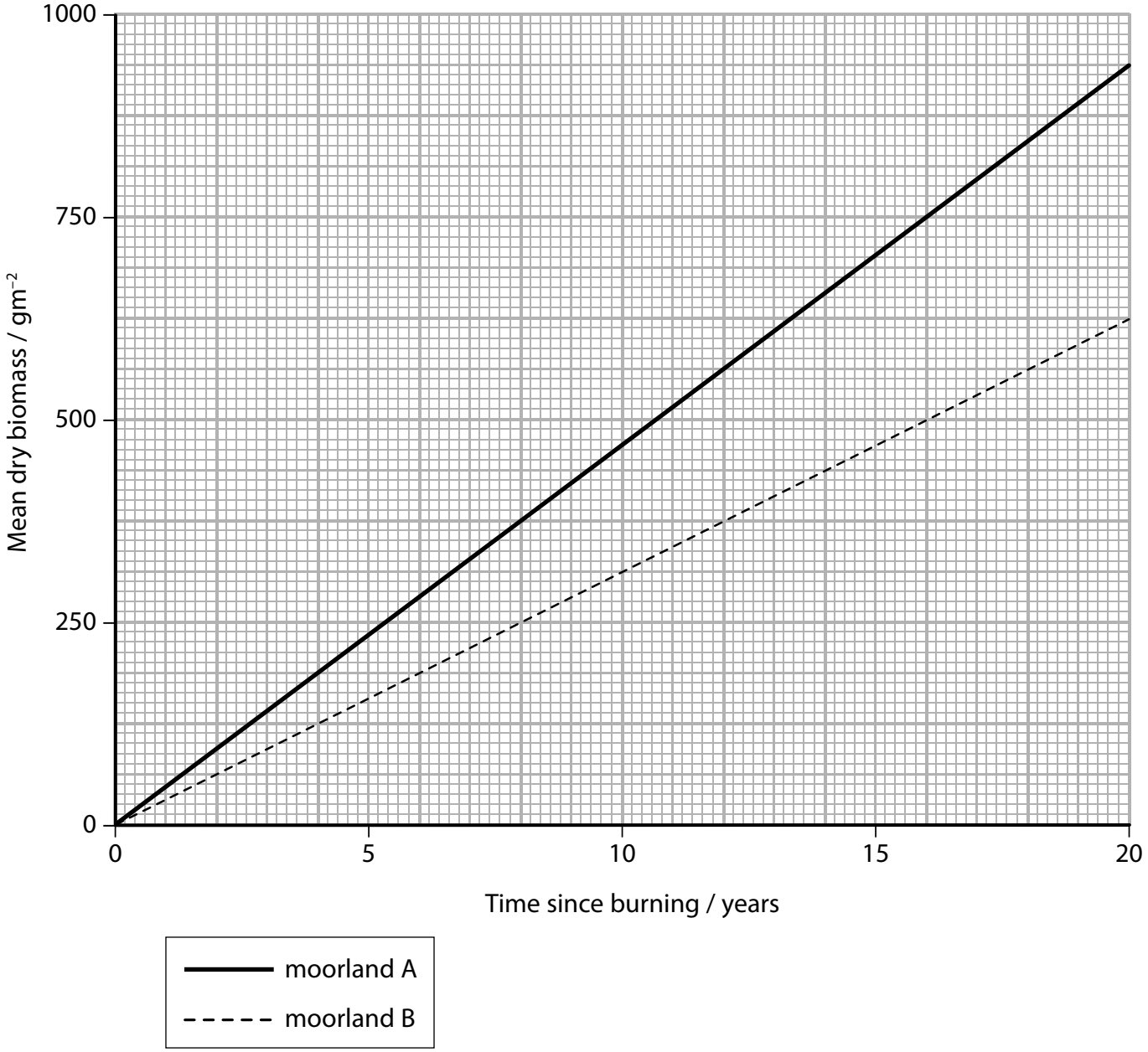
(b) The graph shows the change in the mean dry biomass of the heather plants during the 20 year period.



(i) Describe a method that could be used to obtain the mean dry biomass of the heather plants in year 20.

(2)

(ii) The total solar radiation reaching moorland A was 3 144 000 kJ m^{-2} yr^{-1}.
Each gram of dry heather contains 22.186 kJ.

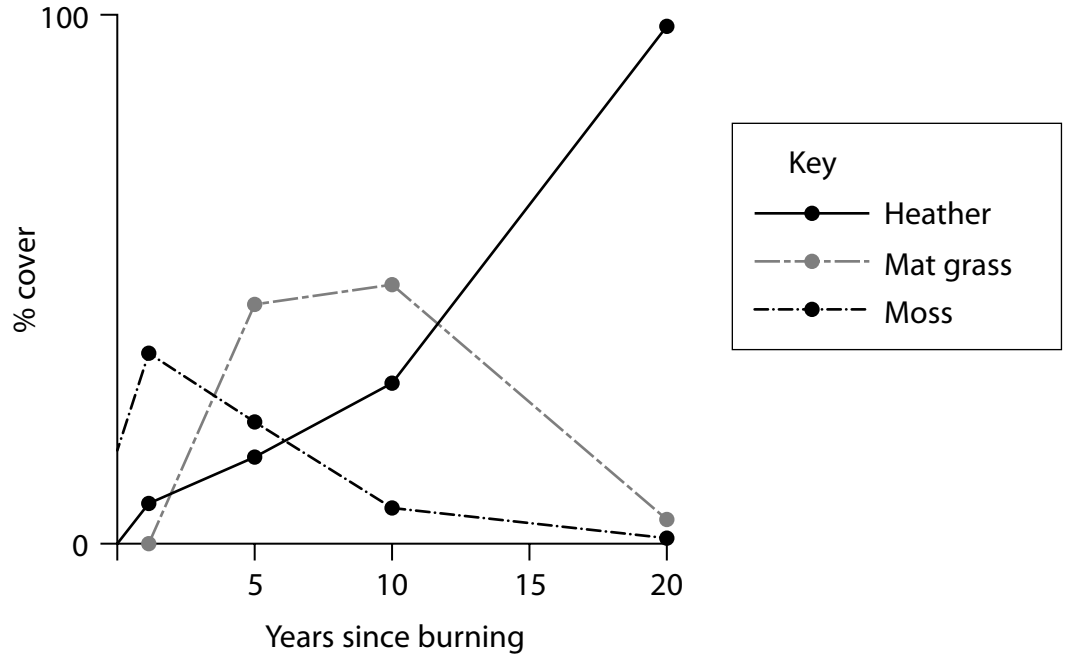
Calculate the percentage efficiency of heather plants from moorland **A** at converting solar radiation into dry biomass.

(2)

Answer.....

(iii) After the burning of the moorland, a process of succession occurred.

The following information shows some of the changes found over the 20 years.



Analyse the data to explain the changes shown.

(3)

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(Total for Question 6 = 8 marks)

7 Researchers carried out a study on the prey of predatory ground beetles. They removed the contents of the guts of beetles which had been feeding and analysed them to see if they could identify the species they had fed on.

In one study, to see if the method worked, they fed the beetles on earthworms of the species *Allolobophora chlorotica* only.

DNA was extracted from the gut contents and analysed.

(a) The quantity of worm DNA in the beetle gut was very small.

Describe how sufficient DNA was produced to carry out the analysis.

(3)

(b) (i) The DNA in the samples from the beetle guts was cut into fragments. The fragments were different for each species and had to be separated by gel electrophoresis.

Which of the following describes the movement of the DNA fragments in gel electrophoresis?

(1)

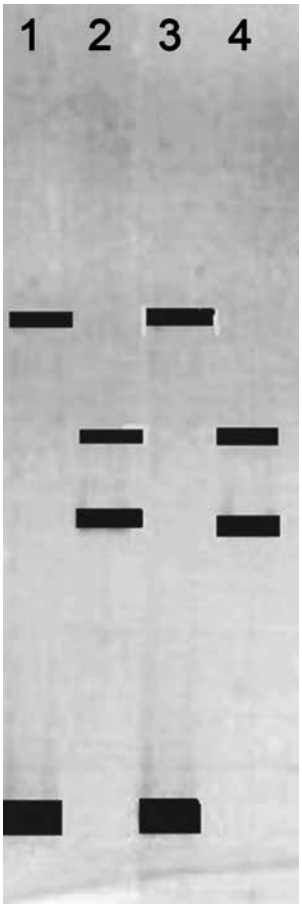
☒ **A** large fragments move further than small fragments towards the anode

☒ **B** large fragments move further than small fragments towards the cathode

☒ **C** small fragments move further than large fragments towards the anode

☒ **D** small fragments move further than large fragments towards the cathode

(ii) The picture shows one set of results in which four samples have been separated.



(Source: Evaluation of temperature gradient gel electrophoresis for the analysis of prey DNA within the guts of invertebrate Sheppard et al. Cardiff School of Biosciences)

Explain what these results show you about the diet of the ground beetles.

(2)

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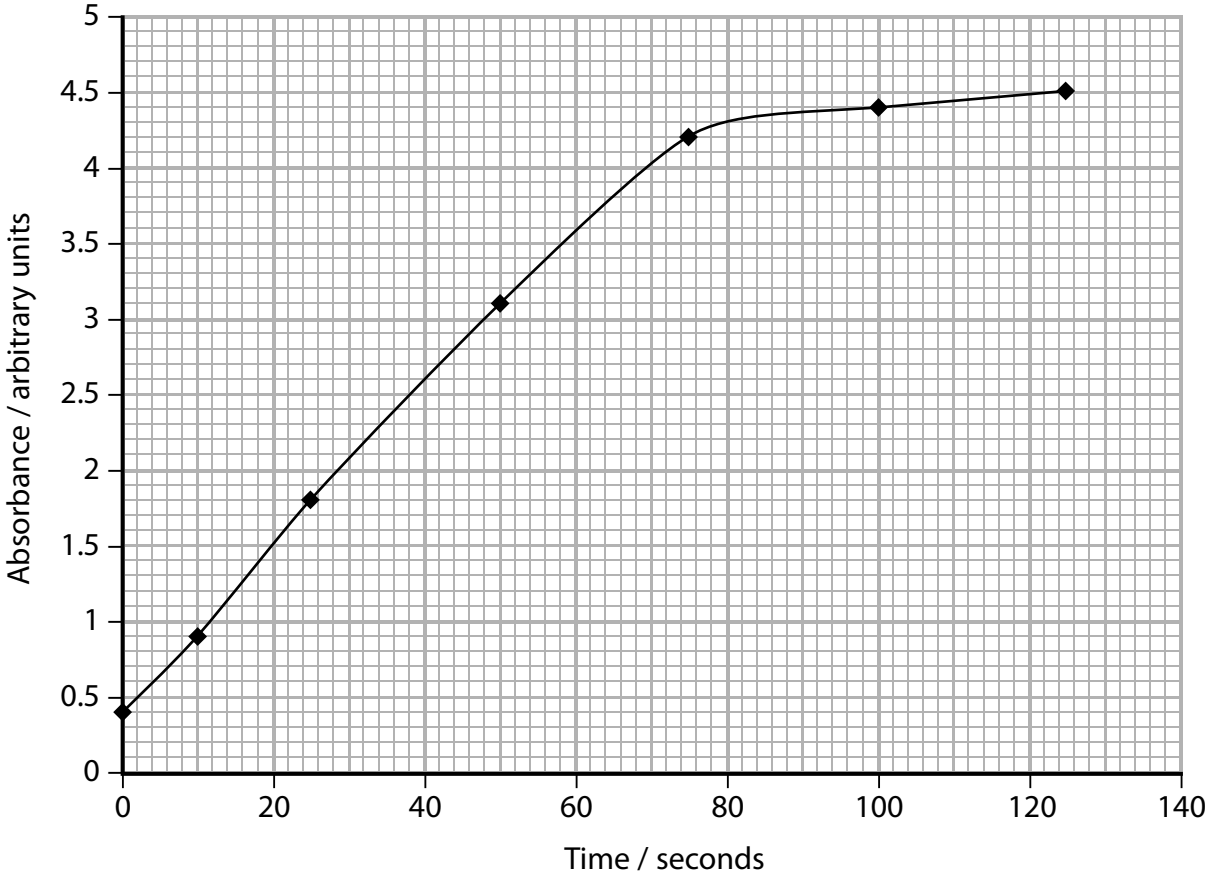
(Total for Question 7 = 6 marks)

8 L-dopa forms a colourless solution in water. Dopa oxidase is an enzyme that converts L-dopa into dopachrome, which is red.

A colorimeter can be used to study this reaction. As the red colour appears, the amount of light absorbed by the solution increases.

(a) The graph shows the course of a reaction in which there was an enzyme concentration of 20 (arbitrary units) of reaction mixture.



Calculate the initial rate of reaction for this concentration of enzyme.

(3)

Answer .....

(b) In another study, a student used this procedure with a range of enzyme concentrations. The results are shown in the table below.

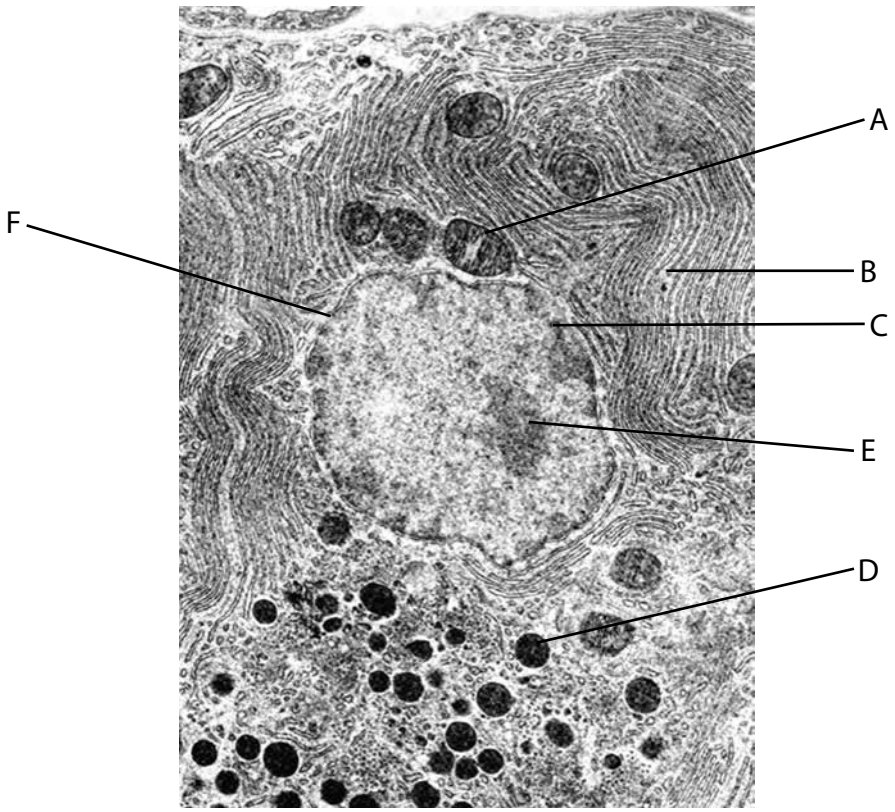
Enzyme concentration / arbitrary units	Initial rate of reaction / absorbance s^{-1}
0	0.0
10	2.5
30	6.1
50	9.0
70	11.0
90	11.0

Explain the effect of enzyme concentration on the initial rate of this reaction.

(3)

(c) Enzymes are made, modified, stored and used in cells.

The photograph shows an electron micrograph of a cell from the pancreas.



(i) Which structure in the photograph uses enzymes in respiration?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) Which structure in the photograph is the nucleolus?

(1)

☒ **B**

☒ **C**

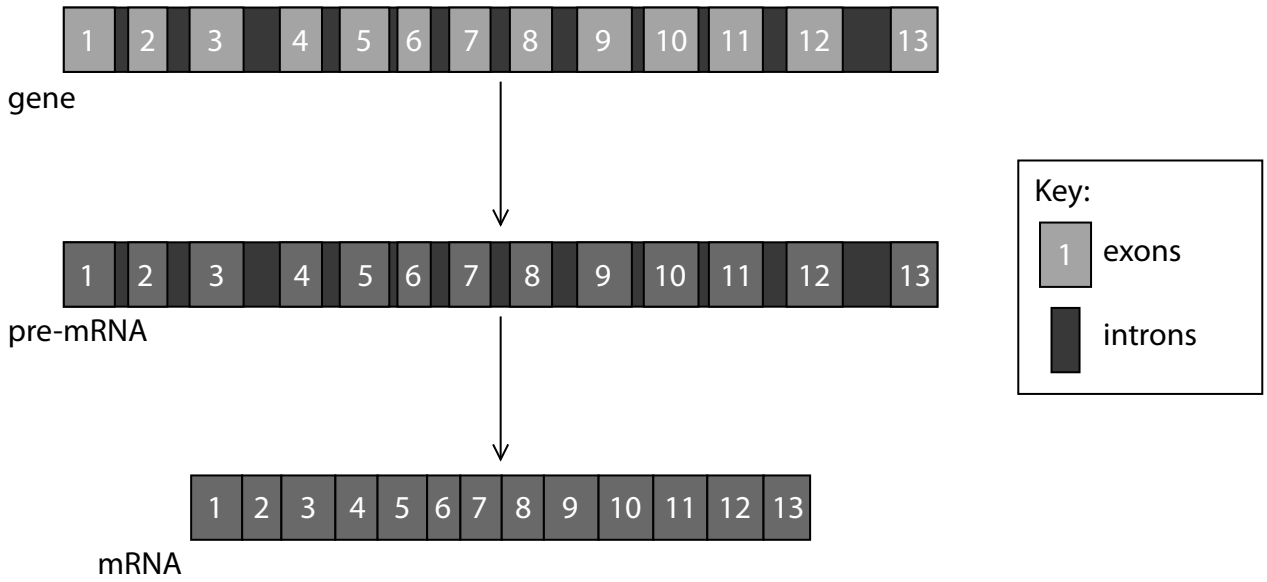
☒ **E**

☒ **F**

(Total for Question 8 = 8 marks)

9 A central idea in biology is that DNA codes for the synthesis of proteins from amino acids. The instructions for making proteins are in the form of mRNA.

