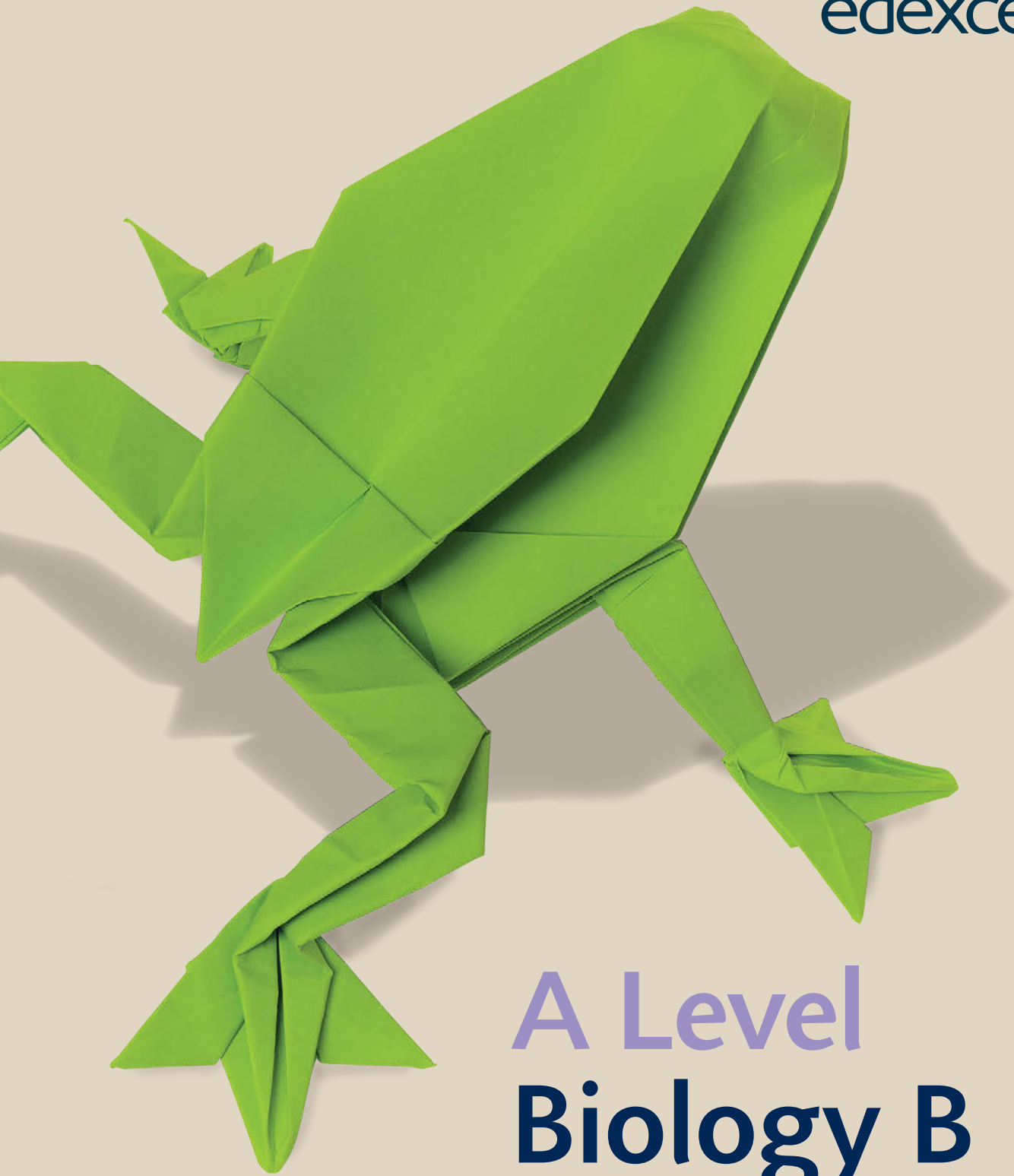




A Level Biology B

Sample Assessment Materials

Pearson Edexcel Level 3 Advanced GCE in Biology B (9BI0)

First teaching from September 2015

First certification from 2017

Issue 1

**Pearson
Edexcel Level 3
Advanced GCE
in Biology B (9BI0)
Sample Assessment Materials**

First certification 2017

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Original origami artwork: Mark Bolitho

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ISBN 978 1 446 91454 0

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Introduction

The Pearson Edexcel Level 3 Advanced GCE in Biology B 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 B Advanced Paper 1: Advanced Biochemistry, Microbiology and Genetics	
Sample Assessment Material for first teaching September 2015 Time: 1 hour 45 minutes	Paper Reference 9BI0/01
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 90.
- 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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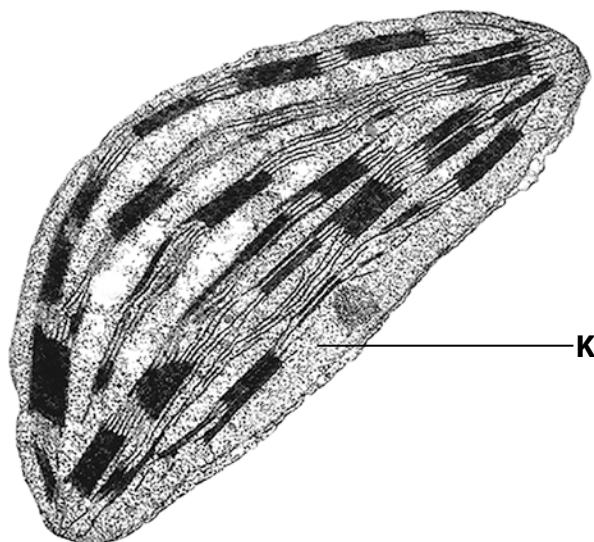
PEARSON

Answer ALL questions.

Write your answers in the spaces provided.

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 photograph below shows an electron micrograph (EM) image of a chloroplast.



© Chloroplast, TEM Dr Jeremy Burgess/Science Photo Library

- (a) Which of the following is correct for the part labelled **K**?

(1)

	Name	Reaction that takes place
☒ A	granum	light-dependent
☒ B	granum	light-independent
☒ C	stroma	light-dependent
☒ D	stroma	light-independent

(b) Describe the role of membranes inside the chloroplast.

(3)

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(Total for Question 1 = 4 marks)

- 2 Retinitis pigmentosa is a genetic eye disease that affects rod cells. The disease results in night blindness and sight defects.

Induced pluripotent stem cells (iPS cells) are being used by scientists studying this disease.

(a) Which of the following is correct for a pluripotent cell?

(1)

	Is obtained from	Can differentiate into
☐ A	early embryo	any cell type
☐ B	early embryo	limited cell types
☐ C	late embryo	any cell type
☐ D	late embryo	limited cell types

(b) Describe how iPS cells can be produced.

(3)

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(c) Describe how iPS cells could be used to cure retinitis pigmentosa.

(2)

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(Total for Question 2 = 6 marks)

3 The classification of viruses is based on their structure and the type of nucleic acid that they contain.

(a) Which of the following is a reason why the influenza virus is classified as a retrovirus? (1)

- ☐ **A** it has a capsid
- ☐ **B** it has an envelope
- ☐ **C** it contains RNA
- ☐ **D** it contains DNA

(b) Which of the following methods would be best for preventing the transmission of influenza through a population?

(1)

- ☐ **A** take paracetamol
- ☐ **B** wear a face mask
- ☐ **C** use insect repellent
- ☐ **D** take antibiotics

(c) Explain how the influenza virus has a pathogenic effect.

(4)

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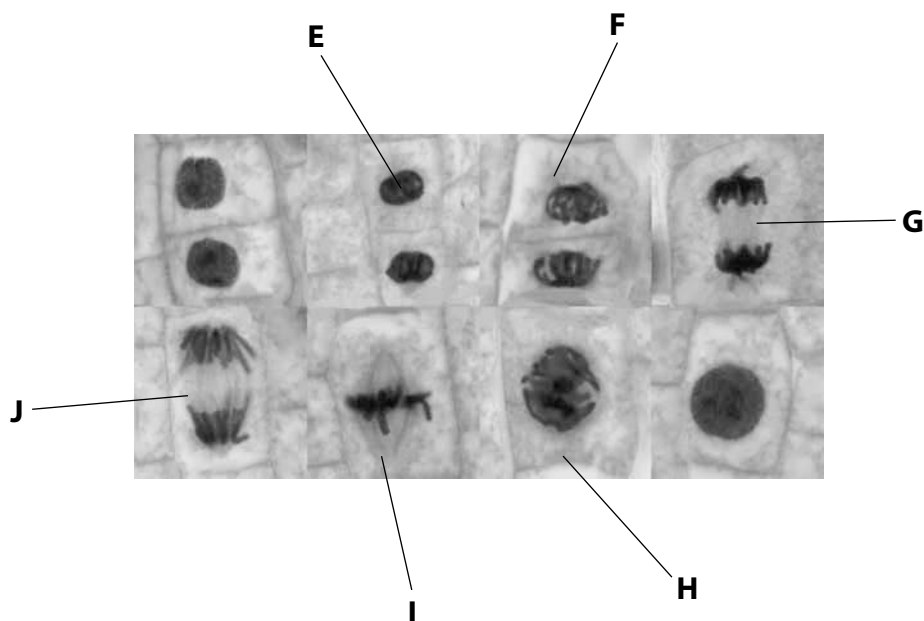
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(Total for Question 3 = 6 marks)

4 The photograph below shows cells dividing by mitosis.



© Steve Gschmeissner / Science Photo Library

(a) The actual length of cell **J** is $23.5\ \mu\text{m}$.

(i) Calculate the magnification of this photograph.

(3)

Answer

(ii) Describe what has happened in cell **J**.

(4)

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(b) (i) Which sequence of letters represent the cells in order of their appearance in the phases of mitosis?

(1)

☐ **A** E, F, G, H, I, J

☐ **B** G, F, H, I, J, E

☐ **C** H, I, J, G, F, E

☐ **D** J, I, H, G, F, E

(ii) Give a reason why there are differences in the appearance of cells **E** and **G**.

(1)

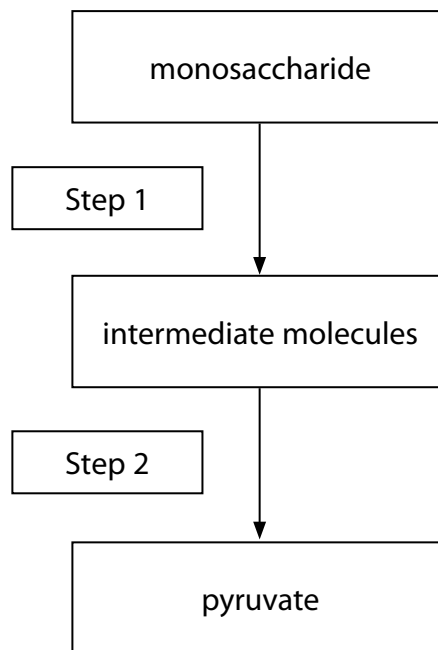
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(Total for Question 4 = 9 marks)

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- 5 The diagram below shows a stage of the process of respiration in the cytoplasm of muscle cells.



(a) What is the name of this stage?

(1)

- ☐ A Calvin cycle
- ☐ B glycogenolysis
- ☐ C glycolysis
- ☐ D Krebs cycle

(b) Which other products are formed during this stage?