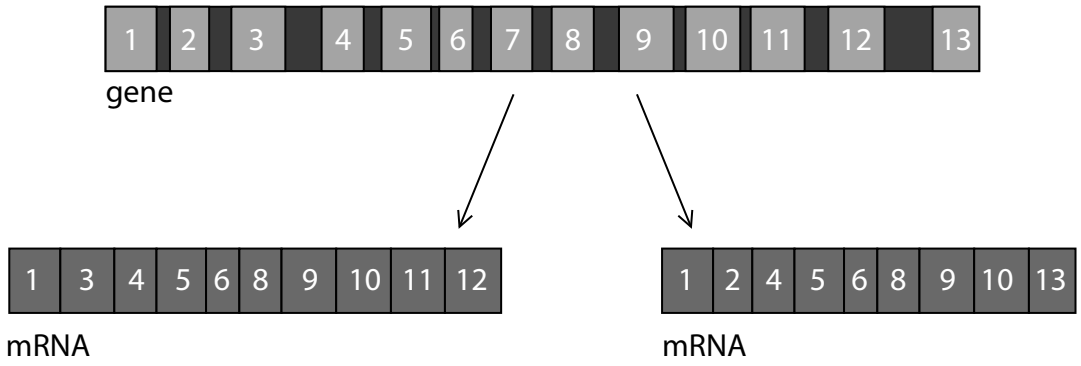
The diagram shows two stages in the production of mRNA.



(a) Explain how this molecule of mRNA is produced.

(4)

(b) Sometimes the process is more complicated as shown in the diagram below.



An initial estimate of the number of genes, based on the number of proteins found in humans, was in the region of 100 000. It is now known that the number of genes is around 25 000.

Explain how the formation of mRNA, shown in the diagram, might account for this.

(5)

(Total for Question 9 = 9 marks)

10 A student investigated the light-dependent reactions of photosynthesis in spinach leaves.

The leaves were cut into pieces and ground in a cold solution of sucrose and a buffer.

The mixture was filtered and centrifuged. The liquid in the tube was poured off and kept in an ice water bath.

The pellet at the bottom of the tube was suspended by mixing with fresh sucrose and buffer and stored in an ice water bath.

Four tubes were then set up as follows:

Tube	Liquid poured off after centrifuging / cm^3	Resuspended pellet / cm^3	Sucrose and buffer solution / cm^3
1	–	0.5	–
2	–	–	0.5
3	–	0.5	–
4	0.5	–	–

The tubes had 5 cm^3 of DCPIP added to them. Tube 3 was kept in the dark and the others kept in the light.

After twenty minutes, the colour in each tube was recorded. The results are shown in the table below.

Tube	Colour in tube
1	pale green
2	blue
3	blue
4	blue

(a) (i) Give **two** reasons why a cold solution containing sucrose and a buffer was used in this investigation.

(2)

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(ii) Give a reason why tube 3 was used in this investigation.

(1)

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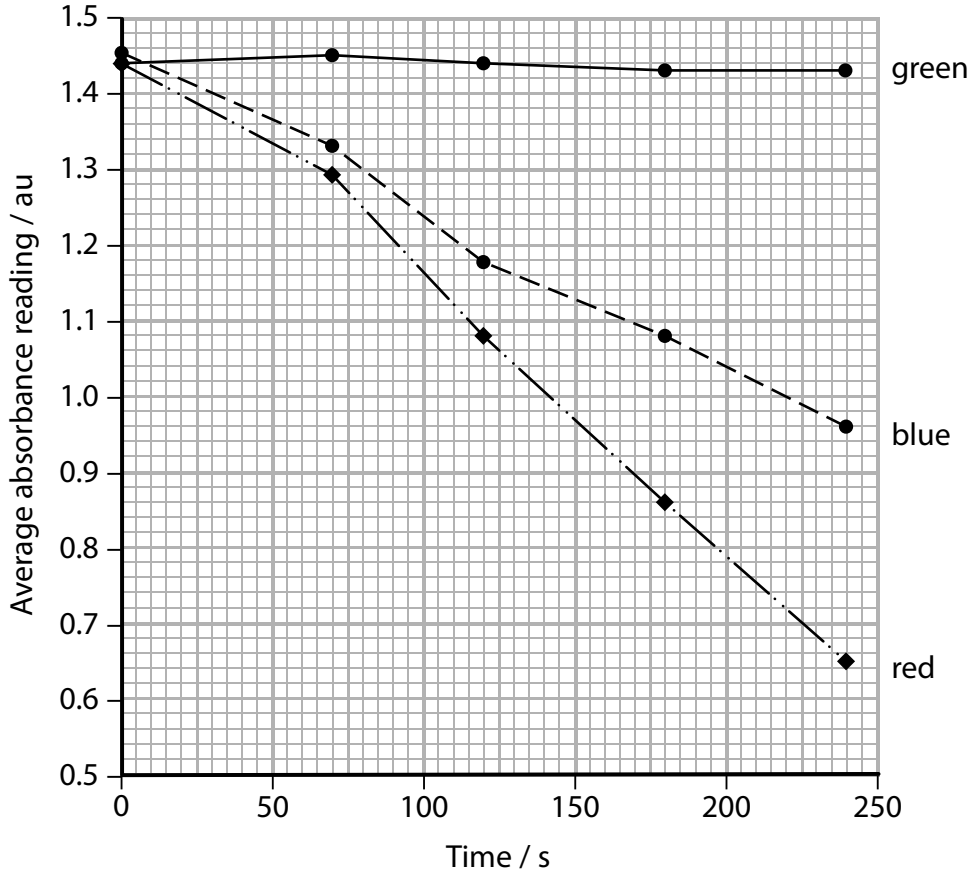
(iii) In another investigation, the student wanted to determine the effect of different wavelengths of light on the light-dependent stage of photosynthesis.

The student modified her first investigation to obtain results.

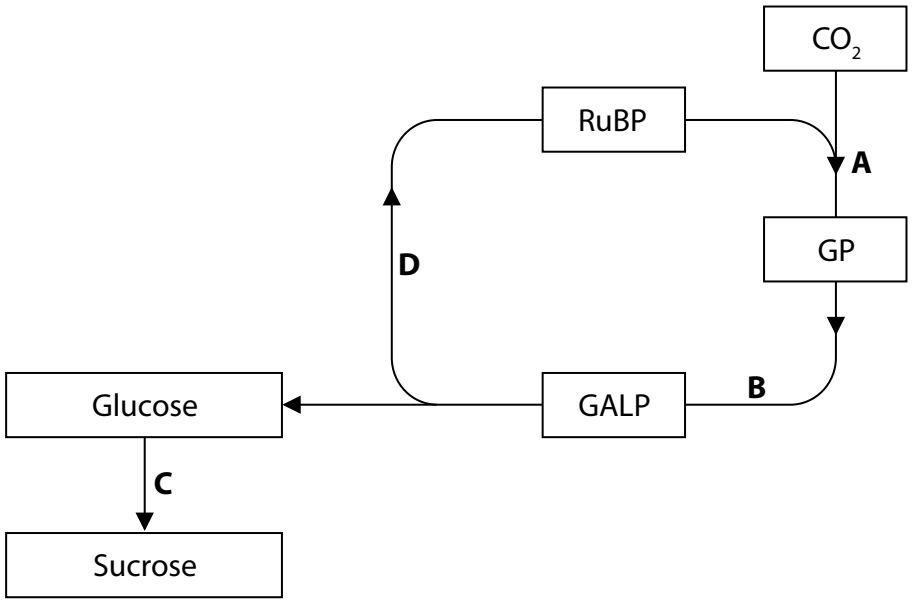
The graph shows the results of her modified investigation.



Explain how the student modified the practical procedure of the first investigation to enable these results to be obtained.

(4)

(b) The diagram shows part of the Calvin cycle (light-independent reactions) of photosynthesis.



Place a cross in the box which indicates the correct stage (A – D) for the following statements.

(i) The stage which involves a condensation reaction and fructose.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) The stage where the enzyme RUBISCO is involved.

(1)

☒ **A**

☒ **B**

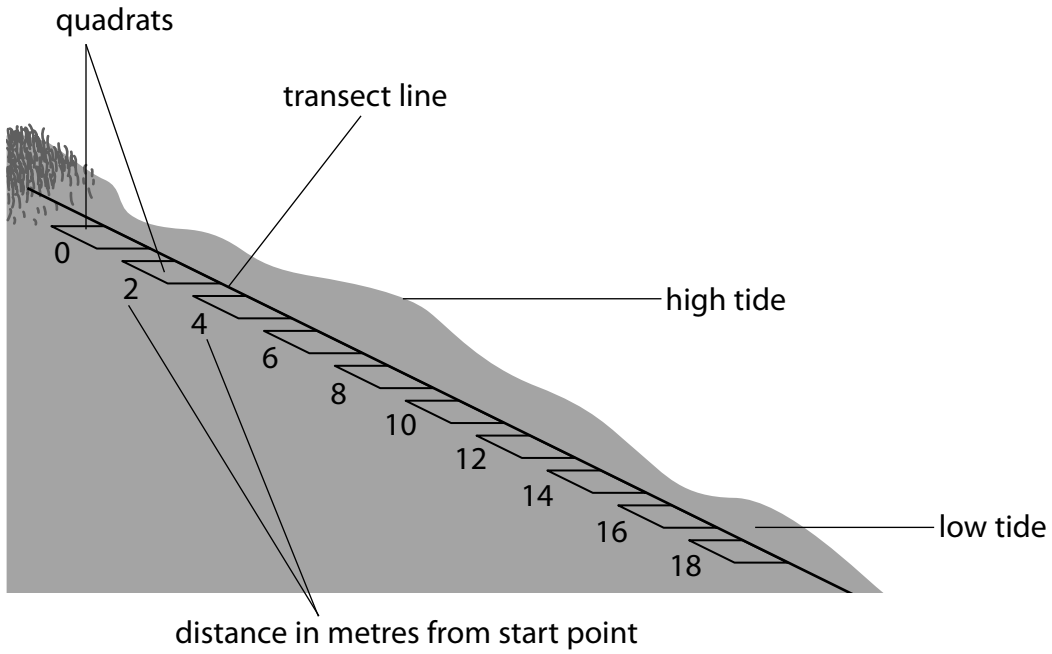
☒ **C**

☒ **D**

(Total for Question 10 = 9 marks)

11 The distribution and abundance of species on a rocky shore were investigated using a systematic sampling technique.

(a) The diagram shows the placing of the transect and quadrats on a rocky shore.



Not to scale

(i) Give a reason why systematic sampling, rather than random sampling, was used in this investigation.

(1)

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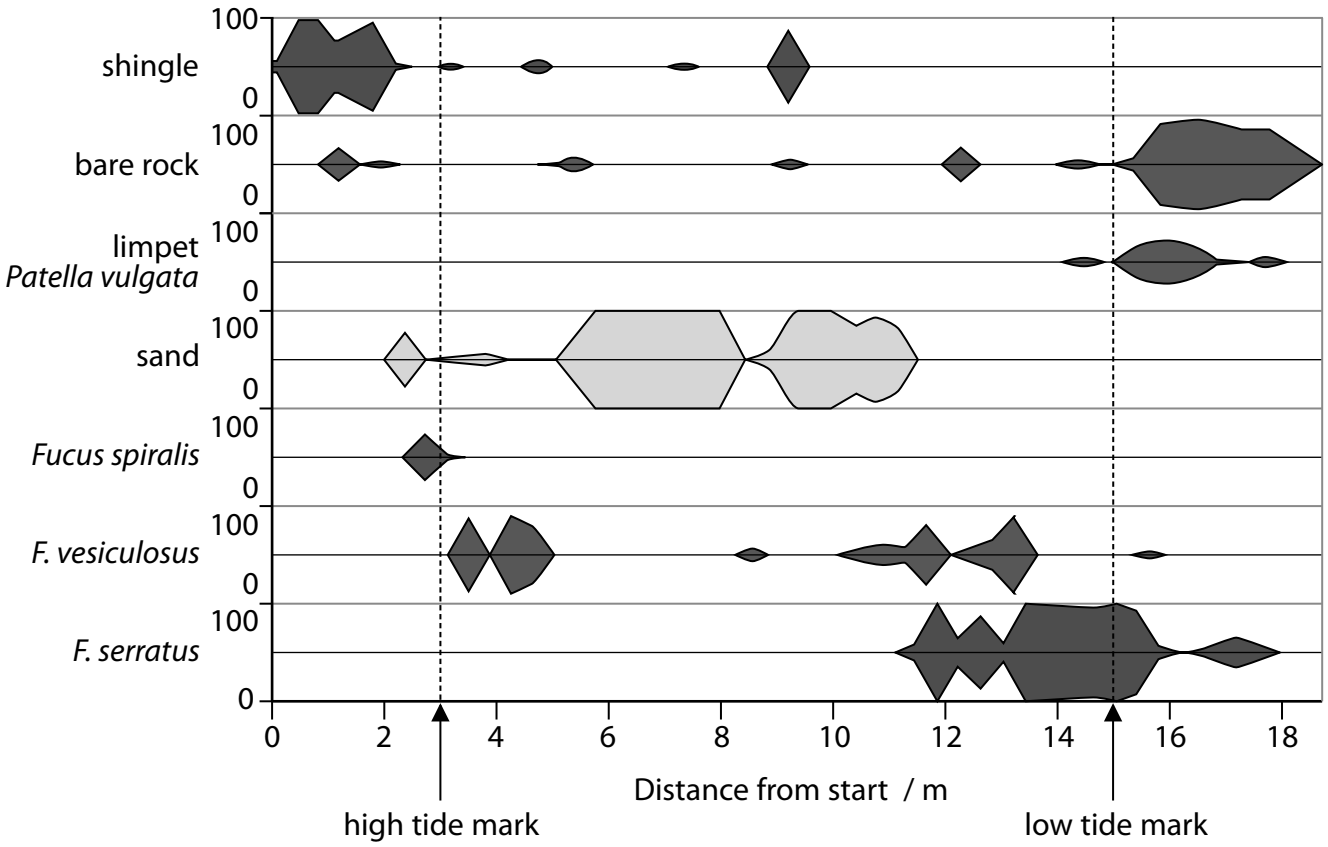
*(ii) The diagram shows the distribution of some of the abiotic and biotic components of a sea shore. There are three species of seaweed (*Fucus*) and one species of limpet (*Patella vulgata*). Limpets feed on seaweed.



Analyse the data to explain how the distribution patterns of *Fucus spiralis, Fucus vesiculosus* and *Fucus serratus* are affected by abiotic and biotic factors.

(6)

(b) (i) Another study compared the diversity of species at different places on the shore. On the upper shore the following data were obtained.

Species	Number of individuals found
Pelvetia canaliculata	10
Enteromorpha sp.	3
Patella vulgata	3
Littorina littorea	15
Gibbula sp.	14
Lichens	15

Calculate an index of diversity (D) for this site using the formula below.

(3)

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

n = total number of organisms of a particular species

N = total number of organisms of all species

Answer .....

(ii) On the middle shore the index was found to be 7.74 with a total individual count of 37.

Comment on the relationship between diversity and the total number of individuals on these two parts of the shore.

(2)

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(Total for Question 11 = 12 marks)

12 A student carried out an investigation to compare the antibacterial effect of a garlic extract with that of three antibiotics, all at the same concentration.

(a) (i) To obtain the extract, a clove of garlic was cut into lots of small pieces and soaked in 0.1% ethanol for a long time.

Explain why this is an effective method of extraction.

(2)

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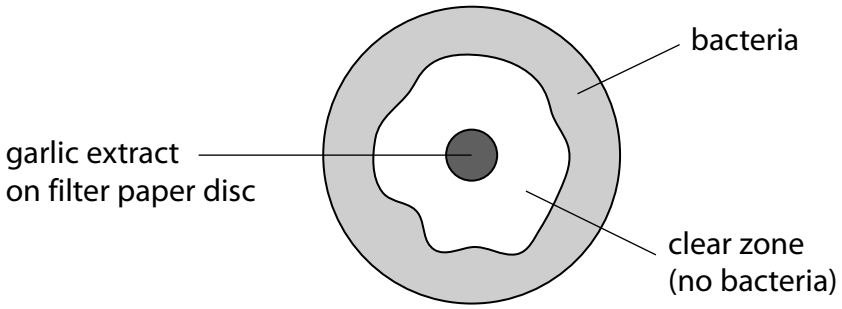
(ii) The diagram shows the effect of the garlic extract on bacteria growing on an agar plate.



The area of the clear zone was calculated by assuming it is a circle and estimating the diameter. The estimate made was 4.3 cm.

Calculate the estimated area of the clear zone.

(2)

Answer .....

(b) The results of the investigation are shown in the table.

Sample number	Estimated area of clear zone / mm^2			
	Antibiotics			Plant extract
	Chloramphenicol	Tetracycline	Streptomycin	Garlic
1	28	16	15	20
2	26	19	13	28
3	29	11	14	18
4	28	21	12	25
5	26	7	14	27
6	29	11	15	26
7	22	8	9	25
8	25	21	14	25
9	29	10	12	29
Mean	27	14	13	25
Standard deviation	2.37	5.54	1.90	3.60

These data were analysed using *t*-tests.

(i) Several statistical tests were available to the student to analyse these data, including the *t*-test, Chi squared and the correlation coefficient.

Explain why the *t*-test was chosen to analyse these data, rather than the other two tests.

(3)

(ii) Calculate the *t* value for the data to compare garlic with chloramphenicol, using the formula:

$$t = \frac{\left|\overline{x}^1 - \overline{x}^2\right|}{\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}}$$

(3)

Answer .....

(iii) The table shows the critical values of *t* with 16 degrees of freedom.

Significance level (p)	0.20	0.10	0.05	0.01	0.001
Critical value of *t*	1.34	1.75	2.12	2.92	4.02

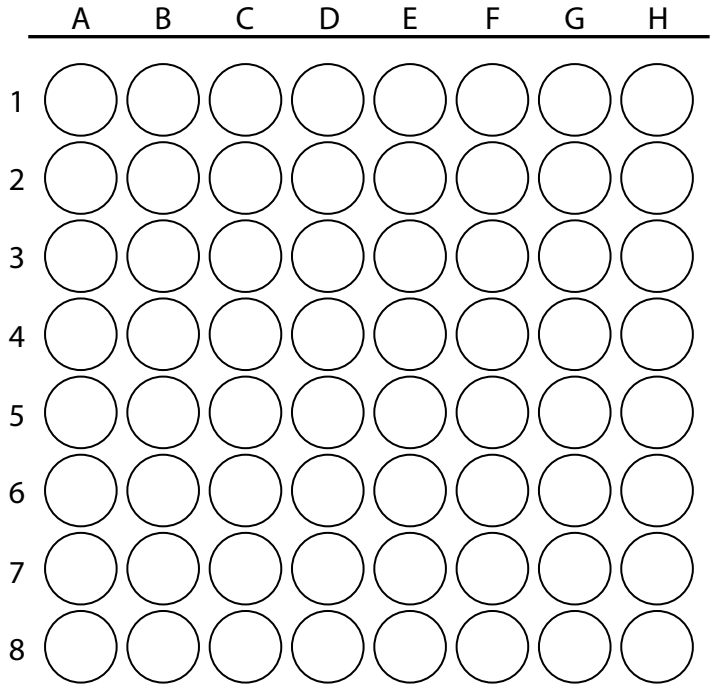
Use your value of *t* to test the validity of a stated null hypothesis.

(4)

(c) The size of the clear zone depends on variables other than the antibacterial properties of the substances used, such as size and solubility of the antimicrobial molecules in the extract.

A new method was developed in which the minimum concentration of extract that causes inhibition of bacterial growth (Minimum Inhibitory Concentration, MIC), was found.

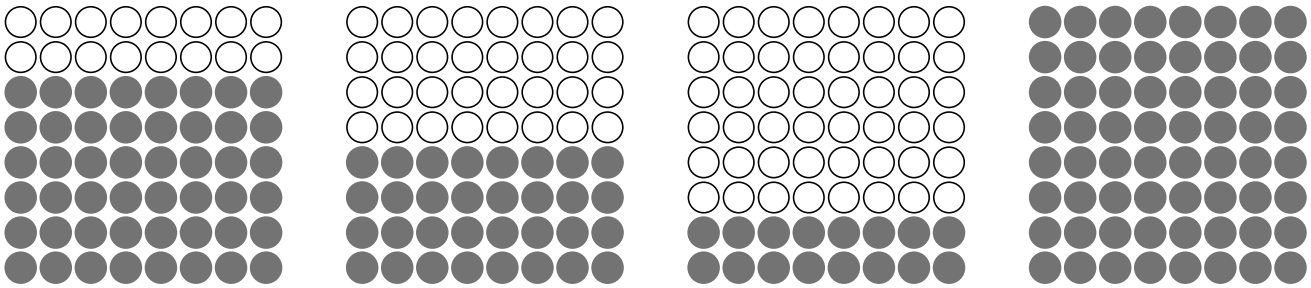
Samples of extract, bacteria (*E. coli*) and a respiration indicator were placed in a micro-titre tray.



1 = 4%
2 = 2%
3 = 1%
4 = 0.5%
5 = 0.25%
6 = 0.125%
7 = 0.0625%
8 = 0.0%

concentration of extract

The diagrams show the results obtained. The tubes are black when respiration occurs and clear when no respiration occurs.



rosemary geranium garlic cedar

(i) Analyse the data to explain the results of this experiment.

(2)

(ii) Give **two** changes that can be made to the procedure to get a more accurate measure of MIC.

(2)

(iii) It was concluded that plant extracts inhibit respiration of bacteria. This conclusion may not be valid because the investigation has limitations.

Describe how the investigation could be modified to reduce the effect of two named limitations.

(2)

(Total for Question 12 = 20 marks)

TOTAL FOR PAPER = 100 MARKS

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Question Number	Acceptable Answer	Additional guidance	Mark
1(a)	$Q_{10} = 8 \div 4 = 2$ (1)	No mark for correct answer must have working.	**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
1(b)	An explanation that makes reference to three of the following: • increasing temperature increases {movement of both enzyme and substrate molecules / kinetic energy of molecules} (1) • therefore molecules collide {more often / with more force} causing the rate to increase (1) • resulting in {enzyme denaturation / change in bonding in the enzyme} above 30 °C (1) • which causes active site shape to change and causing the rate to decrease (1)		**(3)**

(Total for Question 1 = 4 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
2(a)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(b)	B		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(c)	B		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(d)	An answer that makes reference to one of the following points: • virus has a non-cellular structure whereas bacteria has a cellular structure (1) • a virus has a protein capsid whereas a bacterium has a polysaccharide cell wall (1) • viruses have one type of nucleic acid whereas a bacterium has two (1)		**(1)**

(Total for Question 2 = 4 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
3(a)	A		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
3(b)	An explanation that makes reference to the following: • mosquitoes are geographically isolated in the tunnels (1) • random genetic mutations cause variation in the population which allows some individuals to feed on rats, mice and humans (1) • these individuals {will be selected for / are more likely to survive and reproduce} (1) • the proportion of individuals in the population with this mutation will change over time (1) • over many generations these populations become genetically distinct from the above ground population (1)		**(5)**

(Total for Question 3 = 6 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
4(a)	An answer that makes reference to four of the following: (Safer) • because pure drug used rather than extract (1) • due to pre-testing on {cells / animals} before testing on humans (1) • because regulated by legislation (1) (More valid) • because a placebo is used as a comparison (1) • because modern testing may involve double-blind trials (1) • because controlling {factors / variables / eq} tested cohort e.g. age, lifestyle (1) (More reliable) • because more people are tested (1) • because results are analysed statistically (1)	No marks awarded for safer, more valid or more reliable	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(b)	An answer that makes reference to the following: • the drug did improve the condition of the patients more than the placebo but it was only 6 au with a concentration of 400 mg so not much of an improvement (1) • increasing the dosage by a further 200 mg doubled the improvement over the placebo (1) Plus one from: • therefore to be effective higher doses of the drug would be required (1) • statistical tests would be required in order to comment further (1)		**(3)**

(Total for Question 4 = 7 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
5(a)	A		**(1)**

Question Number	Indicative content		
***5(b)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the 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 indicated as relevant. Additional content included in the response must be scientific and relevant. • Vaccination stimulates primary immune response • Reference to antigen presenting cells • Activation of T helper cells / reference to cytokines • Reference to B effector cells / activation of T killer cells • (Differentiation into) plasma cells that secrete antibody • Reference to memory cells • (Secondary immune response) antibody production is {sooner / faster / greater} for pathogen A • Insufficient antibody initially produced in primary response for pathogen B		
Level	Mark	Descriptor	
	0	No awardable content	
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented. Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures).	

		The explanation shows some linkages and lines of reasoning with some structure.

Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented. Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured.

(Total for Question 5 = 7 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
6(a)	NPP = GPP – R (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(i)	A description that makes reference to the following: • use of several quadrats of stated area placed at random (1) • heather placed in drying oven until constant mass (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(ii)	• (gradient) 46.875 (g m^{-2} yr^{-1}) x 22.186 (kJ) = 1039.97 (g kJ m^{-2} yr^{-1}) (1) • (1037.97 ÷ 3 144 000) x 100 = 0.033% (1)	Example 750 g m^{-2} ÷ 16 years = 46.875 g m^{-2} yr^{-1}	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(iii)	An explanation that makes reference to the following: • moss not all removed by burning so quickly re-grows (1) • mat grass colonises after 1 year and outcompetes moss for {light / minerals / water} so is the dominant plant after 5 years (1) • both decrease as heather colonises and becomes dominant as the heather outcompetes them both for {light / minerals / water} (1)		**(3)**

(Total for Question 6 = 8 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
7(a)	A description that makes reference to the following: • reference to PCR to include reference to {primers / DNA polymerase / nucleotides} (1) • procedure repeated {multiple times / 20 to 40 times} (1) • temperature requirements to denature and anneal (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)(i)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)(ii)	An explanation that makes reference to: • pattern of bands different between 1 and 3 and 2 and 4 (1) • so *Allolobophora chlorotica* not all one species (1)		**(2)**

(Total for Question 7 = 6 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
8(a)	• suitable time interval chosen (in range 0 to 70 s, must be on straight line portion) (1) • absorbance change calculated (1) • ans. 0.053 au s^{-1} (or as appropriate for part of graph chosen) (1)	Example: at 0 s abs = 0.4, at 60 s abs = 3.6 (1) so change is 3.6 − 0.4 = 3.2 (1) over 60 s, make rate 3.2 ÷ 60 = 0.053 au s^{-1} (1)	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
8(b)	An explanation that makes reference to three of the following: • as enzyme concentration increases the rate of reaction increases and levels off (1) • because number of active sites of the enzyme molecules is increasing (1) • because enzyme concentration is the limiting factor (1) • it levels off because the substrate concentration is limiting (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
8(c)(i)	A		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
8(c)(ii)	E		**(1)**

(Total for Question 8 = 8 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
9(a)	An explanation that makes reference to four of the following: • DNA unzips and one strand acts as a template (1) • ribonucleotides pair up with complementary bases (1) • RNA polymerase joins ribonucleotides together to form pre-mRNA (1) • the mRNA has fewer bases than pre-mRNA / gene (1) • as a result of removal of introns / mRNA made up of exons only (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to the following: • it was assumed that one gene makes one protein (so there should be 100 000 genes but there are 25 000 genes) (1) • the diagram shows that one gene can make more than one mRNA (1) • one gene can code for several proteins (1) • due to removal of different exons (1) • reference to post-transcriptional change (1)		**(5)**

(Total for Question 9 = 9 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(i)	An answer that makes reference to the following: • {cold / buffered} to stop enzyme denaturation (1) • sucrose to stop osmotic loss of water from chloroplasts (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(ii)	• tube 3 is a control to show DCPIP does not change colour over time (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(iii)	An explanation that makes reference to the following: • set up tubes identical to tube 1 so that chloroplasts are available (1) • set up several tubes to ensure data is reliable (1) • tubes exposed to light of different wavelengths for same time because time affects number of electrons released / tubes exposed to light of same intensity because intensity affects number of electrons released (1) • use a colorimeter with a red filter to measure absorbance (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(b)(i)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(b)(ii)	A		**(1)**

(Total for Question 10 = 9 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
11(a)(i)	because there is environmental gradient (1)		**(1)**

Question Number	Indicative content		
11(a)(ii)*	Answers will be credited according to candidate's deployment of knowledge and understanding of the 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 indicated as relevant. Additional content included in the response must be scientific and relevant. • reference to F. spir / F. ves at top and F. serr. at bottom / F. ves distributed from top to bottom / ranges of each of the three species quoted • reference to top of shore exposed to different levels of abiotic factors such as {water / temperature} than lower part of shore • reference to the F. spir / F. ves able to resist {dehydration / temperature fluctuations} more than F. serr. • reference to bare rock as an abiotic factor and that F. serr. {needs solid surface to {grow / attach} / not able to {grow / attach} in sand} • reference to competition between {Fucus species / other plants} for {space / light} on rocks in lower shore • reference to different distribution of {consumers / animals / limpets} that consume Fucus species /idea that different consumers live on rock than in sand		
Level	Mark	Descriptor	
	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one variable. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	

Question Number	Acceptable Answer	Additional guidance	Mark
11(a)(i)	because there is environmental gradient (1)		**(1)**

Question Number	Indicative content		
11(a)(ii)*	Answers will be credited according to candidate's deployment of knowledge and understanding of the 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 indicated as relevant. Additional content included in the response must be scientific and relevant. • reference to F. spir / F. ves at top and F. serr. at bottom / F. ves distributed from top to bottom / ranges of each of the three species quoted • reference to top of shore exposed to different levels of abiotic factors such as {water / temperature} than lower part of shore • reference to the F. spir / F. ves able to resist {dehydration / temperature fluctuations} more than F. serr. • reference to bare rock as an abiotic factor and that F. serr. {needs solid surface to {grow / attach} / not able to {grow / attach} in sand} • reference to competition between {Fucus species / other plants} for {space / light} on rocks in lower shore • reference to different distribution of {consumers / animals / limpets} that consume Fucus species /idea that different consumers live on rock than in sand		
Level	Mark	Descriptor	
	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one variable. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	

Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both variables. The explanation shows some linkages and lines of scientific reasoning with some structure.
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Question Number	Acceptable Answer	Additional guidance	Mark
11(b)(i)	• N(N-1) = 3540 (1) • Σ n(n-1) = 704 (1) • = 3540 ÷ 704 = 5.028 / 5.03 (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
11(b)(ii)	An answer that makes reference to the following: • middle shore has higher diversity (1) • even though there are fewer individuals (1)	Allow converse argument.	**(2)**

(Total for Question 11 = 12 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
12(a)(i)	An explanation that makes reference to the following: • (small pieces) provides large surface area to volume ratio (1) • (use of ethanol for a long time means) the antibacterial substance is soluble in ethanol and more will be extracted (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(a)(ii)	$\pi 2.15^2$ (1) 14.5 cm^2 (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(b)(i)	An explanation that makes reference to the following: • the *t*-test assess the significance of the difference between the means of the two treatments (1) • Chi squared not appropriate because there are no expected values (1) • correlation coefficient not appropriate because the independent variable is discontinuous / not continuous (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(b)(ii)	$2.37^2 \div 9 = 0.62$ and $3.60^2 \div 9 = 1.44$ (1) $\sqrt{(0.62 + 1.44)} = 1.44$ (1) $(27 - 25) \div 1.44 = t = 1.39$ (1)	Correct answer gains full marks	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(b)(iii)	An answer that makes reference to the following: • there is no significant difference between the clear area caused by garlic compared with that caused by chloramphenicol (1) • $p > 0.05$ (1) • difference due to chance (1) • therefore accept null hypothesis (1)	Allow marking points for the calculated value of *t* from the candidate	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(c)(i)	An explanation that makes reference to the following: • suggests cedar wood oil has no anti-microbial effect on *E. coli* and all other oils do (1) • quoting at least two values from: rosemary 2%, geranium 0.5%, garlic 0.125% / manipulation of data to show relative effects (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(c)(ii)	An answer that makes reference to the following: • for cedar wood oil try concentrations above 4% (1) • for all the others, try concentrations below 0.0625% (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(c)(iii)	A description that makes reference to the following: • only one tray per species – need repeated measurements (1) • species – only used one species of bacteria / only used extracts from four plant species (1)		**(2)**

(Total for Question 12 = 20 marks)

Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | | | | | |

Candidate Number | | | | |

Biology A (Salters Nuffield)

Advanced

Paper 2: Energy, Exercise and Co-ordination

Sample Assessment Material for first teaching September 2015

Time: 2 hours

Paper Reference **9BN0/02**

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

Total Marks

Instructions

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

Information

- The total mark for this paper is 100.
- 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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S 4 7 5 6 4 A 0 1 3 6

PEARSON

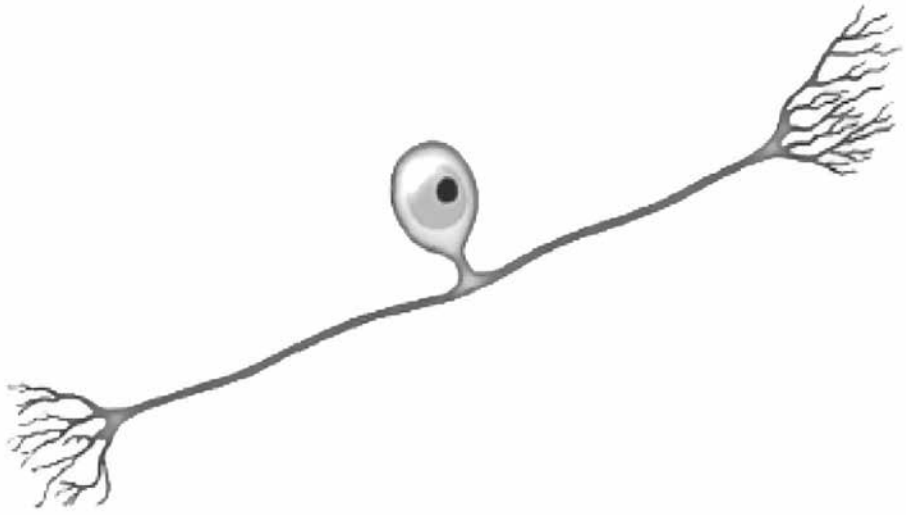
Answer ALL questions.

Write your answers in the spaces provided.

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

1 The nervous system contains myelinated and unmyelinated neurones.

The diagram below shows a myelinated sensory neurone.



(a) Give **one** feature, shown in the diagram, that identifies this cell as a sensory neurone.

(1)

.....

.....

(b) The table shows the conduction velocity of a nerve impulse along a myelinated and an unmyelinated neurone, each with a diameter of 5 μm.

Conduction velocity / ms^{-1}	
Myelinated neurone	**Unmyelinated neurone**
24.9	5.1

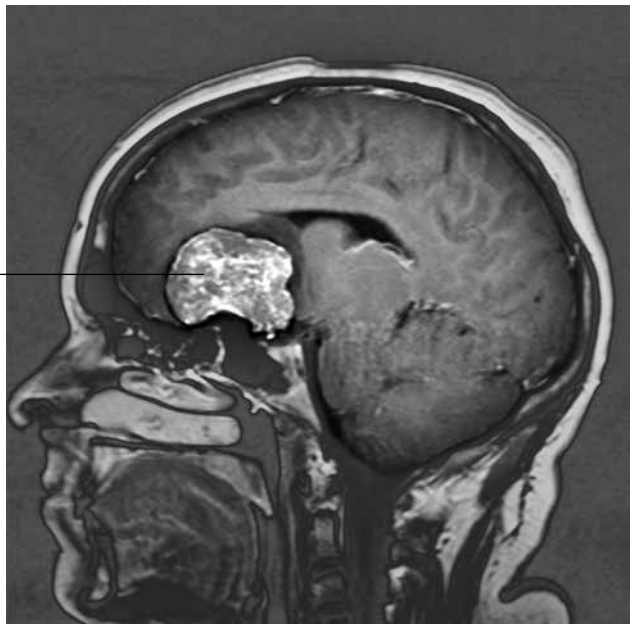
Explain why there is a difference in the conduction velocity of these neurones.

(5)

(Total for Question 1 = 6 marks)

2 Magnetic resonance imaging (MRI) can be used to study brain structure.

The MRI scan shows a human brain with a tumour.



Magnification ×0.3

(a) The part of the brain in which the tumour has grown is the

(1)

- ☒ **A** cerebellum
- ☒ **B** cerebral hemisphere
- ☒ **C** hypothalamus
- ☒ **D** medulla oblongata

(b) Explain the advantages of using MRI scanning to identify tumours compared to using CT scanning.

(3)

(c) fMRI scanning is another way of collecting information about the brain.

Explain how fMRI scanning would help neuroscientists to identify the part of the brain involved in controlling a voluntary action such as picking up a pen to write on paper.

(3)

(Total for Question 2 = 7 marks)

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3 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 dm^3 min^{-1}.