(1)

- ☐ A ADP and carbon dioxide
- ☐ B ADP and oxidised coenzyme
- ☐ C ATP and carbon dioxide
- ☐ D ATP and reduced coenzyme

(c) What occurs in the first reaction of step 1?

(1)

- ☐ A condensation
- ☐ B hydrolysis
- ☐ C phosphorylation
- ☐ D photophosphorylation

(d) Describe what happens to the pyruvate when the muscle is supplied with oxygen.

(4)

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(Total for Question 5 = 7 marks)

6 (a) Describe the action of bactericidal and bacteriostatic antibiotics.

(2)

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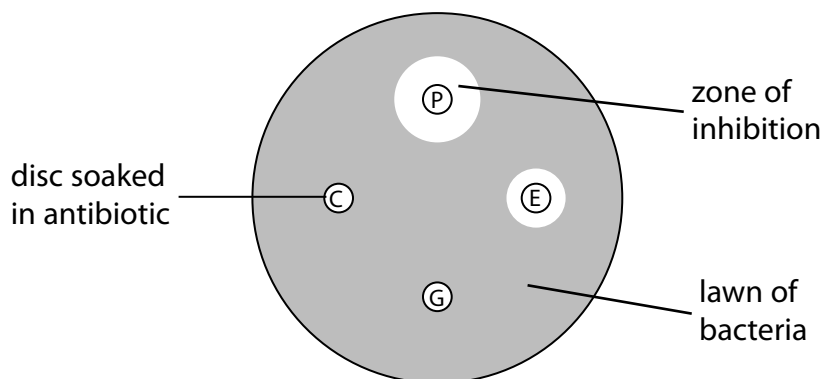
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(b) The resistance of one type of bacteria to a range of different antibiotics was investigated.

A lawn of bacteria was prepared by spreading a suspension of the bacteria over the surface of agar. Paper discs that had been soaked previously in different antibiotics were placed on top of the bacteria. The antibiotics were all the same concentration. The culture was incubated for 48 hours.

The diagram below shows the appearance of the culture after incubation.



Key:

C = chloramphenicol

E = erythromycin

G = gentamycin

P = penicillin

Explain why these results indicate that the bacteria must be Gram positive.

(3)

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- (c) Plasmids with genes for resistance to antibiotics are widely used in gene technology. These plasmids are used to create recombinant bacteria.

Explain how culturing could be used to obtain recombinant bacteria.

(5)

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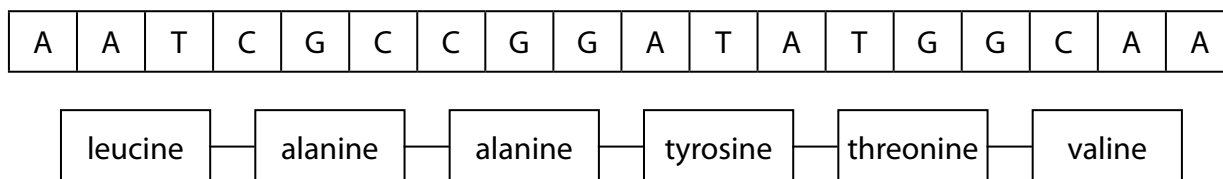
(Total for Question 6 = 10 marks)

7 The order of bases in a section of DNA codes for a sequence of amino acids in a protein.

(a) Draw a diagram to show the structure of an amino acid.

(2)

(b) The diagram below shows the order of bases in a section of DNA that codes for part of a polypeptide chain.



(i) Give the sequence of bases in the mRNA that codes for the amino acid leucine.

(1)

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(ii) Explain how this length of DNA will code for this sequence of amino acids.

(3)

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* (iii) Discuss the possible consequences for this sequence of amino acids if a point mutation occurred in this section of DNA.

(6)

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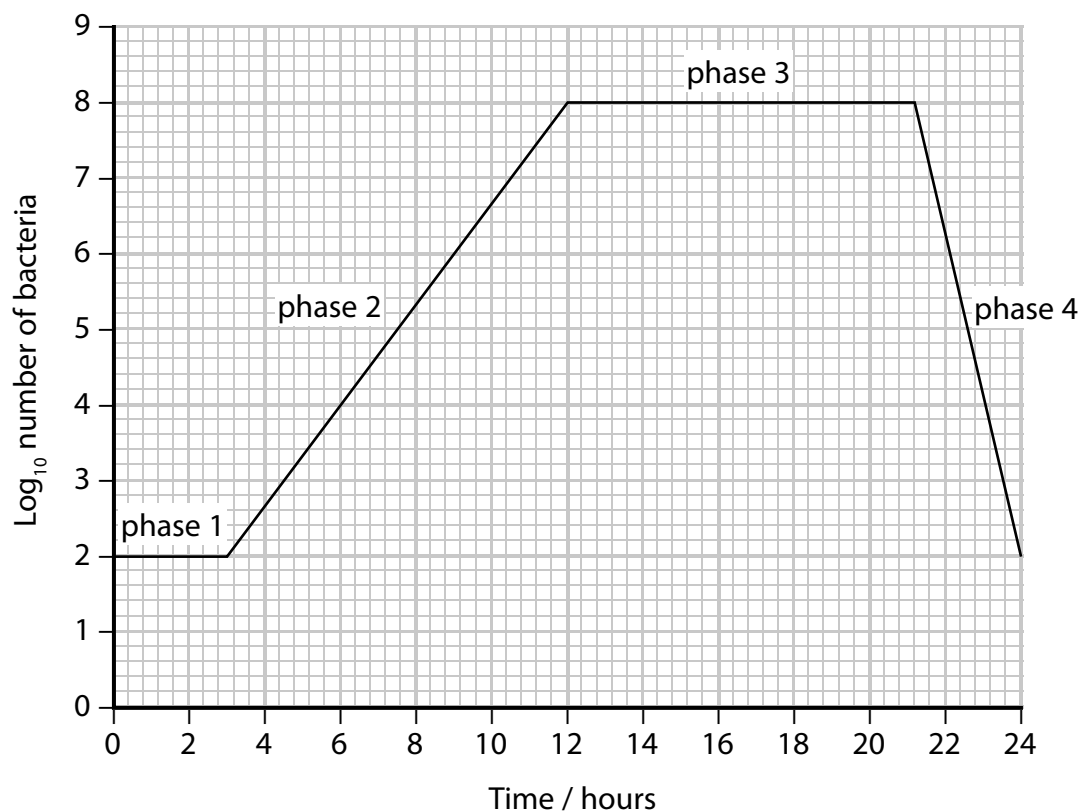
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(Total for Question 7 = 12 marks)