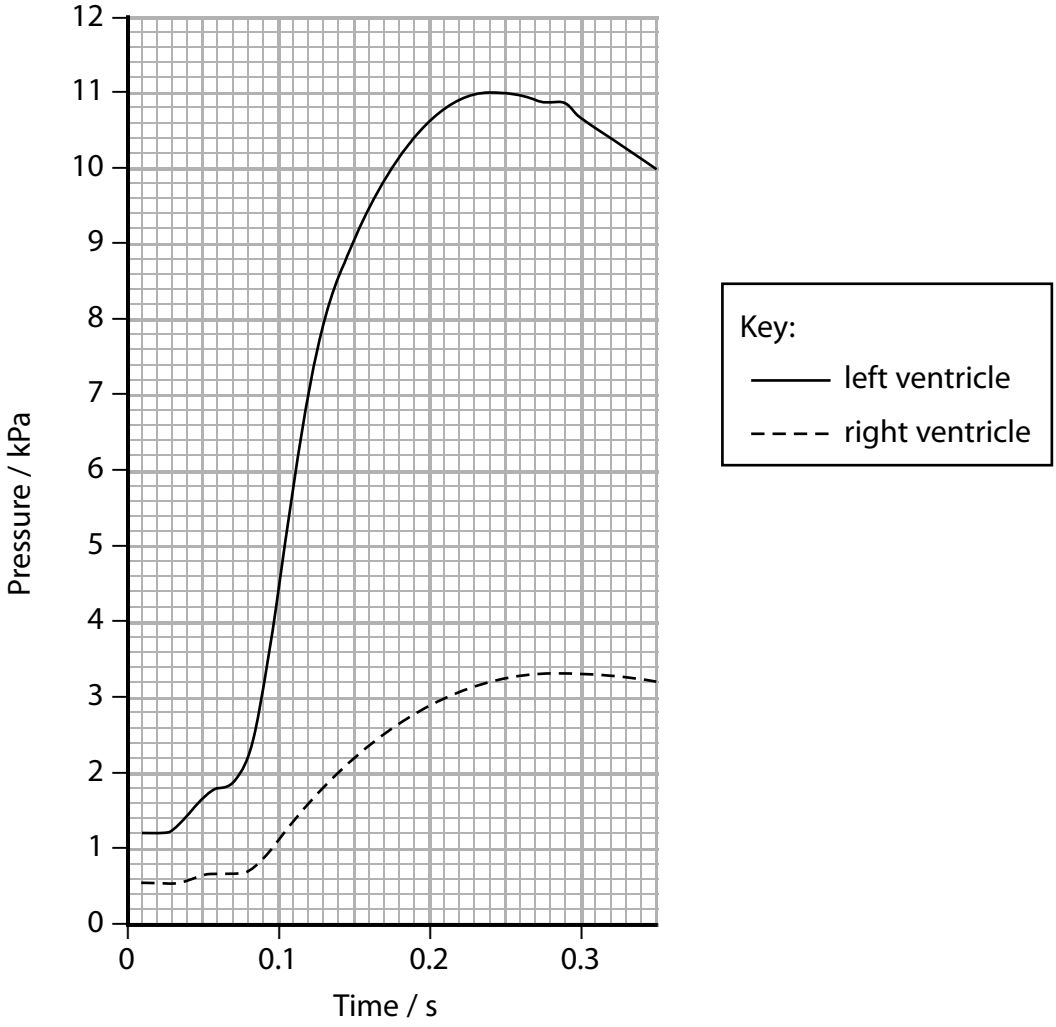
Calculate the stroke volume of the heart of this person.

(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)

(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?

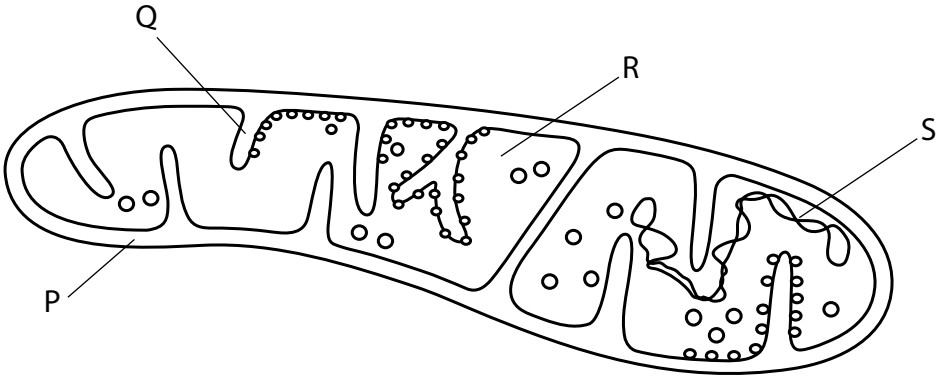
(1)

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

(Total for Question 3 = 6 marks)

4 Aerobic respiration is a series of reactions that occur in the cytoplasm and mitochondria of animal and plant cells.

(a) The diagram shows a mitochondrion.



Which row of the table shows where each process takes place in a mitochondrion?

(1)

	Diffusion of hydrogen ions / production of ATP in chemiosmosis	Production of reduced NAD
☒ **A**	P	Q
☒ **B**	Q	R
☒ **C**	R	S
☒ **D**	S	P

(b) The link reaction takes place in mitochondria.

Which row of the table shows the correct substances produced by the link reaction?

(1)

	Carbon dioxide	ATP	Reduced NAD
☒ **A**	no	no	no
☒ **B**	no	yes	no
☒ **C**	yes	yes	yes
☒ **D**	yes	no	yes

(c) The number of ATP molecules synthesised in mitochondria from one molecule of acetyl CoA is

(1)

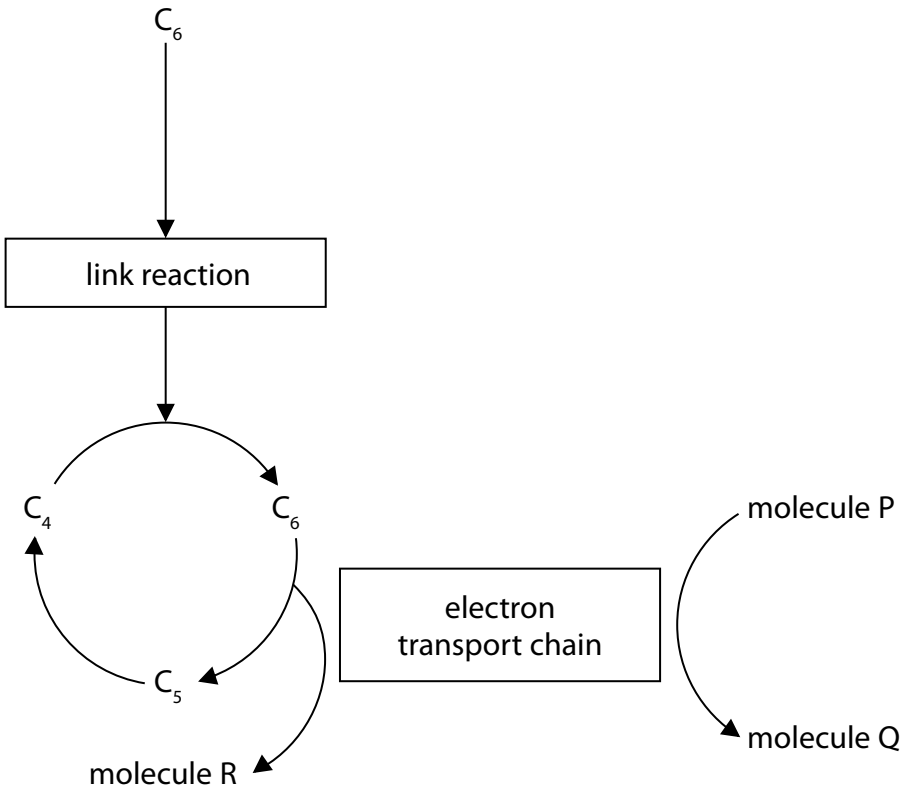
☒ **A** 11

☒ **B** 12

☒ **C** 22

☒ **D** 24

(d) The diagram shows some of the stages of aerobic respiration.



(i) Which row of the table correctly describes molecule R and molecule Q?

(1)

	Molecule R	Molecule Q
☒ **A**	ATP	oxygen
☒ **B**	carbon dioxide	water
☒ **C**	reduced NAD	carbon dioxide
☒ **D**	ATP	reduced NAD

*(ii) The last carrier in the electron transport chain is the enzyme cytochrome oxidase. Cyanide attaches permanently to the active site of this enzyme.

Explain why cyanide is a lethal metabolic poison.

(6)

(Total for Question 4 = 10 marks)

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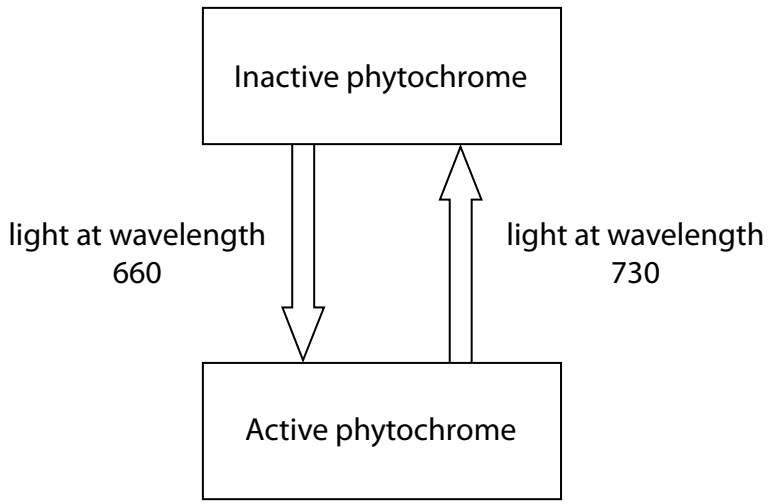
5 Phytochromes are photoreceptors found in many plants.

The diagram below shows the interconversion of inactive phytochrome (Pr / P660) and active phytochrome (Pfr / P730).



(a) Which row of the table correctly shows the light conditions that convert the active form of phytochrome back to the inactive form?

(1)

	Light condition		
	exposed to red light	**exposed to far red light**	**exposed to darkness**
☒ **A**	yes	no	yes
☒ **B**	no	yes	no
☒ **C**	no	yes	yes
☒ **D**	yes	no	no

(b) A study was carried out to investigate the effect of red light and far red light on the growth of flowers in a plant.

Plants were kept under two different light regimes, A and B. Regime A used red light and far red light at the same intensity. Regime B used red light and far red light but the red light was at a lower intensity. The intensity of the far red light was unchanged.

When the plants were fully grown, the dry mass of the flowers produced was measured.

This study was repeated using a new group of plants.

The results for the original study and the repeat study are shown in the table.

Study	**Mean dry mass of the flowers / g**	
	Regime A	**Regime B**
Original	58	45
Repeat	43	38

(i) Calculate the percentage difference between the mean dry mass of flowers in regime A with that in regime B in the original study.

(2)

Answer .....

(ii) Compare and contrast the results of regime A with regime B for both the original and repeat studies.

(2)

(c) The ability to grow long stems is important in woodland plants because longer stems increase the chance of the plant receiving light for photosynthesis.

Any plant in the shade of other plants will be exposed to more far red light than red light because other plants absorb most of the red light.

A student wrote the hypothesis:

'The length of a plant stem depends on the amount of red light or far red light they receive'.

Design an investigation the student could use to test this hypothesis.

(4)

(Total for Question 5 = 9 marks)

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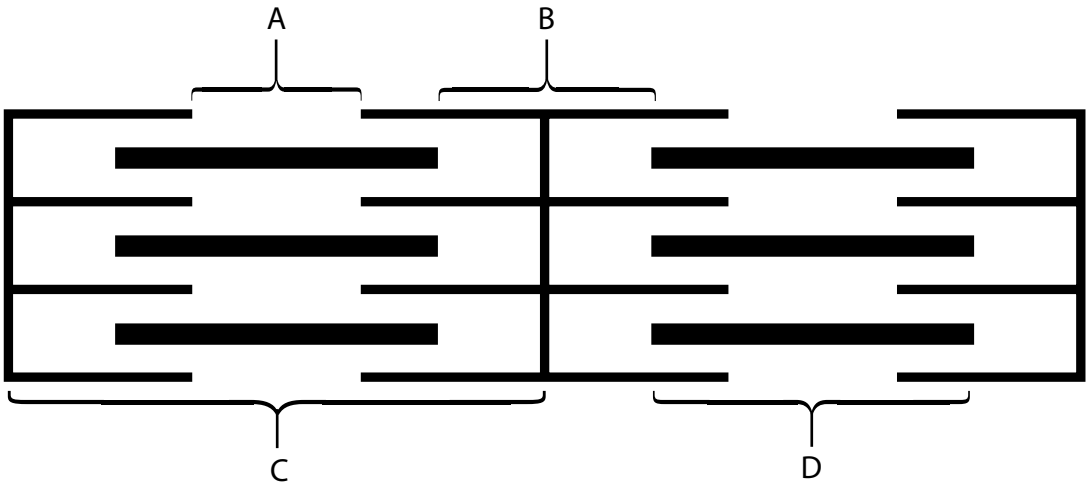
6 Muscles enable movement to take place.

(a) The diagram shows part of a muscle fibre.

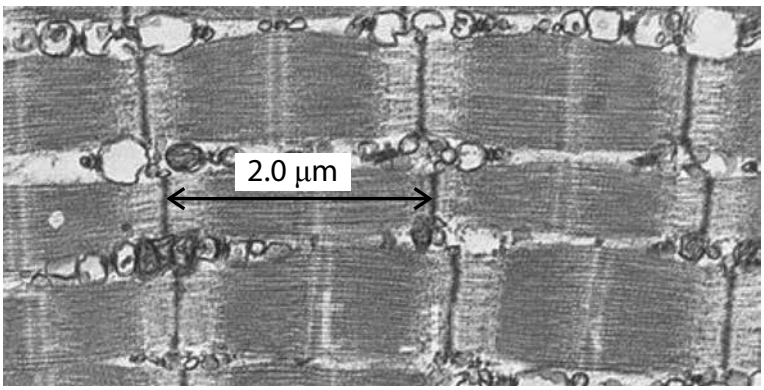


Which label on the diagram shows a sarcomere?

(1)

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

(b) The electron micrograph shows the arrangement of protein filaments in the contractile units of muscle myofibrils.



© P154/0217 Skeletal muscle, Biology Media/Science Photo Library

(i) Calculate the magnification of this electron micrograph.

(2)

Answer .....

(ii) The number of myofibrils in this electron micrograph is

(1)

- ☒ **A** one
- ☒ **B** three
- ☒ **C** six
- ☒ **D** nine

(iii) The electron micrograph shows the myofibrils in a relaxed muscle.

Explain how the appearance of this myofibril changes when a muscle contracts.

(2)

(c) Muscle tissue contains fast twitch and slow twitch fibres.

The table below shows the percentage of these fibres in two different people.

Person	Percentage of muscle fibre	
	Fast twitch	Slow twitch
A	80	20
B	50	50

Explain which person has muscles that are more resistant to fatigue.

(4)

(Total for Question 6 = 10 marks)

7 The response of an animal to a stimulus can change if the stimulus is repeated.

The photograph shows the head and part of the body of a marine worm that lives in a chalky tube.

© Johner Images / Alamy

The worm moves its head out of the tube to feed. The worm will withdraw into its tube if it senses danger and any change in length of the worm can be measured.

An investigation was carried out to study the response of ten worms to a moving shadow and to touch. Five of the worms were kept in their tubes and the other five were removed from their tubes. A shadow was moved over the worms and the decrease in length of each worm was recorded.

The investigation was repeated with another 10 worms but the stimulus used was touch instead of a moving shadow.

The results are shown in the table below.

Worms	**Mean decrease in length / cm**	
	Moving shadow	**Touch**
In tube	1.08	2.03
Not in tube	0.01	1.53

(a) Calculate the percentage difference in the response of the worms to touch.

(2)

Answer .....

(b) Analyse the data to explain the difference in the withdrawal response of the worms to the different stimuli.

(3)

(c) When the touch stimulus is applied several times to the worms, they learn to reduce the withdrawal response.

(i) Give **two** advantages for worms with this type of learning behaviour.

(2)

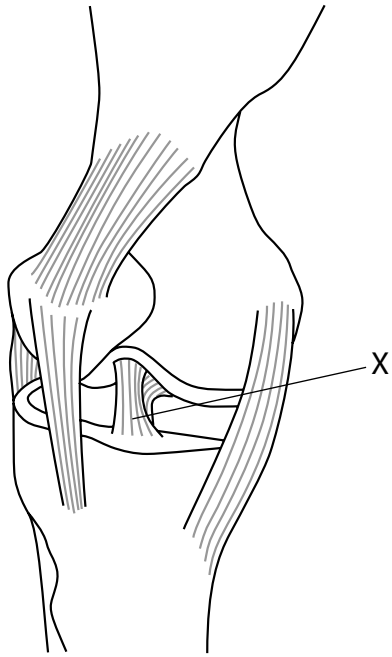
(ii) Explain how repeated touch stimulation reduces the withdrawal response.

(5)

(Total for Question 7 = 12 marks)

8 Movement at a joint is brought about by the contraction of antagonistic muscles which contain slow and fast twitch fibres.

The diagram shows a knee joint.



Lateral view of the knee

(a) Which tissue is used to repair structure X using keyhole surgery?

(1)

- ☒ **A** bone
- ☒ **B** cartilage
- ☒ **C** ligaments
- ☒ **D** tendon

(b) Explain why muscles occur in antagonistic pairs.

(2)

.....

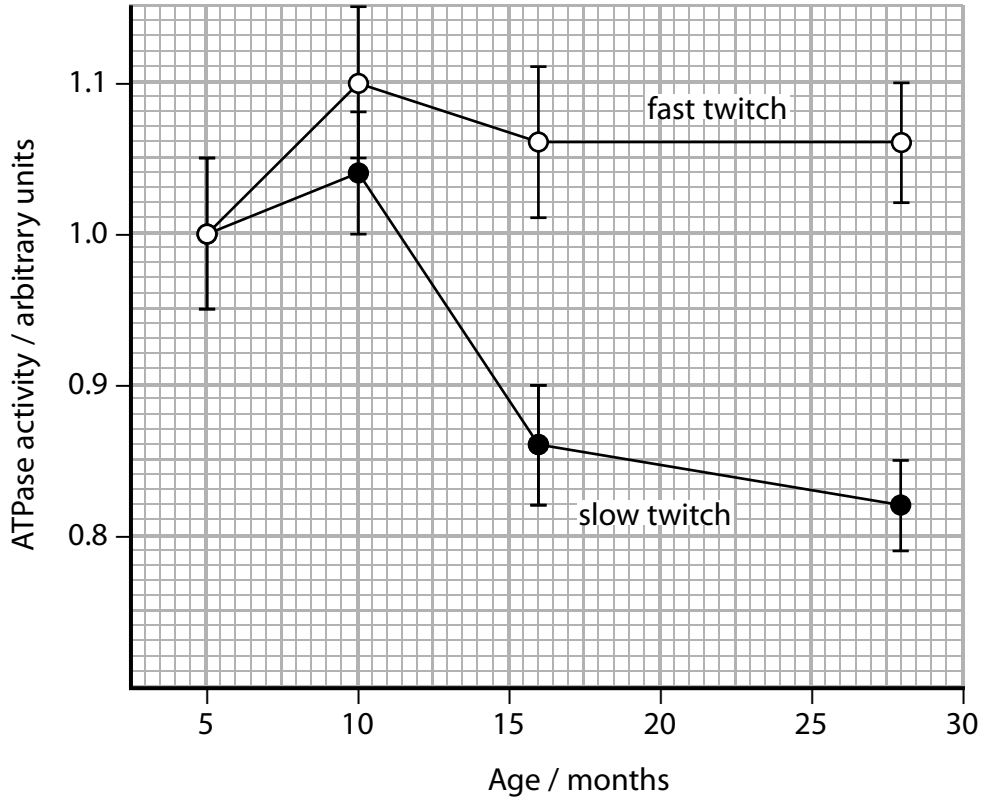
.....

.....

.....

(c) A group of scientists investigated the effect of aging on the Ca-ATPase activity in fast and slow twitch muscle fibres obtained from rats.

The results are shown in the graph.



The membranes in these fibres contain the enzyme Ca-ATPase which is involved in the transport of calcium ions.

The scientists concluded that in older muscle it takes longer to restore the calcium ion balance.

Analyse the data to evaluate whether these results support the scientists' conclusion.

(6)

.....

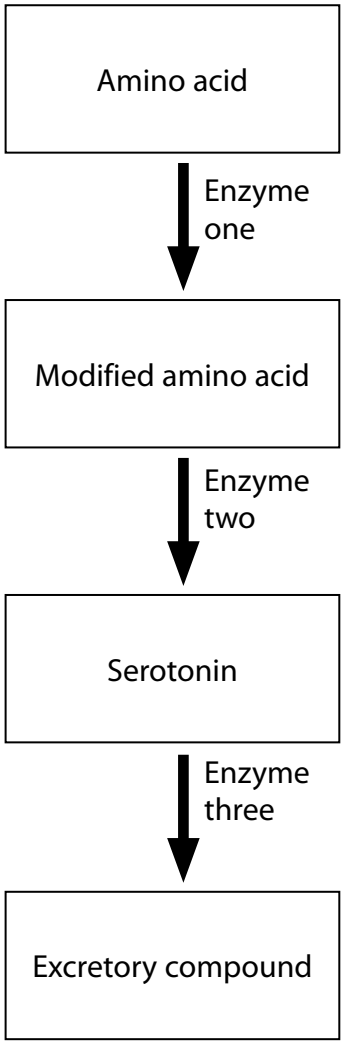
.....

.....

.....

(Total for Question 8 = 9 marks)

9 Serotonin is a neurotransmitter. It is kept at optimum levels to maintain a feeling of well-being. Serotonin is involved in the metabolic pathway shown in the flow chart.



(a) Explain how the level of activity of these enzymes, in this metabolic pathway, will ensure that optimum levels of serotonin are maintained.

(3)

(b) Drugs called selective serotonin re-uptake inhibitors (SSRIs) are used to reduce depression. They work by inhibiting the reabsorption of serotonin at a synapse.

Explain how SSRIs help to maintain a feeling of well-being.

(3)

(c) Extracts of the plant St John's wort have also been used to treat depression.

A double blind trial compared the effectiveness of treating depression using a SSRI, an extract of St John's wort, and a placebo.

Depression was measured using the Hamilton Rating Scale for Depression (HRSD). The higher the HRSD score the greater the depression.

The table shows the results of this trial.

Time / weeks	HRSD score		
	SSRI	St John's wort	Placebo
0	16	16	17
1	14	15	15
2	13	14	12
3	12	13	12
4	10	13	12
5	9	12	11
6	8	12	11
7	7	11	12
8	6	12	12

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

(1)

.....

.....

(ii) Analyse the data in the table to compare the effectiveness of these three treatments for depression.

(3)

(iii) Double blind trials give scientists confidence in the results collected.

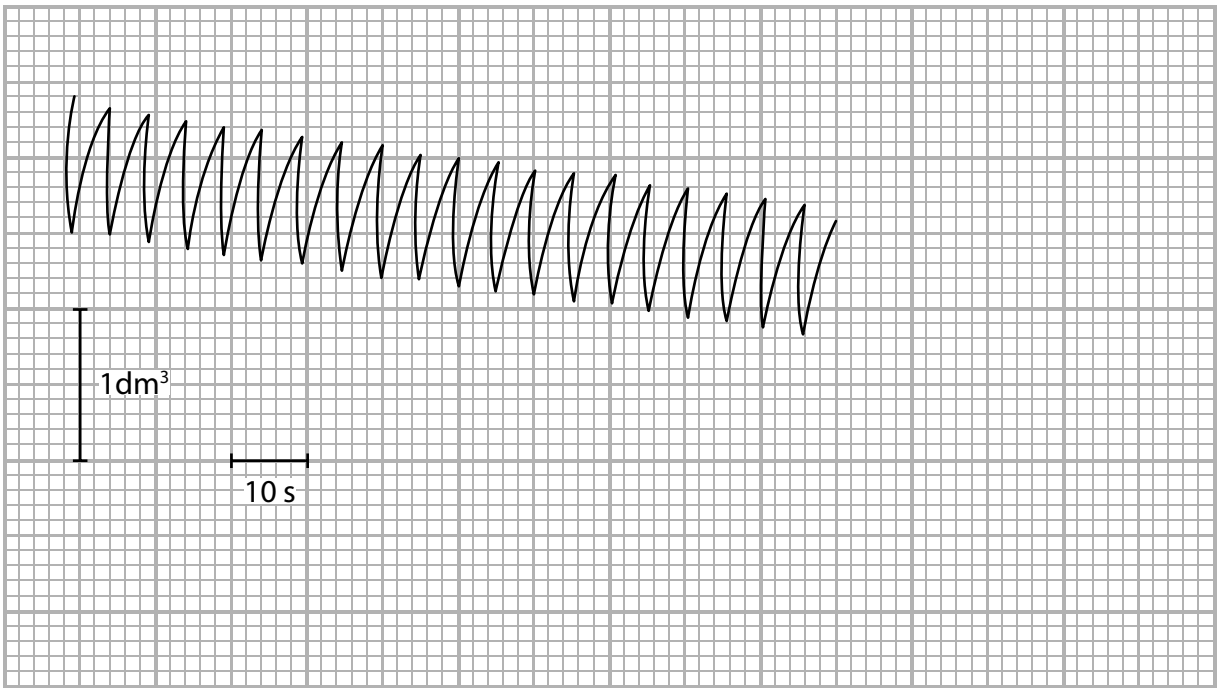
Explain **two** ways the design of this trial could be improved in order to increase confidence in the results.

(4)

(Total for Question 9 = 14 marks)

10 Exercise has an effect on oxygen consumption, the efficiency of ventilation and the risk of type 2 diabetes.

(a) A spirometer can be used to study oxygen consumption. The spirometer trace shown was obtained for a 90 kg male human at rest.



Calculate the mean rate of oxygen consumption at rest for this person.

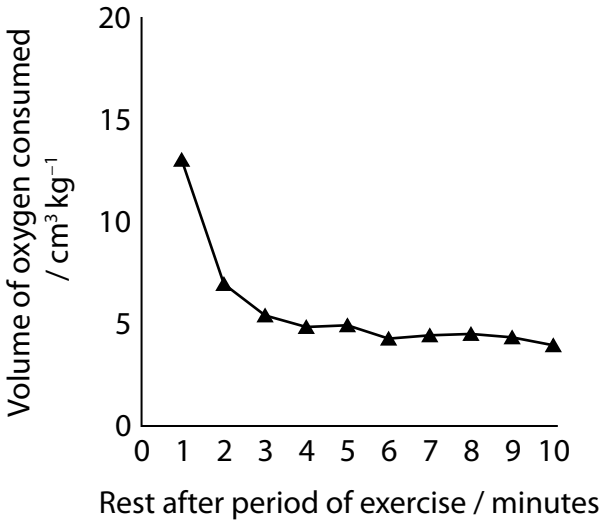
(3)

Answer ..... $cm^3\ kg^{-1}min^{-1}$

(b) A spirometer trace was used to measure the total volume of oxygen consumed by an athlete at rest. The oxygen consumed at rest was 4.0 $cm^3\ kg^{-1}min^{-1}$.

The athlete then did a period of intense exercise.

The graph shows the values for the 10 minutes of rest after the period of exercise.



(i) Explain the change in the oxygen consumption during the 10 minutes of rest after exercise.

(5)

(ii) Explain how the respiratory centre is involved in the control of ventilation rate in the 10 minutes of rest after exercise.

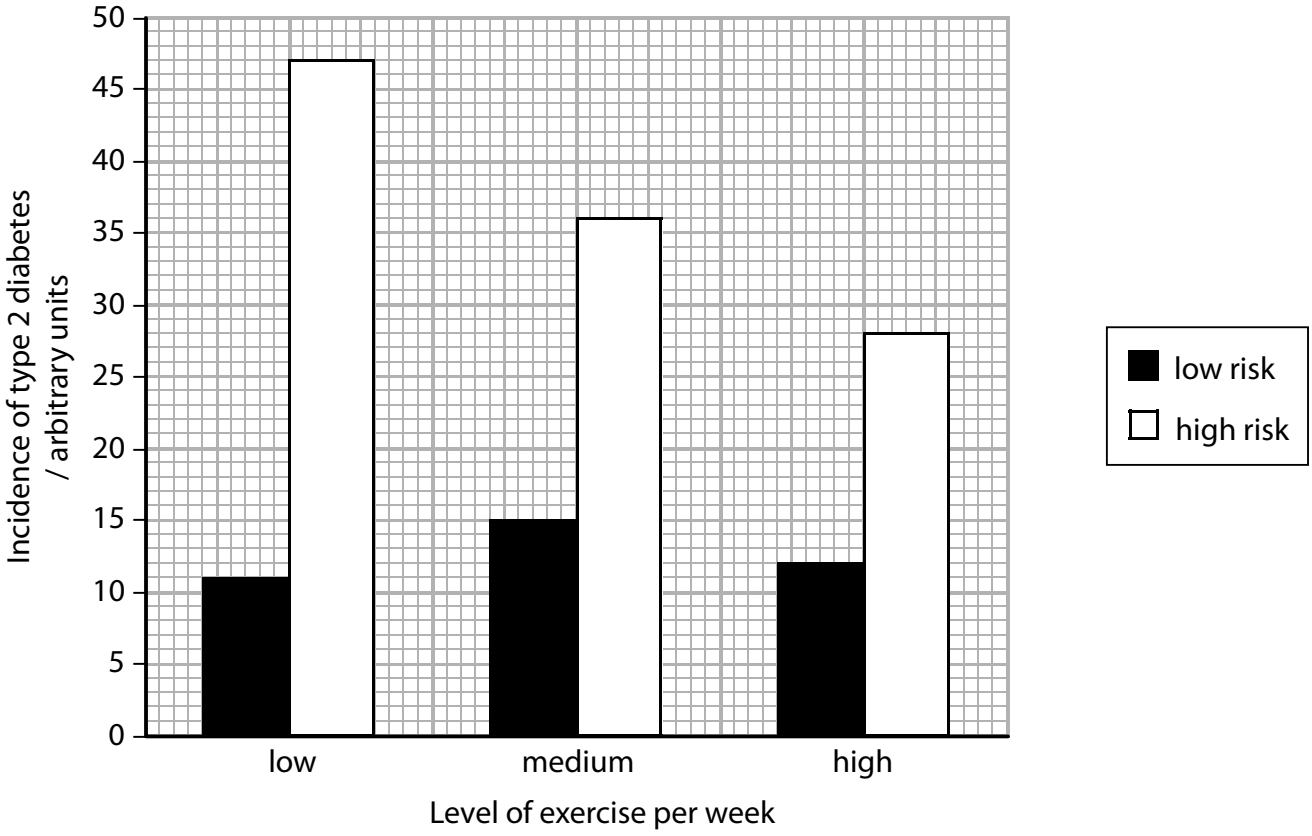
(5)

(c) The development of type 2 diabetes may be linked to lack of exercise.

The graph below shows the effect of exercise on the incidence of type 2 diabetes in two groups of men.

Men at low risk had no family history of developing type 2 diabetes. Men at high risk had a family history of developing type 2 diabetes.

The men were grouped according to their level of exercise per week.



Analyse the data to discuss possible correlation and causation in the relationship between the incidence of type 2 diabetes and the level of weekly exercise.

(4)

(Total for Question 10 = 17 marks)

TOTAL FOR PAPER = 100 MARKS

Question Number	Acceptable Answer	Additional Guidance	Mark
1(a)	• Idea that {cell body / centron} in middle / dendrites at both ends (1)		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
1(b)	An explanation that makes reference to five of the following: • reference to Schwann cells covering the axon in myelinated neurone (1) • {myelin/Schwann cells} provide insulation (1) • {action potential/depolarisation} at nodes of Ranvier (1) • local currents occur over a longer distance (1) • reference to saltatory conduction (1) • impulse jumps from node to node (1)		**(5)**

(Total for Question 1 = 6 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(a)	B		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
2(b)	An explanation that makes reference to three of the following: • MRI gives better resolution (1) • therefore more detail can be seen (1) • no use of X–rays (1) • therefore {safer / less risk of mutation / eq} (1) • therefore can be used more often (1)		**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
2(c)	An explanation that makes reference to the following: • increased neural activity of {cerebellum / cerebrum} (1) • more oxygen needed so increase in {blood flow / oxyhaemoglobin} (1) • less {radio wave / signal} absorbed (1)		**(3)**

(Total for Question 2 = 7 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(a)	17.0 ÷140 (1) =121.43 cm^3 (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
3(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
3(b)(ii)	D		**(1)**

(Total for Question 3 = 6 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)	B		**(1)**

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

Question Number	Acceptable Answer	Additional Guidance	Mark
4(c)	B		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
4(d)(i)	B		**(1)**

Question Number	Indicative content	
***4(d)(ii)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the 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 indicated as relevant. Additional content included in the response must be scientific and relevant. An explanation that makes reference to the following: • cyanide inhibits cytochrome oxidase so it can no longer accept electrons • electrons stop moving along the electron transport chain • so no movement of hydrogen ions into intermembrane space • so no movement of protons down gradient / no chemiosmosis • NADH/FADH can no longer give up electrons and regenerate NAD/FAD so Krebs cycle stops • so no production of ATP from Krebs cycle or electron transport chain • so cellular processes have no energy source / reference to named muscle contraction e.g. heart muscle being prevented	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented. Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows some linkages and lines of reasoning with some structure.

Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented. Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured.

(Total for Question 4 = 10 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(a)	C		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)(i)	58- 45 = 13 (13÷58)×100 (1) = 22.4% (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)(ii)	An answer that makes reference to the following: • mass higher in A (compared with B) for both studies (1) • the difference is less in repeat study / mass lower in repeats (of both A and B (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
5(c)	An answer that makes reference to four of the following points: • plants grown in pots containing same {soil / pH / minerals / water}as these factors can affect growth (1) • one group under lamp emitting red light and one group under a lamp emitting far red light / one group under lamp emitting red and far red light at same intensity and one group under lamp emitting far red light at higher intensity than red(1) • keep temperature the same in both as enzymes involved in growth (1) • reference to {several groups of pots / multiple plants} to ensure results are {reliable / suitable for valid statistical analysis} (1) • use {cloned / genetically identical} plants of same species as genes can affect growth (1)		**(4)**

(Total for Question 5 = 9 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)	C		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(i)	Length measured from diagram correctly (1) z-z line =3.0 cm then this is 3.0×10^{-3} M ÷ 2.0×10^{-6}m = 1500 magnification (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(ii)	B		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b) (iii)	An explanation that makes reference to the following: • actin and myosin molecules remain the same length (1) • these slide past each other / sarcomere is shorter / Z lines move closer together (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(c)	An explanation that makes reference to four of the following: • person B has more slow twitch fibres than person A (1) • slow twitch are more efficient at aerobic respiration because they have more mitochondria (1) • slow twitch have many capillaries to give good oxygen supply (1) • slow twitch have lots of myoglobin to store oxygen (1) • therefore less likely to build up lactate (1)		**(4)**

(Total for Question 6 = 10 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(a)	• 2.03 – 1.53 = 0.5 ÷ 2.03 x 100 (1) • = 24.63% (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
7(b)	An explanation that makes reference to three of the following: • moving shadow and touch are perceived as presence of {danger / predator} (1) • response to touch is greater than to shadow because touch perceived as {more dangerous/ closeness of predator} (1) • response in tube is greater than response out of tube because tube provides physical surface to assist {contraction/ withdrawal} (1) • worm has receptors and those for light generate less response than those for touch (1) • when out of tube, a shadow stimulus affects all of a worm but a touch stimulus affects part of a worm (1)		**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
7(c)(i)	An answer that makes reference to the following: • prevents wasting energy (1) • allows maximum feeding effort (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
7(c)(ii)	An explanation that makes reference to the following: • there is less response because there is less depolarisation of the post–synaptic membrane (1) • because there are fewer calcium ions entering the pre synaptic membrane so fewer vesicles fuse with the presynaptic cell membrane (1) • so less neurotransmitter diffuses across the synaptic cleft (1) • therefore less binding to the receptors on the post–synaptic membrane so fewer sodium channels open (1) • resulting in no {action potential / impulse} in the post–synaptic neurone leading to no withdrawal response (1)	Allow description of sodium ion movement	**(5)**

(Total for Question 7 = 12 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(a)	D		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8(b)	An explanation that makes reference to: • muscles can only work in one direction (1) Plus one from: • therefore a need to create opposite forces (1) • so must have extensors and flexors (1)		**(2)**

Question Number	Indicative content	
8(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the 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 indicated as relevant. Additional content included in the response must be scientific and relevant. *Supports* • this is true after 10 months because there is a significant decrease for the slow twitch • if muscle is {mainly slow twitch / has fewer fast twitch} • Ca-ATPase will take longer to transport calcium ions into the sarcoplasmic reticulum *Does not support* • ageing has {no / little} effect on fast twitch fibres • there is little difference between the fast and slow twitch up to 10 months • appropriate comment on the difference between the data related to the variation as shown by the error bars	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Limited scientific judgement made with a focus on one side of the argument only. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.
Level 2	3-4	A scientific judgement is made through the application of relevant evidence to both sides of the argument. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.