8 A broth culture for growing bacteria was set up.

Dilution plating was used to determine the number of live bacteria in the culture over a period of 24 hours.

The graph below shows the number of live bacteria in the culture during this 24-hour period.



(a) Which is the correct order of the phases 1 to 4 shown on the graph?

(1)

- ☐ **A** lag, log, death, stationary
- ☐ **B** lag, log, stationary, death
- ☐ **C** log, lag, death, stationary
- ☐ **D** log, lag, stationary, death

*(b) Evaluate the use of dilution plating and optical methods for determining the number of bacterial cells in a culture.

(6)

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(c) Calculate the growth rate constant (k) for phase 2 of this culture, using the formula:

$$k = \frac{\log_{10} N_t - \log_{10} N_0}{0.301 \times t}$$

(4)

Answer

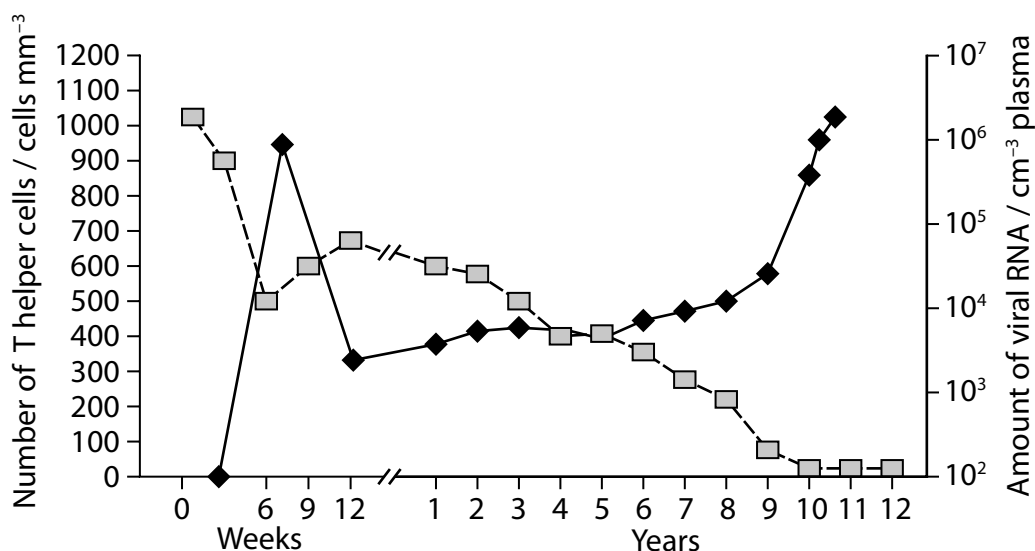
(Total for Question 8 = 11 marks)

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Turn over for question 9

- 9 The Human Immunodeficiency Virus (HIV) causes an infection called Acquired Immune Deficiency Syndrome (AIDS).

The virus attacks T helper cells in the body and eventually leads to death, usually as a result of opportunistic infections.

The graph below shows changes in the T helper cell count and in the amount of viral RNA in a person during a period from initial HIV infection to death.



- (a) Calculate the percentage change in viral RNA from week two to week six.

(2)

Answer

(b) Analyse the data to explain the changes in the T helper cell count from initial HIV infection until death.

(5)

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(c) The HIV virus contains an enzyme called reverse transcriptase. This enzyme uses the viral RNA as a template to synthesise a single strand of complementary DNA in the host cell.

(i) A sequence of bases in a section of RNA from HIV is UCCCCAGCG.

Which of the following shows the correct sequence of bases in the single strand of complementary DNA made using reverse transcriptase?

(1)

- ☐ **A** UCCCCAGCG
- ☐ **B** AGGGGTCGC
- ☐ **C** AGGGGUCGC
- ☐ **D** TCCCCTCGC

(ii) Describe how other enzymes convert the complementary single strand of DNA into a double strand of DNA in the host cell.

(2)

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(d) There are drugs that can be taken to reduce the reproduction of HIV.

Explain why a patient is usually given several different drugs at the same time.

(2)

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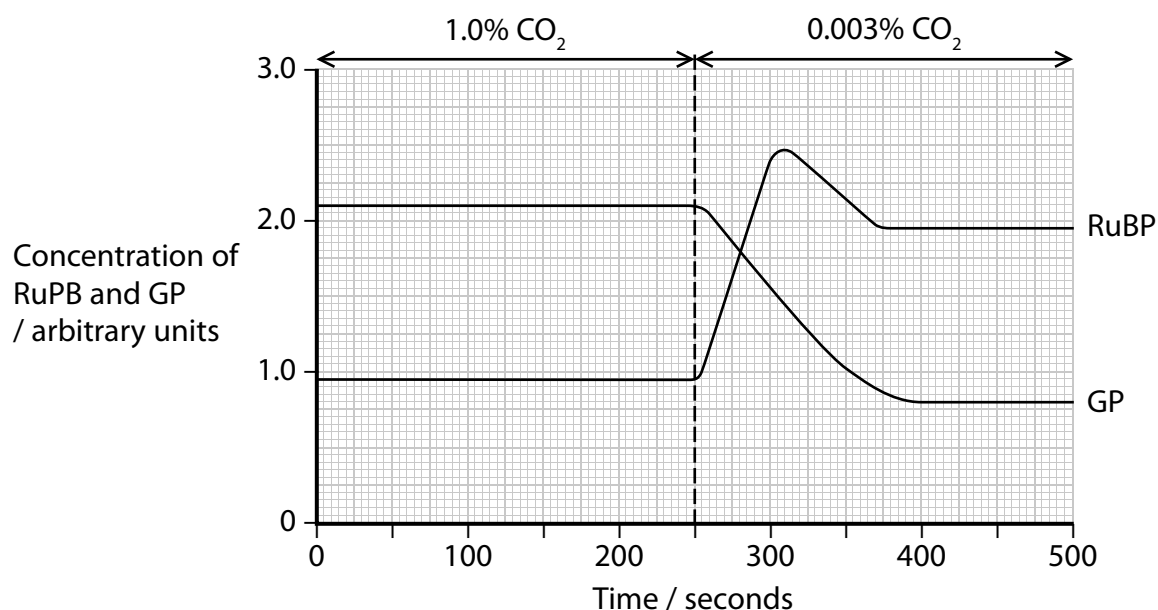
(Total for Question 9 = 12 marks)

- 10** An investigation was carried out into the effect of carbon dioxide concentration on photosynthesis.

Cells of a unicellular alga were suspended in a solution containing 1.0% carbon dioxide. After 250 seconds the carbon dioxide was changed to 0.003% CO₂.

The cells were illuminated with a bright light and some were removed at regular time intervals. The concentrations of ribulose biphosphate (RuBP) and glycerate 3-phosphate (GP) in the cells were measured.

The graph below shows the results of the investigation.



- (a) Explain why the cells were illuminated at a high light intensity during this investigation.

(3)

(b) (i) Analyse the data to explain the effect of carbon dioxide concentrations on the production of RuBP.

(4)

(ii) Analyse the data to explain the effect of carbon dioxide concentrations on the rate of production of GP.

(3)

(c) This investigation was carried out at 25°C.

Explain the effect of lowering the temperature on the concentration of RuBP for the first 250 seconds of this investigation.

(3)

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(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

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Biology B Paper 1 Mark Scheme

Question Number	Acceptable Answer	Additional guidance	Mark
1(a)	D		(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
1(b)	A description that makes reference to three of the following: • compartmentalisation from stroma (1) • site of light-dependant reactions (1) • they contain {chlorophyll / photosynthetic pigments / electron carrier proteins} (1) • membranes increase the number of {pigments / proteins} that can be held (1) • contain ATP synthase / ATP synthesised (1)		(3)

(Total for Question 1 = 4 marks)

Question Number	Answer	Additional guidance	Mark
2(a)	D		(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(b)	A description that makes reference to the following: • {fibroblasts / non-pluripotent cells / somatic cells} are used (1) • {specific / reprogramming } {genes / transcription factors / miRNAs} are put into the cells (1) Plus one of the following: • credit named gene, e.g. Oct4 (Pou5f1), Sox2, cMyc, or Klf4 (1) • using a {vector / virus} (1) • cells are cultured (1)		(3)

Question Number	Acceptable Answer	Additional guidance	Mark
2(c)	A description that makes reference to the following: • replace the dysfunctional cells with functional cells derived from iPS cells (1) • iPS cells are injected into the retina and then develop into normal retinal cells (1)		(2)

(Total for Question 2 = 6 marks)

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

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

Question Number	Acceptable Answer	Additional guidance	Mark
3(c)	An explanation that makes reference to the following: - virus can {bind to / infect} cells of {throat / lung} (1) - virus has {haemagglutinin / glycoprotein / receptors} (on its surface) (1) Plus two from: - detail of viral replication (1) - leads to cell {lysis / tissue} damage (1) - immune response is triggered which results in symptoms that include {fever / headaches / fatigue / sore throat} (1)		(4)

(Total for Question 3 = 6 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
4(a)(i)	- length of cell = 20 (mm) (1) - conversion into μm = $20000 \div 23.5$ (1) - magnification = 851 (1) [ecf applies for mp 2 and 3]	Accept ± 1 mm Accept other appropriate calculation, e.g. measure in cm or converting 23.5 μm to mm or cm Correct answer gains full marks	(3)

Question Number	Acceptable Answer	Additional guidance	Mark
4(a)(ii)	A description that makes reference to the following: - centromeres have separated (1) - spindle fibres have {shortened / contracted} (1) - chromatids pulled apart (1) - chromatids have moved to opposite poles (1)		(4)

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

Question Number	Acceptable Answer	Additional guidance	Mark
4(b)(ii)	Because E is {in cytokinesis / in late telophase / dividing its cytoplasm} but G is still in {anaphase / mitosis} (1)		(1)

(Total for Question 4 = 9 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
5(a)	C		(1)
Question Number	Acceptable Answer	Additional guidance	Mark
5(b)	B		(1)
Question Number	Acceptable Answer	Additional guidance	Mark
5(c)	C		(1)
Question Number	Acceptable Answer	Additional guidance	Mark
5(d)	A description that makes reference to the following: • it is transported into the (matrix) mitochondria (1) • link reaction oxidises pyruvate to form NADH + H⁺ (1) • carbon dioxide is removed (1) • molecule combines with acetyl CoA to form coenzyme A (1)		(4)

(Total for Question 5 = 7 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
6(a)	A description that makes reference to the following: • bactericidal kills by affecting structure of the cell membrane/cell wall (1) • bacteriostatic prevents reproduction by affecting DNA replication (1)		(2)