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.

(Total for Question 8 = 9 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
9(a)	An explanation that makes a reference to the following: • serotonin cannot be broken down faster than produced (1) • therefore activity of the two enzymes that produce serotonin must be similar to the activity of enzyme 3 (1) • one of the enzymes must be rate limiting (1)		**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(b)	An explanation that makes a reference to three of the following: • SSRIs bind to {channel / reuptake} proteins (1) • serotonin levels remain high in synapse (1) • serotonin binds to receptor proteins in post-synaptic membrane (1) • depolarisation of post-synaptic membrane (1) • {action potentials / impulses / transmission} continues (1)		**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(c)(i)	• neither patients nor {doctors /scientists / eq} know which treatment the patients were given (1)		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(c)(ii)	An answer that makes reference to three of the following: • idea that SSRI works best (1) • placebo works faster than SJW (1) • SJW and placebo effect {wear off / level / end at 12 / same final score / fall then rise / eq} (1) • correct comparative manipulation of figures to support analysis (1)		**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(c)(iii)	An explanation that makes reference to two of the following pairs: • use more patients / increase sample size / repeat the trial (1) • to increase reliability (1) **and/or** • consider sample selection to use same age / gender / ethnicity / lifestyle / health of patients (1) • to control biotic variables (1) **and/or** • extension of time for trial (1) • to ensure SSRIs continue to reduce HRSD score or not / SJW continue to decrease HRSD score or not (1) **and/or** • use of statistical analysis (1) • to see if the differences are significant (1)		**(4)**

(Total for Question 9 = 14 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
10(a)	volume change e.g. 0.5 dm^3 in 1 minute (1) correct conversion to ml from dm^3 (1) answer 500 ÷ 90 = 5.5 (1)	Correct answer gains full marks, no working shown	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
10(b)(i)	An explanation that makes reference to five of the following: • anaerobic respiration occurs during exercise because oxygen supply to cells is limited (1) • therefore glycolysis used to produce ATP (1) • glycolysis also produces lactate (1) • oxygen consumption is higher at end of exercise than at rest because lactate is converted back to pyruvate (1) • pyruvate enters Krebs cycle (1) • oxygen used in electron transport chain / oxidative phosphorylation as final hydrogen electron acceptor / to form water (1)	Allow some lactate is converted into glycogen (1)	**(5)**

Question Number	Acceptable Answer	Additional Guidance	Mark
10(b)(ii)	An explanation that makes reference to five of the following: • High CO_2 in the blood stimulates the respiratory centre (1) • Increase in lactate / fall in pH stimulates the respiratory centre (1) • Reference to chemoreceptors in the medulla/carotid bodies/aortic bodies (1) • More impulses sent to diaphragm and intercostal muscles (1) • Resulting in an increase in the rate and depth of breathing (1) • pH returns to normal as CO_2 is removed and ventilation rate decreases (1)		**(5)**

Question Number	Acceptable Answer	Additional Guidance	Mark
10(c)	An answer that makes reference to four of the following: • For high risk, an increase in exercise reduces incidence of type II diabetes (1) • For low risk, an increase in exercise has no effect on incidence of type II diabetes (1) • Reference to correlation in correct context (1) • A causal relationship is {shown by the high risk group and level of exercise / not shown by the low risk group and level of exercise} (1) • Other factors may cause type II diabetes, e.g. obesity, diet, age, ethnicity (1)	Accept high risk = family history low risk = no family history	**(4)**

(Total for Question 10 = 17 marks)

Pearson Edexcel Level 3 GCE

Biology A (Salters-Nuffield)

Advanced

Paper 3 - Pre-release material

Sample Assessment Material for first teaching September 2015

Paper Reference
9BN0/03

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PEARSON

Cheaters – drug abuse in sport

1 Lance Armstrong was a driven athlete, an American road racing cyclist who won a record number of races. The *Tour de France* is considered to be one of the toughest races, which Armstrong won a record seven consecutive times. However his career was dogged with speculation about doping – taking banned performance-enhancing substances. Although Armstrong strongly denied allegations of doping for many years, he finally admitted – in a televised interview with Oprah Winfrey in 2013 – that a deep flaw in his character, which he described as his "ruthless desire to win", led him to take banned substances throughout his career. He admitted to taking the hormones cortisone, testosterone and erythropoietin (EPO), and also to conducting blood transfusions to boost his oxygen levels. The United States Anti-Doping Agency (USADA) had formally presented evidence against Armstrong in 2012, including laboratory test results and evidence of financial payments. The Chief Executive of the USADA said at the time that this was, "the most sophisticated, professionalised and successful doping programme that the sport had ever seen." The Union Cycliste Internationale (UCI) subsequently disqualified Armstrong from all of his *Tour de France* races, stripping him of the titles and banning him from cycle road racing for life.

2 The media loved this Armstrong story; and sport is filled with similar stories about athletes prepared to use banned substances in their drive to win. George Mitchell named 89 Major League Baseball players in a report released in 2007 and based on 20 months of investigation into performance-enhancing drug use amongst players. "The illegal use of performance-enhancing substances poses a serious threat to the integrity of the game," the Mitchell Report said, and added, "Widespread use by players of such substances unfairly disadvantages the honest athletes who refuse to use them and raises questions about the validity of baseball records". So why do some athletes take banned substances? The risks are high: discovery often results in suspension from the sport we are led to believe they love, which can be career-damaging in itself. But it can be worse – Armstrong has had talks with US Justice Department officials about returning a proportion of the estimated US$40 million in sponsorship funding that his cycling team received. Some athletes have been jailed and others have died prematurely from conditions and complications associated with taking banned substances.

3 It's a cat and mouse game that the media are always keen to play. A game that's complex with high stakes and while the tests become ever more sensitive, the cheaters are always one-step ahead. Athletes understand the rewards of training hard and the elation of standing on the top of the podium. Depending on their discipline, athletes' main aim is to build muscle mass, strength and endurance and to increase the delivery (speed and amount) of oxygen to the working muscles. Training can achieve this for them, but the use of drugs can boost performance further. Additionally, they may also use drugs to mask pain, stimulate the body, relax, lose weight and of course, hide the use of other drugs. This article will look at the substances and techniques used by athletes, how drugs can affect the body, including side-effects, and how those responsible for testing are trying to keep up with the game, whilst always being at least one step behind.

Muscle mass and strength

4 Hypertrophy is the increase in size of an organ due to an increase in size of its component cells, rather than an increase in the total number of cells in the organ. Muscular hypertrophy is an increase in the cross-sectional area of individual muscle fibres, due to an increase in contractile proteins. Muscles adapt in this way when subject to increasing workloads during training sessions. Heart muscle can be developed through training, so that the heart can pump more efficiently, pushing out a greater volume of blood from its chambers with every pump and pumping more quickly. Skeletal muscle can also be developed through training by working faster and for longer periods. This is the aim of the athlete – to increase their strength and speed. Working faster – and for longer – is limited by the time it takes to move oxygenated blood from the heart to the exercising tissues, and so it is this process that is often targeted through drug use. If the speed of movement of oxygen from the heart to where it is needed can be increased, then athletes will be able to work harder over a longer time.

5 Athletes often use performance-enhancing drugs that are naturally-occurring molecules in the body, such as hormones. Taking more of these naturally-occurring substances will increase their effect. Although it is difficult to detect a substance that is found in humans naturally, increasing the levels of substances in the body can cause a range of side-effects, which can range from hardly noticeable effects to adverse or serious ones, and even death.

6 **Hormone-related substances** used by athletes to build mass and strength include:

- Anabolic steroids
- Beta-2 agonists
- Human growth hormones:
  - Human chorionic gonadotropin (HCG)
  - Luteinizing hormone (LH)
  - Human growth hormone (HGH)
  - Insulin-like growth factor (IGF-1)
  - Insulin

Anabolic steroids

7 **Anabolic steroids** build muscle and bone mass, as opposed to catabolic steroids, which break down tissues. Anabolic steroids work primarily by stimulating the muscle and bone cells to make new protein, thereby increasing muscle mass and also decreasing fat. This allows the athlete to train harder and for longer. They are manufactured drugs that mimic the effects of the male hormone testosterone, enhancing male reproductive and secondary sexual characteristics.

8 Anabolic steroids are usually injected into the muscle and often a 'cycling' method is used in order to avoid the undesirable side effects. 'Cycling' means that athletes inject the steroids for a period of time and then stop for a rest period, before starting, often synchronising the rest periods with when they are expecting to be tested, so that the tests do not detect the increased levels of the drugs.

9 Some athletes use additional steroids simultaneously, in the belief that this increases the effectiveness. This method is known as 'stacking'. Some athletes combine cycling and stacking methods, this is known as 'pyramiding'. The drug dosage is gradually increased over a period of weeks and then slowly reduced again to nothing, to allow the body a rest period, before repeating. The idea is to train harder whilst taking the drugs to maximise their effects.

10 The unwanted physiological side effects of steroid use include heart attack or stroke; tumours on liver and kidney; high blood pressure (hypertension); blood clots; fluid retention and high cholesterol. In addition, in men the following effects have been seen: reduced sperm count; infertility; shrunken testicles; baldness and breast development. In women it causes a range of male features, including hair growth on face and body; reduction of breasts; deepening of voice and menstrual problems. In addition, both men and women have experienced the psychological effects of aggressive behaviour, mood swings, manic behaviour, hallucinations and delusions.

11 Anabolic steroids are addictive – athletes may experience cravings. Habitual users will require more and more of the drug to achieve the same effect and if use is suddenly stopped, they will experience withdrawal symptoms, which may include depression and apathy; feelings of anxiety; difficulty concentrating; insomnia; anorexia; decreased sex drive; fatigue (extreme tiredness); headaches; muscle and joint pain. An addict will keep using a drug, despite its side effects.

12 Many people take anabolic steroids in the misguided belief that it will help them become fit and healthy. Adolescent boys and young men often take steroids when they consider their body not to be sufficiently big or strong. Steroid misuse is widespread in many sporting areas. Bodybuilders take them to increase bulk and strength and athletes are under even more pressure to perform, especially those requiring strength and endurance, such as weightlifters.

Beta-2 agonists

13 **Beta-2 agonists** mimic the action of adrenaline and noradrenaline that are secreted by the sympathetic nerves. They are inhaled by asthma patients to relax the smooth muscle in the airways. Asthma is chronic inflammation of the airway. It is an over-reaction to external stimuli, such as dust and pollution and can lead to bronchoconstriction. There is a genetic element to asthma and it is one of the most common chronic disorders, found in about 5% of the adult population. However, it is more common amongst athletes, found in around 10–20% of the population. This may be due, for winter sports athletes, to inhaling cold, dry air; and in the case of swimmers, where it is particularly prevalent, of training in chlorinated atmospheres. Additionally, asthmatic symptoms may be triggered by acute physical exercise, which is described as 'exercise induced asthma' (EIA).

14 If something is described as being 'ergogenic', it is intended to enhance physical performance, stamina, or recovery. In 2006, Kindermann and Meyer published the results of a review that they had carried out and concluded that "there is no ergogenic potential of inhaled beta-2 agonists in non-asthmatic athletes" and went on to recommend that "the inclusion of inhaled beta-2 agonists on the list of prohibited substances should be reconsidered".

15 The USADA Prohibited List for 2014 specifically bans all oral beta-2 agonists. It allows the use of three inhaled beta-2 agonists, but states the exact dosing that must not be exceeded. If these doses are to be exceeded then written medical consent is required, as it is for other beta-2 agonists for therapeutic use.

16 Athletes believe that when beta-2 agonists are injected into the bloodstream they have an anabolic effect (build muscle mass) and a catabolic effect (reduce body fat). They actually act to constrict blood vessels and cause a range of side-effects: constriction of blood vessel in the brain causes feelings of nausea, headaches and dizziness; constriction of blood vessels in muscles causes muscles cramps. They also stimulate heart rate, causing rapid heartbeats or flutters.

Human Growth Hormones

17 **Human chorionic gonadotrophin (HCG)** is a glycoprotein hormone which is produced in large amounts during pregnancy by the developing foetus. It is the substance that most home pregnancy test kits detect. It is not banned for female athletes, who, if pregnant, may have naturally high levels in their body.

18 Some male athletes use manufactured HCG before competition to stimulate testosterone production. It is also used to prevent infertility and testicular shrinkage to counter the effects of prolonged steroid use, ironically, as the side effects are similar to those of steroid use.

19 **Luteinising hormone (LH)** is a peptide hormone which plays an important role in maintaining normal levels of testosterone (in the male) and oestrogen (in the female). Work published by Warren in 1999 evidenced 'exercise induced amenorrhea' (absence of a menstrual period in a woman of reproductive age) in female athletes due to environmental and metabolic stresses, mainly low calorie, low fat diets, which led to the suppression of levels of LH and follicle stimulating hormone (FSH). In male athletes, excess LH or its artificial derivatives increase testosterone levels and possibly cause similar side effects to those of anabolic steroids. They are banned for male athletes.

20 **Human growth hormone (HGH)** is a naturally-occurring protein hormone which is made and secreted by cells in the anterior pituitary gland located at the base of the brain. It is involved with cellular metabolism and is important for normal growth and development.

21 The major role of HGH in body growth is to stimulate the liver and other tissues to secrete insulin-like growth factor (IGF-1), which in turn stimulates production of cartilage cells, resulting in bone growth. It also plays a key role in muscle and organ growth.

22 HGH has ergogenic, (performance-enhancing) anabolic (increasing muscle mass and bone growth) and catabolic (breakdown of fat cells) effects. Additionally, it enhances the anabolic power of steroids. HGH was difficult to detect and thus was becoming more and more popular, despite its side effects, which include acromegaly. This is the name given to enlarged face, hands and feet and enlarged internal organs, particularly the heart, kidneys, liver and tongue. In 2010, there was a blood-testing innovation that led to the suspension of a British rugby player who tested positive for HGH.

23 **Insulin-like growth factor (IGF-1)** also known as somatomedin-C, is an important protein growth hormone. It has an independent growth-stimulating effect on cartilage cells and Laron (2001) reported a possibility that this effect may be optimised by a synergistic action with HGH. Again, it also has anabolic and catabolic effects. Side effects are similar to those seen with HGH and also include hypoglycaemia (low blood sugar).

24 **Insulin** is a naturally-occurring peptide hormone produced by beta cells in the pancreas. It is vital in the regulation and metabolism of sugars, starches, fats and proteins, as it controls absorption of glucose from the blood. This absorbed glucose is stored in the liver and muscle as glycogen and stops the body from using fat as a source of energy.

25 When there is very little insulin in the blood, or none at all, glucose is not taken up and so our body uses fat as a source of energy. Athletes take insulin in combination with anabolic steroids or HGH to increase muscle mass by stimulating protein synthesis. Side effects are mainly associated with low blood sugar levels – shaking, nausea and weakness, however, excessive hypoglycaemia can lead to coma and even death.

Oxygen Delivery

26 The three main methods to increase the amount of oxygen in the tissues are the use of protein hormones, artificial oxygen carriers or blood doping.

Protein hormones

27 **Erythropoietin (EPO)** is a glycoprotein hormone, made in the kidney, that controls red blood production (erythropoiesis) in the bone marrow. EPO is released when blood oxygen levels are low to stimulate the production of red blood cells, which increase the delivery of oxygen to the tissues and organs, including the kidney. The use of EPO by endurance athletes (e.g. cross-country skiers, marathon runners and cyclists) can significantly increase their oxygen supply and its use is difficult to detect.

28 The use of EPO by athletes causes increases to their blood density, so that their blood has a constituency more like honey than water. This 'thick' blood does not flow easily and the heart must work much harder to pump the blood around the body, thereby increasing the risks of heart attack and stroke.

29 The first test for EPO was introduced at the Sydney Olympics in 2000. Synthetic EPO produces smaller than normal red blood cells, which bind more iron than natural EPO. By looking at the size of the red blood cells and their iron content, it can be established whether an athlete has taken EPO.

Artificial Oxygen Carriers

30 These are manufactured substances that mimic the role of haemoglobin. They are used legitimately by medical professionals to treat people experiencing breathing difficulties, such as premature babies, deep-sea divers and casualties with severe lung injuries. They are based around substances such as perfluorocarbons (PFCs), synthetic or modified haemoglobins and liposome-encased haemoglobins, and have the ability to carry oxygen in the body.

31 Schumacher *et al* (2001) investigated the effects of "solutions based on recombinant, bovine or human haemoglobin and perfluorocarbon-emulsions" and their tests on animals and humans demonstrated improved oxygen delivery to the muscle and thus improved aerobic exercise capacity. However, side effects are serious and can be lethal, including nephrotoxicity (kidney damage that result in the kidney no longer being able to eliminate urine and wastes); high blood pressure and problems associated with the immune system.

Blood doping

32 **Homologous blood transfusion (HBT)** is storing someone else's blood (with the same blood type), which is then injected into you when required. By contrast, autologous blood doping is the transfusion of your own blood, which has been stored (refrigerated or frozen) until needed.

33 Athletes have been using blood doping techniques to cheat for several decades and a test for homologous blood was implemented at the 2004 Summer Olympic Games in Athens. The World Anti-Doping Agency (WADA) is currently funding research projects to develop a test for autologous transfusions.

34 Unofficial blood transfusions can have serious medical consequences. Without proper screening, another person's blood may contain a virus, such as HIV. Blood also needs to be handled and stored correctly and the transfusion procedures carried out in a proper manner, in order not to put the recipient at significant health risks. Increased blood volume causes high blood pressure and increases the risk of heart attack, stroke, and pulmonary or cerebral embolism.

Pain

35 Injuries are an inevitable part of training, especially at high intensities for prolonged periods, such as undertaken by top athletes. Careers can be plagued with and hampered by injuries, which can also end careers prematurely. The sensation of pain is usually a signal for us to stop what we are doing, because something is wrong with our body: continuing may cause further damage. Athletes sometimes try to mask their injury pain with drugs, including narcotics, adrenal cortex hormones and local anaesthetics, in order to continue competing and performing beyond their normal pain threshold.

36 **Narcotics** use in sport is banned because this class of drugs impair athletes' judgment in potentially dangerous situations. Athletes have been known to use morphine, methadone and heroin. Narcotics are highly addictive and cause mental impairment, including judgement, balance and concentration as well as potentially long-term mental health issues.