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)	An explanation that makes reference to the following: • there is a zone of inhibition around the penicillin disc / because penicillin only affects Gram positive bacteria (1) Plus two from the following points: • because it has a thick cell wall (1) • because penicillin interferes with formation of cross links (1) • during synthesis of new cell wall (1) • this results in bacteria being susceptible to osmotic shock (1)		(3)

Question Number	Acceptable Answer	Additional guidance	Mark
6(c)	An explanation that makes reference to five of the following: • the gene of interest is inserted into plasmids (1) • this plasmid has a marker gene for antibiotic resistance (1) • the recombinant bacteria will be resistant to this antibiotic (1) • the bacteria are grown on agar containing that antibiotic (1) • only the recombinant bacteria will grow (1) • use of replica plating to transfer recombinant bacteria to fresh medium (1)		(5)

(Total for Question 6 = 10 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
7(a)	$ \begin{array}{c} \text{R} \\ \\ \text{NH}_2 - \text{C} - \text{COOH} \\ \\ \text{H} \end{array} $ - central carbon atom bonded to NH₂ and COOH group (1) - central carbon atom bonded to R group and H atom (1)	Allow opposite orientation with R group and R may be replaced with appropriate group	(2)

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

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)(ii)	An explanation that makes reference to the following: 18 bases code for six amino acids (1) plus any two from: - because genetic code is made up of triplets of bases (1) - because the code is degenerate, some amino acids can have more than one code (1) - because of non-overlapping code (1)		(3)

Question Number	Indicative content	
*7(b)(iii)	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. • Frame shift effect due to addition / deletion • Replace amino acid due to substitution • No effect on amino acids due to substitution • Degeneracy of code due to substitution • Shorter due to stop codon • Consequence for protein structure explained	
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. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion 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.

		Consequences are discussed, which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed, which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

(Total for Question 7 = 12 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
8(a)	B		(1)

Question Number	Indicative content
*8(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. • Dilution plating takes longer to obtain a result but optical methods are quicker • Because incubation period needed for dilution plating • Because need to do serial dilutions to find correct concentration for dilution plating • Dilution plating counts living cells but optical methods measure living and dead cells • Dilution plating gives direct count but optical methods give turbidity reading • To calculate original concentration of bacterial cells, the volume of diluted suspension added to each agar plate needs to be known / optical methods require use of calibration curves • Dilution plating requires easily available apparatus but optical methods require colorimeter / spectrophotometer • Dilution plating has risk of error if colonies run into each other but optical methods produce error if tube not shaken

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.
Level 3	5-6	A scientific judgement is made that 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.

Question Number	Acceptable Answer	Additional Guidance	Mark
8(c)	$\log_{10} N_t = 8$ and $\log_{10} N_o = 2$ (1) $\log_{10} N_t - \log_{10} N_o = 6$ (1) $t = 9$ (1) $k = 2.215$ (1) [ecf applies for mps 2, 3 and 4]	Correct answer gains full marks with no working	(4)

(Total for Question 8 = 11 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
9(a)	$\frac{(10^6 - 10^2)}{100} \div 10^2$ 999900 % (1)	Correct answer gains full marks with no working	(2)

Question Number	Acceptable Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to the following: • overall the T helper cell count falls from {week 0 / initial HIV infection} and the amount of viral RNA increases (1) • between week 6 and week 12 the amount of viral RNA falls, therefore the T helper cell count increases (1) plus any three of the following: • virus attaches to (CD4) surface receptors (1) • virus genetic material / RNA enters T helper cell (1) • virus genetic material produces virus proteins / new virus particles (1) • T helper cells lyse (1) • T killer cells attack infected T helper cells / phagocytosis by macrophages (1)		(5)

Question Number	Acceptable Answer	Additional guidance	Mark
9(c)(i)	B		(1)

Question Number	Acceptable Answer	Additional guidance	Mark
9(c)(ii)	A description that makes reference to the following: - DNA polymerase to join nucleotides / bases / formation of phosphodiester bonds (1) - ligase to join DNA sections (1)		(2)

Question Number	Acceptable Answer	Additional guidance	Mark
9(d)	An explanation that makes reference to the following: - HIV mutates (1) - resistance to one drug but not to {all / others} (1)		(2)

(Total for Question 9 = 12 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)	An explanation that makes reference to the following: • light (intensity) will not be a limiting factor (1) • therefore carbon dioxide (concentration) is (only) limiting factor (1) • so the effect of carbon dioxide concentration can be seen (1)	Accept: {ATP / NADPH / eq} produced during light dependent reactions	(3)

Question Number	Acceptable Answer	Additional guidance	Mark
10(b)(i)	An explanation that makes reference to four of the following: • reducing the carbon dioxide concentration causes the RuBP to increase (1) • (at higher carbon dioxide concentration) RuBP is low because it is converted to carbohydrate / used to fix carbon dioxide (1) • RuBP rises because being regenerated / eq (1) • RuBP falls as being used to {fix / eq} carbon dioxide (1) • RuBP level remains constant once (new) equilibrium reached (1)	Accept correct manipulation of figures Correct answer gains full marks	(4)

Write your name here	
Surname	Other names
Pearson Edexcel Level 3 GCE	Centre Number
Candidate Number 	
Biology B Advanced Paper 2: Advanced Physiology, Evolution and Ecology	
Sample Assessment Material for first teaching September 2015 Time: 1 hour 45 minutes	Paper Reference 9BI0/02
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 90.
- 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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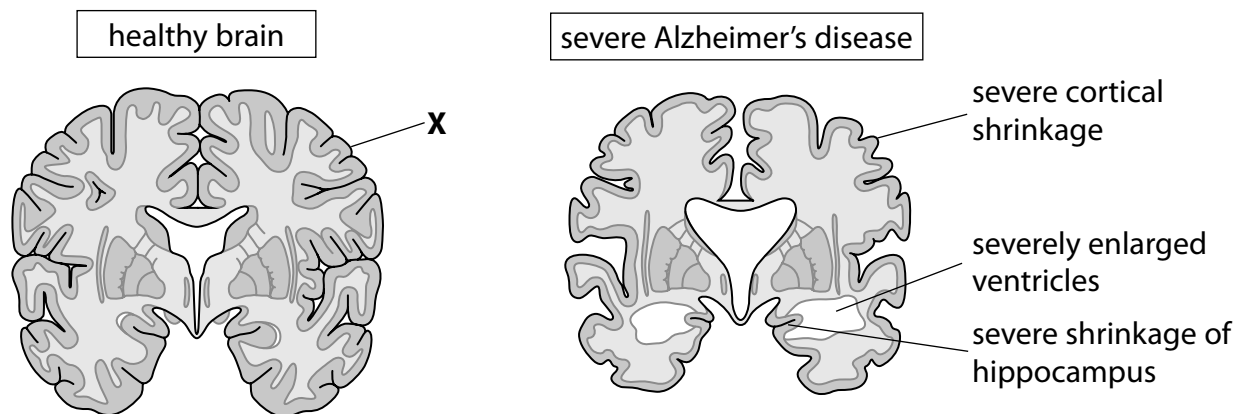
PEARSON

Answer ALL questions.

Write your answers in the spaces provided.

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 diagrams below show a horizontal cross section of a healthy human brain and a brain from a person with severe Alzheimer's disease.



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- (a) Name the part of the brain which is labelled **X**.

(1)

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- (b) Explain why a person with Alzheimer's disease may show a change in behaviour.

(2)

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(c) Drug treatments are available to reduce the symptoms of Alzheimer's disease.

One of the drugs available works as a non-competitive inhibitor of cholinesterase, the enzyme that breaks down acetylcholine in the synapse.

Describe how the action of this drug helps reduce the symptoms of Alzheimer's disease.

(3)

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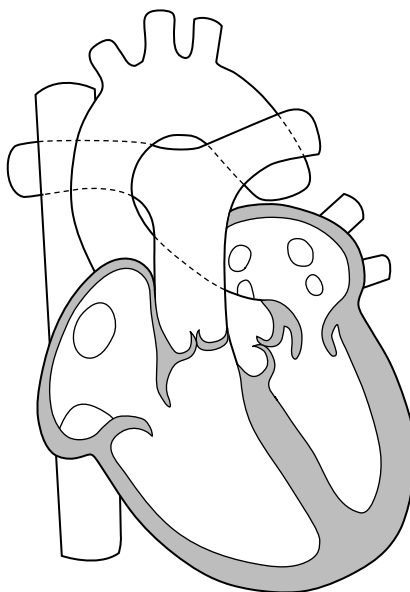
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(Total for Question 1 = 6 marks)

2 The diagram below shows the structure of a mammalian heart.

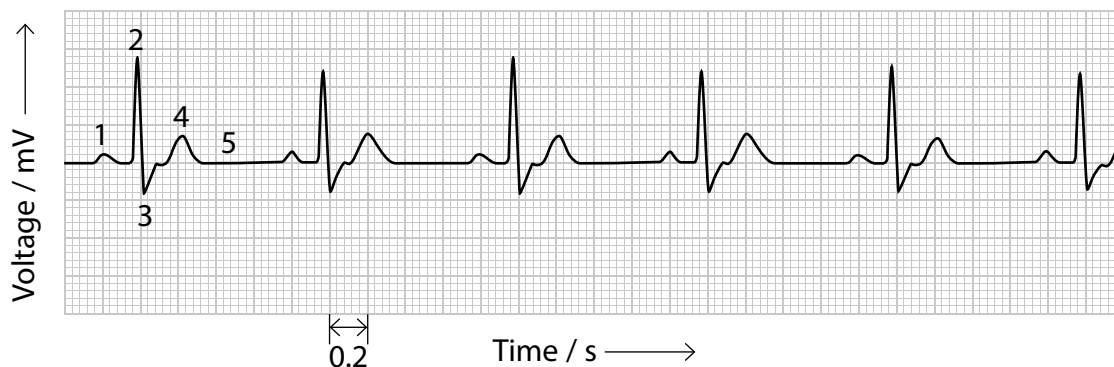


(a) Which stage of the cardiac cycle is shown by this heart?

- ☐ **A** atrial systole and ventricular systole
- ☐ **B** atrial systole and ventricular diastole
- ☐ **C** atrial diastole and ventricular systole
- ☐ **D** atrial diastole and ventricular diastole

(1)

(b) The diagram below shows an ECG trace for a person with a healthy heart.



(i) Which label identifies depolarisation of the sinoatrial node (SAN) in the cardiac cycle?

(1)

- ☐ **A** label 1
- ☐ **B** label 3
- ☐ **C** label 4
- ☐ **D** label 5

(ii) Which label identifies repolarisation of the ventricles in the cardiac cycle?

(1)

- ☐ **A** label 2
- ☐ **B** label 3
- ☐ **C** label 4
- ☐ **D** label 5

(c) Calculate the heart rate for this person.

(2)

Answer

(d) Describe how the cardiac centre brings about a change in heart rate when the activity level of a person increases.

(4)

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(Total for Question 2 = 9 marks)

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Turn over for question 3

- 3 Of the five rhino species, Javan rhinos (*Rhinoceros sondaicus*) are the most in threat of extinction, with as few as 35 individuals surviving in Ujung Kulon National Park in Java, Indonesia.

This national park is highly vulnerable to tsunamis and volcanic activity. In Java, large areas have been planted with *Arenga pinnata*, which is a source of palm oil. This plant has now colonised 50% of this national park.



© topimages/shutterstock

- (a) Give **one** biotic factor which contributes to *Rhinoceros sondaicus* becoming a critically endangered species.