37 **Adrenal cortex hormones**, such as adrenocorticotropic hormone (ACTH) are protein hormones that work to reduce injury-related inflammation and allergic reactions. ACTH is secreted by the pituitary gland and stimulates the production of hormones from the adrenal cortex. They are used by athletes to increase the production of androgens by the adrenal glands to mask injury pain. However, this also raises cortisol levels, which increases the production of glucose and which in turn raises blood glucose levels. Common side effects include stomach pains, nausea and vomiting; indigestion and weight gain; skin problems and facial swellings; irregular heartbeat, menstrual problems, muscle cramps and irregular bruising and poor healing as well as mental health problems including tiredness, hallucinations, confusion, excitement, restlessness and mood swings.

38 **Local anaesthetics** mask pain in just one area of the body, such as a dentist would use to numb an area of the mouth, without mental impairment (the dentist's patient is conscious). The main issue with their use is that, in masking pain, the athlete may further aggravate an injury. Although WADA currently does not ban the use of local anaesthetics in sport, there is the question of whether reducing or eliminating pain constitutes a performance-enhancing intervention.

Coping with stress

39 **Stimulants** are used by athletes living within strict social rules and training regimes to cope with general fatigue, to help keep them alert, to reduce tiredness and maintain aggressiveness. Commonly used stimulants include caffeine, amphetamines and cocaine, which cause the heart to beat faster, breathing rate to increase and give an increase in mental alertness. There are, of course, the inevitable side effects, including shaking, nervousness, irregular heartbeats, high blood pressure, convulsions and even death.

40 **Relaxants** are taken by some athletes to cope with a stressful timetable, strict social and dietary guidelines and the pressures of competition. **Alcohol** reduces activity in the brain and nervous system and is regularly used by many people to help them relax. It can significantly impair mental functions (judgement, balance, coordination), especially in excess and is restricted by the International Olympic Committee (IOC) and banned altogether in certain events. Meanwhile **beta-blockers** are permitted, by prescription, for athletes competing in archery and shooting competitions and other sports that require a steady hand. They are used to treat high blood pressure and work by slowing down the heart and relaxing the blood vessels. Not surprisingly, side effects include a slow heart rate, leading to fatigue and hypotension (low blood pressure).

41 The clinical value of **cannabinoids**, such as marijuana, still has to be proven, but they are said by some people to relieve pain and are used as a relaxant. Side effects include hallucinations, drowsiness, increased heart rate, impaired judgement, balance, coordination and memory.

Drug testing

42 Urine tests can detect many of the drugs used by athletes. Collecting urine samples from athletes is the responsibility of a drug control officer, who sends the sample for laboratory analysis. The test results are sent directly to the governing sports agency. Blood samples are also sometimes required for detection of certain drugs. Athletes often take additional substances to mask the use of banned drugs, although these are often banned themselves because of their masking effects.

One of the difficulties of drug testing is that the governing bodies and testing technicians have to know what to look for to be able to devise detection tests. This means that when new or different drugs start being used, a new test has to be developed to detect it and this takes time.

Masking drugs in the urine

43 **Diuretics** increase the rate of urine flow and sodium excretion to regulate the volume and composition of body fluids and are a prescribed drug for high blood pressure. They can mask the presence of other banned substances in the urine because they act on the kidneys, increasing the amount of urine produced and thereby diluting the concentration of other drugs. Diuretics are particularly favoured by athletes who are subject to weight restrictions, including jockeys, weightlifters and rowers, because urine excretion results in rapid weight loss: a convenient trick just before your weigh-in.

44 **Secretion inhibitors** prevent certain proteins from being secreted in urine and thus not be detected in urine tests. Side effects include nausea, vomiting, kidney problems and allergic reactions.

Masking drugs in the blood

45 **Epitestosterone** is a natural steroid, which is used to mask the use of testosterone and has been banned for this reason by many sporting authorities, even though it has not been shown to enhance performance itself. Testosterone is tested for by determining the ratio of testosterone to epitestosterone in the blood (T/E ratio). By injecting epitestosterone, the T/E ratio is lowered from the 1:1 ratio expected in healthy male adults.

46 **Plasma expanders** are injected by athletes to increase the volume of the fluid component of their blood and thus reduce the concentration of drugs in their system. They are used by medical professionals in the treatment of victims of shock, trauma and surgery. Side effects are mainly limited to allergic reactions.

Gas chromatography and mass spectrometry tests

47 Gas chromatography (GC) and mass spectrometry (MS) together provide powerful chemical analysis. Urine and blood samples given by athletes are subjected to these methods to detect numerous drugs.

48 **The gas chromatography test** separates all of the components in a sample. This is done by first injecting the sample into the GC machine, where the sample is vaporised in a gaseous solvent. Each substance dissolves differently in the gas and stays in the gas phase for a different length of time. This period is called the 'retention time' and is unique and specific to each substance, helping to differentiate and identify each component. The different retention times are due to different chemical and physical characteristics of the molecules, causing them to travel through the GC column at different speeds. Small, low mass molecules may travel more quickly that larger, heavier molecules. The shape of the molecules will also affect the speed at which they travel through the column, as will interaction between substances, which can increase or decrease their speed. Each component of the sample is absorbed onto a solid or liquid when it comes out of the gas phase and is analysed by a detector in the GC machine, which then provides a print out or digital image of the retention times, called a chromatogram. The location of the peaks in the sample's chromatogram are compared with standard chromatograms of known substances in order to identify and quantify the specific drugs in the athlete's sample. The size of the peaks is proportional to the quantity of the substance in the sample being analysed.

49 **Mass spectrometry** identifies substances by electrically charging the sample molecules with an electron beam and accelerating them through a magnetic field. This blows apart the molecules into charged fragments and these different charges are detected. A spectral plot displays the mass of each fragment, which is unique to that substance and can be identified against plots for known substances. These fragment masses are used to determine the mass of the original molecule, and hence its quantity.

Immuno-assays

50 These are quick and accurate tests that can be carried out on-site to detect specific molecules. The sample is mixed with a solution containing antibodies specific to the target substance and relies on the capacity of the antibodies to bind to the specific structure of a molecule. The antibodies in the test are usually labelled – either with a fluorescent dye or a radioactive substance. In this way the amount of the target substance in the sample can be determined by measuring the level of fluorescence or radioactivity.

51 **WADA is pioneering a new approach to drug detection** in the development of the Athlete Passport. This strategy moves away from individual substance detection, by instead monitoring athletes over time to gain a profile of their system, by recording selected variables. The effects of doping can then be revealed through the detection of abnormal variations. New WADA guidelines came into effect on 1st January 2014 to detect steroid doping by monitoring selected urinary steroid concentrations over time. Others are planned to be introduced as soon as they are ready.

All sporting governing bodies and anti-doping agencies have a hard task ahead of them in trying to keep sports clean; despite athletes, coaches and managers insisting that most competitors do not take drugs. Nevertheless drug testing is now an integral part of competition with routine testing of winners and random testing of others. The pressure on athletes to perform and achieve is huge and the rewards can be equally sizeable – not least through financial rewards or celebrity status – although careers can be very short.

52 The pressure has always been there and even athletes in ancient Greece were willing to take medicinal preparations that gave promises of improved performance. In 1967, Dr Gabe Mirkin asked 100 runners a question that has now also become known as 'Goldman's dilemma'. Goldman repeated the question to athletes in combat and power sports, and observed similar results i.e. over half of athletes replied in the affirmative. What was that question? "If I could give you a pill that would make you an Olympic champion – and also kill you in a year – would you take it?"

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Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Biology A (Salters-Nuffield)

Advanced

Paper 3: General and Practical Applications in Biology

Sample Assessment Material for first teaching September 2015

Time: 2 hours

Paper Reference **9BN0/03**

You may need a ruler, pencil and a calculator.

Total Marks

Instructions

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

Information

- The total mark for this paper is 100.
- 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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PEARSON

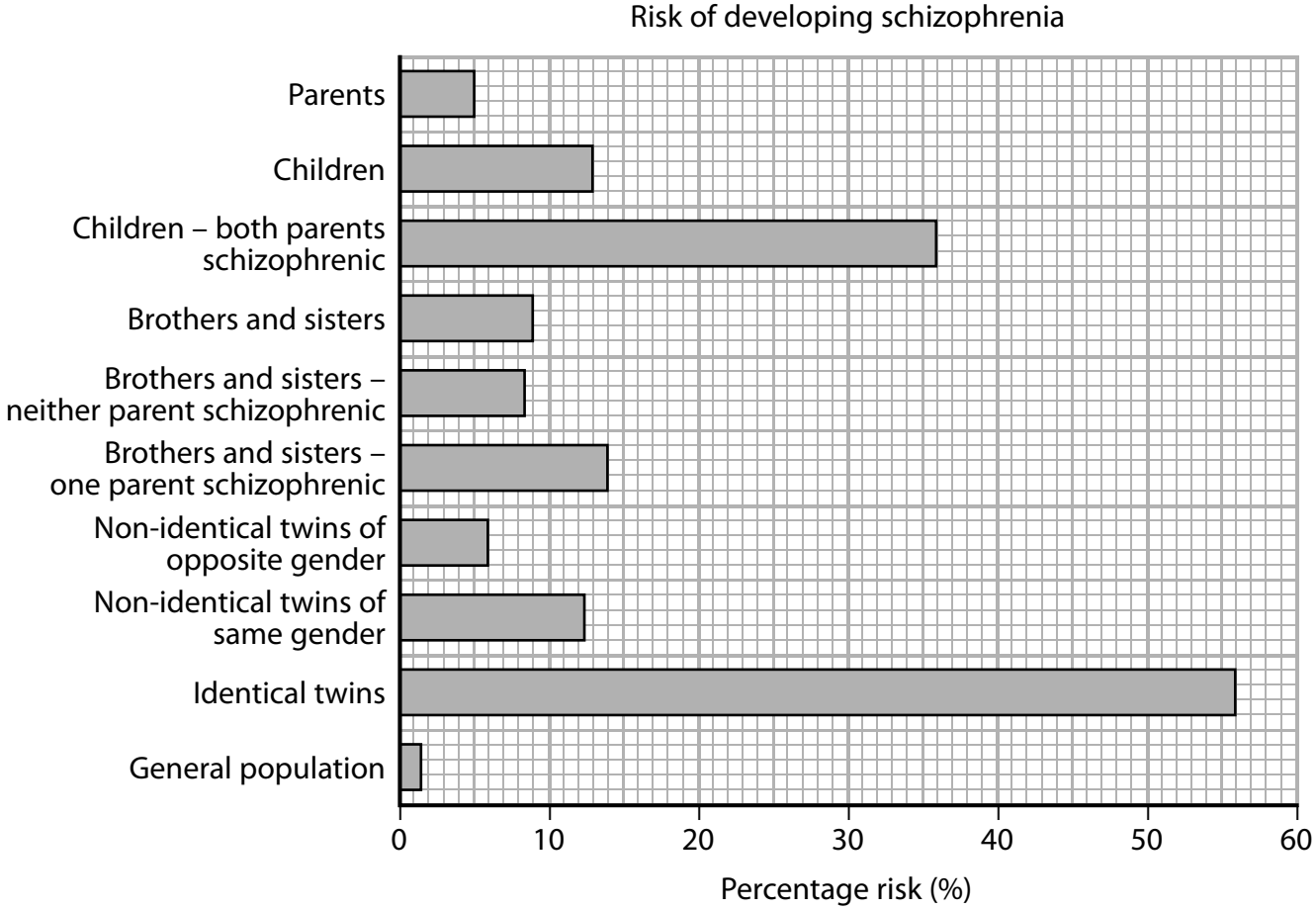
Answer ALL questions.

Write your answers in the spaces provided.

1 Schizophrenia is a disorder that affects brain structure and function and has a variety of symptoms.

The bar graph shows how the relationship to a family member suffering from schizophrenia affects the risk that the individual will also develop schizophrenia.

The percentage risk of schizophrenia in the general population is included for comparison.



(a) Explain the difference between the percentage risks of developing schizophrenia in identical twins and non-identical twins of the same gender.

(2)

(b) Some early studies of schizophrenia included identical twins raised in separate families.

(i) Explain how the design of these studies allows the influence of environmental factors on the development of schizophrenia to be investigated.

(2)

(ii) The conclusions based on these early studies of identical twins raised in separate families are said to lack validity.

Give **two** reasons why these studies may lack validity.

(2)

(c) Schizophrenia has been linked to abnormally high levels of a neurotransmitter in the brain.

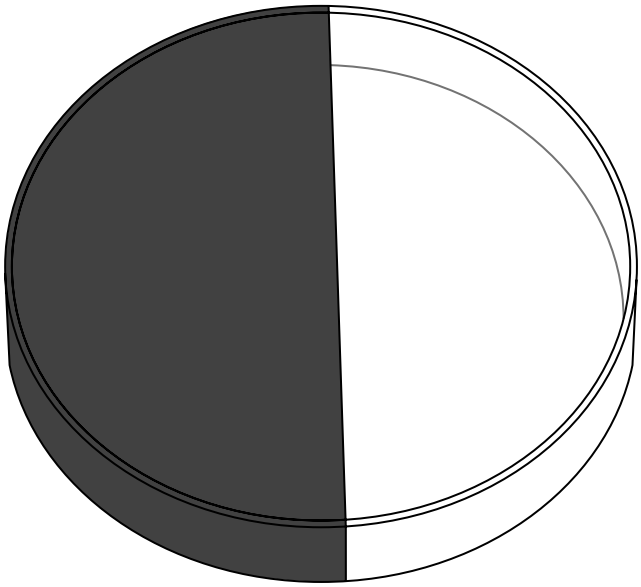
Explain how the action of the drugs used to treat schizophrenia may lead some patients to experience symptoms similar to those of Parkinson's disease.

(5)

(Total for Question 1 = 11 marks)

2 Blowfly larvae can be used by a forensic scientist to help determine the time of death of a body.

The diagram shows a Petri dish used by a student to investigate whether young and old blowfly larvae show a preference for light or dark conditions.



In the first trial, the left side was dark and the right side was light.

Five blowfly larvae were added to each side of the chamber.

After five minutes, the number of larvae on each side of the Petri dish was recorded.

In the second trial, the same experiment was repeated but this time the right side was dark and the left side was light.

The table shows the results of the trials.

Trial	Number of young blowfly larvae		Number of old blowfly larvae	
	Left side dark	Right side light	Left side dark	Right side light
1	9	1	2	8
2	2	8	9	1

(a) Give a null hypothesis for this investigation.

(1)

.....

.....

(b) The Chi squared test can be used to determine whether the results of this investigation indicate a significant difference in the distribution of young larvae between the light and the dark side.

(i) Use the formula to calculate the Chi-squared value for young larvae.

(3)

$$\chi^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

Answer .....

(ii) The table below gives some critical values for Chi-squared.

p value			
0.15	0.1	0.05	0.025
2.07	2.71	3.84	5.02

Use your calculated value to determine whether the difference between the observed and expected results is significant.

(1)

.....

.....

(c) Forensic scientists measure the length of larvae found in the tissues of a dead person to help them determine time of death. Older larvae are longer than younger larvae.

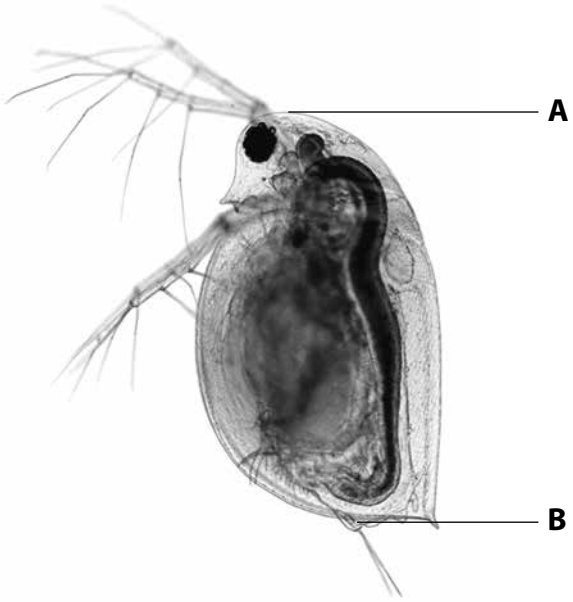
The growth of insect larvae can be affected by a number of factors including toxins.

Explain a procedure that you could use to find out if the presence of a toxin in a sample of dead tissue could affect the accuracy of estimating time of death.

(5)

(Total for Question 2 = 10 marks)

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



Magnification ×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.

Daphnia	**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.

(2)

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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.

(3)

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

(4)

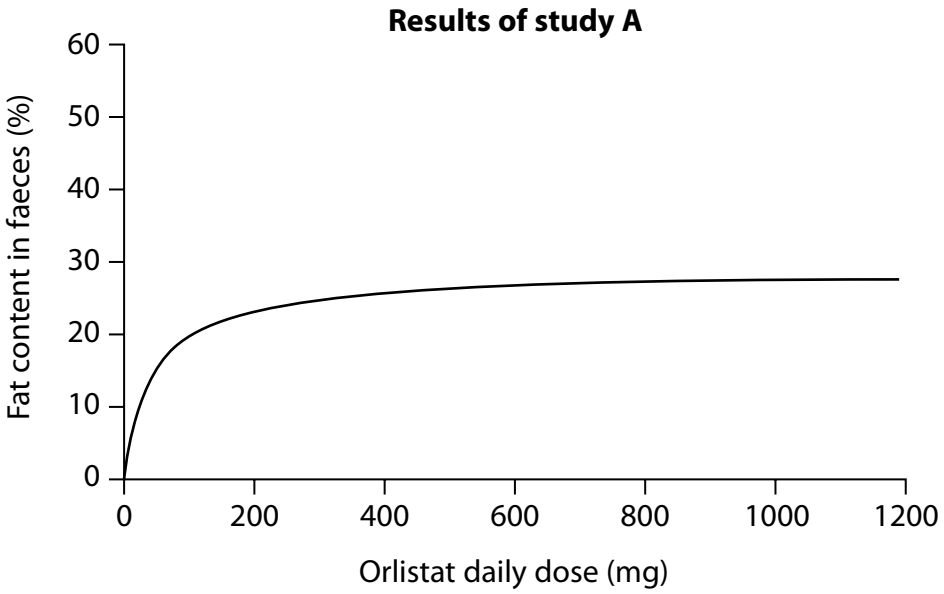
(Total for Question 3 = 13 marks)

4 Obesity is a risk to health.

There is a drug called Orlistat that can help obese people to lose weight. This drug works by permanently attaching to the enzyme lipase.

Two studies, A and B, were carried out to investigate the effectiveness of the drug.

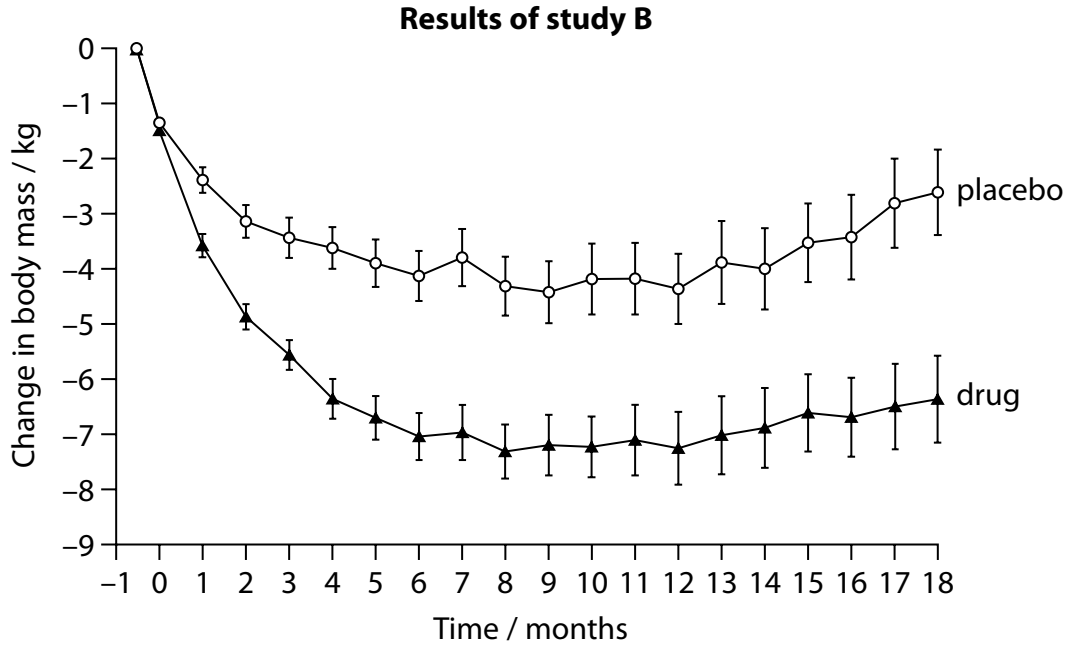
In study A, 20 people were given different concentrations of the drug and the fat content of their faeces was measured. The graph below shows the results.



(a) Analyse the data in the graph to explain how the drug helps obese people to lose weight.

(5)

(b) Study B was a placebo-controlled study. The change in body mass of 300 patients was measured over a period of 18 months. The graph below shows the results.



Explain how the data in study B show that the design of study B is better than the design of study A.

(4)

(c) (i) A high body mass index (BMI) is an indicator of obesity. Use the formula for BMI to calculate the height of a person with a mass of 80 kg and a BMI of 31.25.

(3)

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

Answer .....

(ii) The table shows the percentage decrease in the BMI of 350 people who took the placebo and a group of 350 people who took the drug daily for a period of 12 months.

Treatment	Percentage decrease in BMI (%)	Percentage decrease in body mass (%)
Drug	26.5	19.0
Placebo	15.7	11.7

Give **one** reason why the percentage of people with a decrease in BMI is higher than the percentage of people with a decrease in body mass.

(1)

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(iii) Explain the health risks of having a very high BMI.

(5)

(Total for Question 4 = 18 marks)

5 There have been several studies into the relationship between cigarette smoking and deaths from lung cancer. The data in the table comes from a review of these studies.

Country	Size of study	Number of deaths from lung cancer	Ratio of smokers to non-smokers dying from lung cancer
UK	34 000 males	441	14.00
	6 194 females	27	5.00
Sweden	27 000 males	55	7.00
	28 000 females	8	4.50
Japan	122 000 males	940	3.76
	143 000 females	304	2.03
Canada	78 000 males	331	14.20
USA	358 000 males	2018	8.53
	483 000 females	439	3.58
USA	290 000 males	3126	11.28
USA	188 000 males	448	10.73
USA	68 000 males	368	7.61

(a) Give **two** reasons why the ratios of smokers to non-smokers who die from lung cancer are different for males compared with females.

(2)

(b) These studies suggest that there is a correlation between smoking and lung cancer.

State what is meant by correlation.

(1)

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(c) Smoking tobacco can result in the development of a variety of other health problems including atherosclerosis.

Explain how smoking increases the risk of developing atherosclerosis.

(3)

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*(d) Cancer is the result of the abnormal growth of cells in an organ. These cells develop into a tumour which does not carry out the function of the tissues in the organ.

An article states:

"Tobacco smoke is the cause of kidney cancer!"

Evaluate the claim that tobacco smoke is the primary cause of kidney cancer.

(9)

(Total for Question 5 = 15 marks)

6 The scientific article you have studied is adapted from 'How Performance-Enhancing Drugs Work.'

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

(a) (i) The population of the UK is 63 182 000 of which 49 182 000 are adults (paragraph 13).

Calculate the number of adults who have asthma.

(2)

Answer .....

(ii) People with asthma sometimes have difficulty breathing (paragraph 13).

Explain how beta-2 agonists may help to relieve their symptoms.

(2)

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(iii) Explain how beta-2 agonists can increase the heart rate (paragraph 13).

(4)

(b) Explain how human growth hormone (HGH) is able to stimulate cells to secrete IGF-1 (paragraphs 20 and 21).

(4)

(c) Explain why it is difficult to identify athletes who are using banned substances such as HGH (paragraphs 17, 20 and 22).

(2)

(d) Explain one benefit of using substances developed from perfluorocarbons (PFCs) to treat patients with breathing difficulties (paragraphs 30 and 31).

(2)

(e) Local anaesthetics mask pain by binding to protein channels in the membranes of neurones (paragraph 38).

Explain how binding to protein channels will prevent pain being sensed by the pain centre of the brain.

(4)

(f) Explain why diuretics are a prescribed drug for high blood pressure (paragraph 43).

(2)

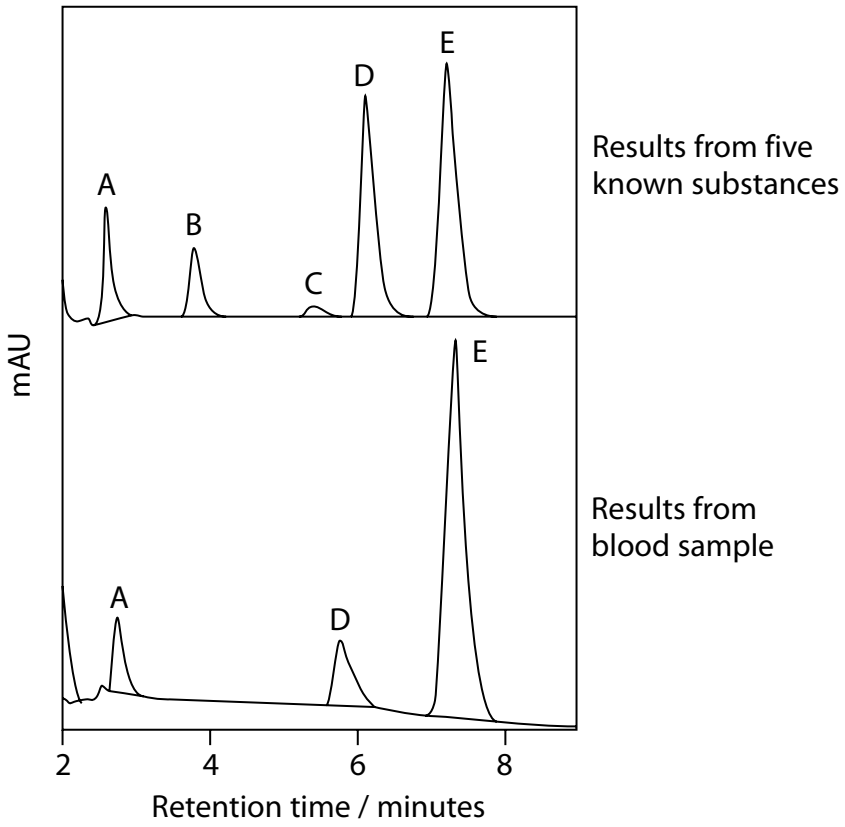
(g) A test for the T/E ratio can help to identify athletes who have injected testosterone into their body (paragraph 45).

Explain the limitation of this test.

(3)

(h) Gas chromatography (GC) can be used to detect athletes who have taken banned drugs (paragraph 48).

The chromatogram shows the GC results for five known banned substances, A, B, C, D and E.



Explain why the peak for drug E is different from the peak for drug A (paragraph 48).

(2)

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(i) Explain how the blood passport may result in more effective monitoring of athletes (paragraph 51).

(2)

(j) Comment on the ethical viewpoints for and against the use of performance-enhancing drugs by athletes.

(4)

(Total for Question 6 = 33 marks)

TOTAL FOR PAPER = 100 MARKS

BLANK PAGE

Question Number	Acceptable Answer	Additional Guidance	Mark
1(a)	An explanation that makes reference to the following: • fraternal twins risk is lower (1) • because fewer alleles in common (1)	Allow converse	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
1(b)(i)	An explanation that makes reference to the following: • Identical twins being raised apart allows environmental factors to be investigated separately from genetic factors (1) • therefore may be able to determine relative amount of risk due to genetic variation / relative amount of risk due to environment (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
1(b)(ii)	An answer that makes reference to the following: • twins have more in common than shared genetics / shared uterine environment (1) • twins may be raised in similar environments(1)	Ignore reference to sample size	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
1(c)	An explanation that makes reference to the following: • Parkinson's symptoms arise due to low dopamine levels (1) • transmission of nerve impulses disrupted causing lack of control of {muscle movements / tremors} (1) • schizophrenia drugs lower {neurotransmitter / dopamine} levels (1) Plus two from: • therefore less dopamine in synaptic / knob secreted into cleft / diffuses across cleft (1) • therefore less dopamine available to bind to receptors (1) • therefore no/little change in membrane structure / permeability of post– synaptic cell (1) • therefore fewer sodium ions enter postsynaptic cell (1) • therefore less depolarisation of postsynaptic cell (1)		**(5)**

(Total for Question 1 = 11 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
2(a)	larvae show no significant preference for light over dark side (1)	Allow vice versa Must have NO in hypothesis.	**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(b)(i)	calculation of expected frequency 10 and 10 (1) $(O-E)^2/E$ for both light and dark sides 49 ÷ 10 = 4.9 (1) sum = 9.8 (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(b)(ii)	An answer that makes reference to the following: • higher than 3.84 therefore Chi square value as high as 9.8 arise by chance alone less than 1 in 20 / 0.05 therefore there is a significant difference (1)	allow ECF for incorrect value of Chi allow converse if calculated of Chi is lower than 3.84	**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(c)	An explanation that makes reference to five of the following: • use of dead tissue containing toxin and dead tissue not containing tissue so valid comparison can be made (1) • {young larvae of same length / fly eggs} allowed access to both types of dead tissue so they have same potential for growth (1) • reference to time scale before growth of larvae measured to allow time for growth to occur (1) • length measured for several larvae to ensure reliability (1) • control of {temperature / type of tissue / age of tissue / species of larvae} because these factors affect growth (1) • recognition that comparison of results may show under or over estimate of time of death (1)		**(5)**

(Total for Question 2 = 10 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
3(a)	Measurement in 5.1 cm / 51 mm correct (1) 51 ÷ 60 = 0.85 mm (1)	need to measure on paper	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
3(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
3(b)(ii)	Calculation of mean = 55 (1) Answer = 55 ÷20.2 = 2.72 (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
3(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
3(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)**

(Total for Question 3 = 13 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
4(a)	An explanation that makes reference to five of the following: • at {low concentrations / up to 200 mg} there is a rapid increase in faecal fat content (1) • drug binds to enzyme and alters the shape of the active site (1) • drug acts as a non-competitive inhibitor (1) • prevents enzyme {substrate / product} complex formation (1) • prevents hydrolysis of {fat / triglyceride} (1) • less fatty acids / glycerol absorbed (1) • at {high concentrations / above 200 mg} there is a levelling at {25 to 30%} no further effect above 400 mg because all enzymes inhibited (1)		**(5)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(b)	An explanation that makes reference to four of the following: • placebo used which allows for a comparison to ensure validity (1) • error bars given which allow for indication of true mean (1) • measurements taken for a long time to see if effects continued (1) • more people used so reliability improved (1) • measured the desired outcome (change in body mass) not an indirect measure (faecal fat) (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(c)(i)	80 ÷ 31.25 = 0.032 (1) height = √ 0.032 (1) = 1.6 m (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(c)(ii)	BMI is calculated within a range on a scale of values / body mass is a definite value (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(c)(iii)	An explanation that makes reference to five of the following: • high blood pressure causes damage to endothelium (1) • atherosclerosis leads to narrowing of lumen of arteries (1) • heart disease as a result of narrowing of coronary arteries (1) • stroke as a result of reduced blood flow to brain (1) • joint damage caused by increased body mass leading to damage of the cartilage (1) • type 2 diabetes caused by reduced sensitivity of insulin receptors (1)		**(5)**

(Total for Question 4 = 18 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
5(a)	An answer that makes reference to two of the following: • because females smoke fewer cigarettes / inhale less (1) • because females smoke different lower tar cigarettes (1) • because smoke for fewer years /started smoking later (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
5(b)	Correlation shows an association or relationship but no causal link (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
5(c)	An explanation that makes reference to the following: • nicotine stimulates adrenaline release which increases {heart rate / blood pressure} (1) • {high blood pressure / toxins} damages endothelium (1) • reference to {inflammatory response / plaque formation} (1)		**(3)**

Question Number	**Indicative content**	
***5(d)**	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 indicated as relevant. Additional content included in the response must be scientific and relevant. Candidates are expected to reach a decision/judgment on whether tobacco smoke is the primary cause of kidney cancer. • Idea that tobacco smoke is a risk factor for kidney cancer: carcinogens from tobacco smoke can travel in the bloodstream to the kidney and are taken up by kidney cells. • Carcinogens cause mutation of the DNA in the kidney cells, for example p53 gene, leading to uncontrolled mitosis, and tumour formation. • Idea of risk of kidney cancer correlating with more than one factor, not just smoking. • Linkage of environmental factors (e.g. diet, weight, alcohol consumption, age) to increased risk of cancer-causing mutations. • Inheritance of genetic mutations, and increased risk of cancer. • The requirement for studies to establish correlations and causal links.	
Level	**Mark**	**Descriptor**
	0	No rewardable material
Level 1	1–3	Demonstrates isolated elements of biological knowledge and understanding. Provides little or no reference to a range of scientific ideas, processes, techniques and procedures. Scientific argument may be attempted, but fails to link biological concepts and/or ideas in order to support decision/conclusion. Limited attempt to address the question.

Level	Mark	Descriptor
Level 2	4–6	Demonstrates adequate biological knowledge and understanding with selection of some biological facts/concepts to support the argument or decision/conclusion being made. Scientific reasoning occasionally supported through the linkage of a range of scientific ideas, processes, techniques and procedures. Scientific argument is partially developed. Attempts to synthesise and integrate relevant knowledge with linkages to biological concepts and/or ideas, leading to a notional scientific argument or decision/conclusion based on evidence.
Level 3	7–9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to support the argument or decision/conclusion being made. Scientific reasoning supported throughout by sustained linkage of a range of scientific ideas, processes, techniques or procedures. Scientific argument is well developed and logical. Demonstrating throughout the skills of synthesising and integrating relevant knowledge with consistent linkages to biological concepts and/or ideas, leading to nuanced and balanced scientific argument or decision/conclusion based on evidence.

(Total for Question 5 = 15 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
6(a)(i)	49 182 000 x 0.05 (1) 2 459 100 (1)	Correct answer gains full marks	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(a)(ii)	An explanation that makes reference to the following: • can dilate bronchioles /airways (1) • therefore allowing more oxygen into lungs /alveoli (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(a)(iii)	An explanation that makes reference to the following: • sympathetic neurotransmitters are released at the SAN (1) • therefore if beta-2 agonists are present the SAN will increase its rate of stimulation (1) • so impulses will spread faster and more often over the atria (1) • therefore the heart muscle will contract more often which increases the heart rate (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)	An explanation that makes reference to four of the following: • HGH binds to receptor in cell surface membrane (1) • activation of messenger molecule in cytoplasm (1) • reference to protein kinase cascade (1) • transcription factor produced (1) • gene for IGF-1 switched on (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(c)	An explanation that makes reference to the following: • occur naturally / would have some present in body (1) • therefore difficult to detect additional HGH (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(d)	An explanation that makes reference to the following: • no need for blood transfusion (1) plus any one from: • therefore no risk of rejection / agglutination/ delay in {tissue/blood} typing (1) • they supply the oxygen requirements for the body (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(e)	An explanation that makes reference to four of the following: • reference to {sodium ion channels / voltage gated sodium ion channels} (1) • binding blocks movement of sodium ions into neurone (1) • membrane is not depolarised (1) • action potential is not generated (1) • no impulses conducted to brain (1)	Accept more sophisticated answers that refer to the effect on calcium ion movement	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(f)	An explanation that makes reference to two of the following: • (they) increase the removal of {water/salts} from blood (1) • (removal of water) lowers blood volume and therefore pressure (1) • (removal of salt) lowers uptake of water into blood (by osmosis from tissue fluid) and therefore blood pressure (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(g)	An explanation that makes reference to the following: • normal ratio is 1:1 (1) • taking testosterone and epitestosterone in equal measures maintains this ratio (1) • therefore it is not possible to detect cheats (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(h)	An explanation that makes reference to the following: • drug E has been retained in the gas phase longer (1) • because it has {greater solubility / smaller mass} (1)	Accept more sophisticated answers related to charge	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(i)	An explanation that makes reference to two of the following: • longitudinal monitoring / to be followed over time (1) • therefore can identify individual differences in naturally occurring drug concentrations (1) • therefore can see pattern or link to competition / injury / look for changes (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(j)	An answer that makes reference to the following: • the absolutist's view would be that they should never be used (1) plus any one from: • because of the damage to the body by the side effects (1) • athletes should compete using their innate {anatomical / physiological} abilities / fair competition should be promoted (1) and • the rationalist's view would be that their use is acceptable if there is a justifiable outcome (1) Plus any one from: • because it is a personal choice (1) • because it could help to overcome the inequalities in {training / medical support} (1)		**(4)**

(Total for Question 6 = 33 marks)

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