(1)

- (b) Explain why a species may become endangered when its population falls to a very low number.

(2)

(c) Conservationists are working with the national park in order to conserve the Javan rhino.

Give **two** methods that could be used to conserve the Javan rhino.

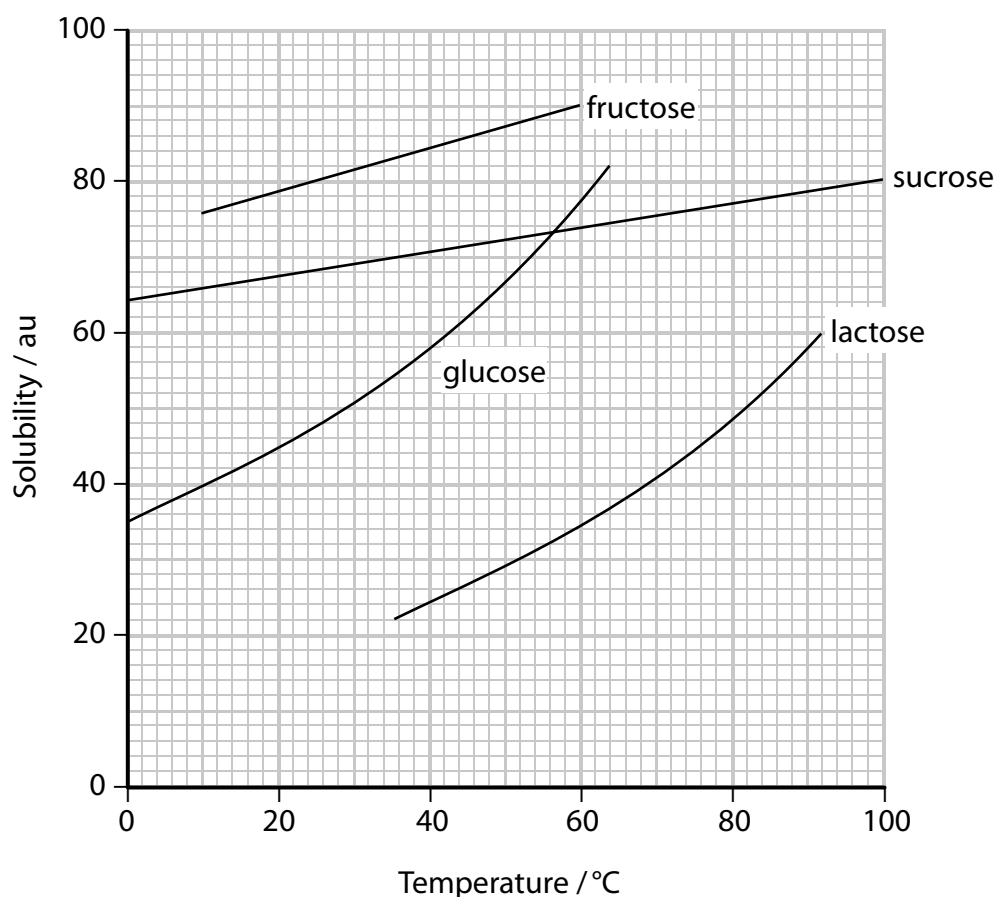
(2)

(Total for Question 3 = 5 marks)

- 4 An investigation into the effect of temperature on the solubility of some monosaccharides and some disaccharides was carried out.

Each monosaccharide and disaccharide was dissolved in water at different temperatures.

The graph below shows the solubility of some monosaccharides and some disaccharides in water at different temperatures.



(a) The graph shows that as water temperature increases, the solubility of

(1)

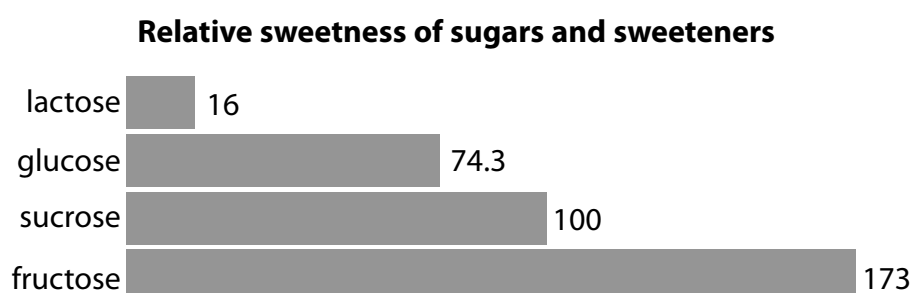
- ☐ A monosaccharides increases more than that of disaccharides
- ☐ B monosaccharides increases less than that of disaccharides
- ☐ C monosaccharides is always more than that of disaccharides
- ☐ D monosaccharides is always less than that of disaccharides

(b) Which row of the table below is correct for carbohydrates?

(1)

	Contains only six carbon atoms	Can be split by hydrolysis
☐ A	glucose	glucose
☐ B	glucose	lactose
☐ C	lactose	glucose
☐ D	lactose	lactose

(c) The graph below shows the relative sweetness of the monosaccharides and disaccharides.



People who are obese are at an increased risk of developing health problems.

Explain why the food industry uses the enzyme glucose isomerase to convert glucose into fructose when manufacturing its slimming products.

(3)

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(Total for Question 4 = 5 marks)

5 Tapirs are nocturnal mammals that are found in South America.

In 2013, the Journal of Mammalogy published an article describing the discovery of a new species of tapir, *Tapirus kabomani*.

Scientists already knew about the animal but thought that it was the same species as *Tapirus terrestris*.



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- (a) Give **one** reason why scientists thought that *Tapirus kabomani* was the same species as *Tapirus terrestris*.

(1)

(b) These two species of tapir can be distinguished using gene sequencing.

Describe how sufficient amounts of DNA could be obtained in preparation for gene sequencing.

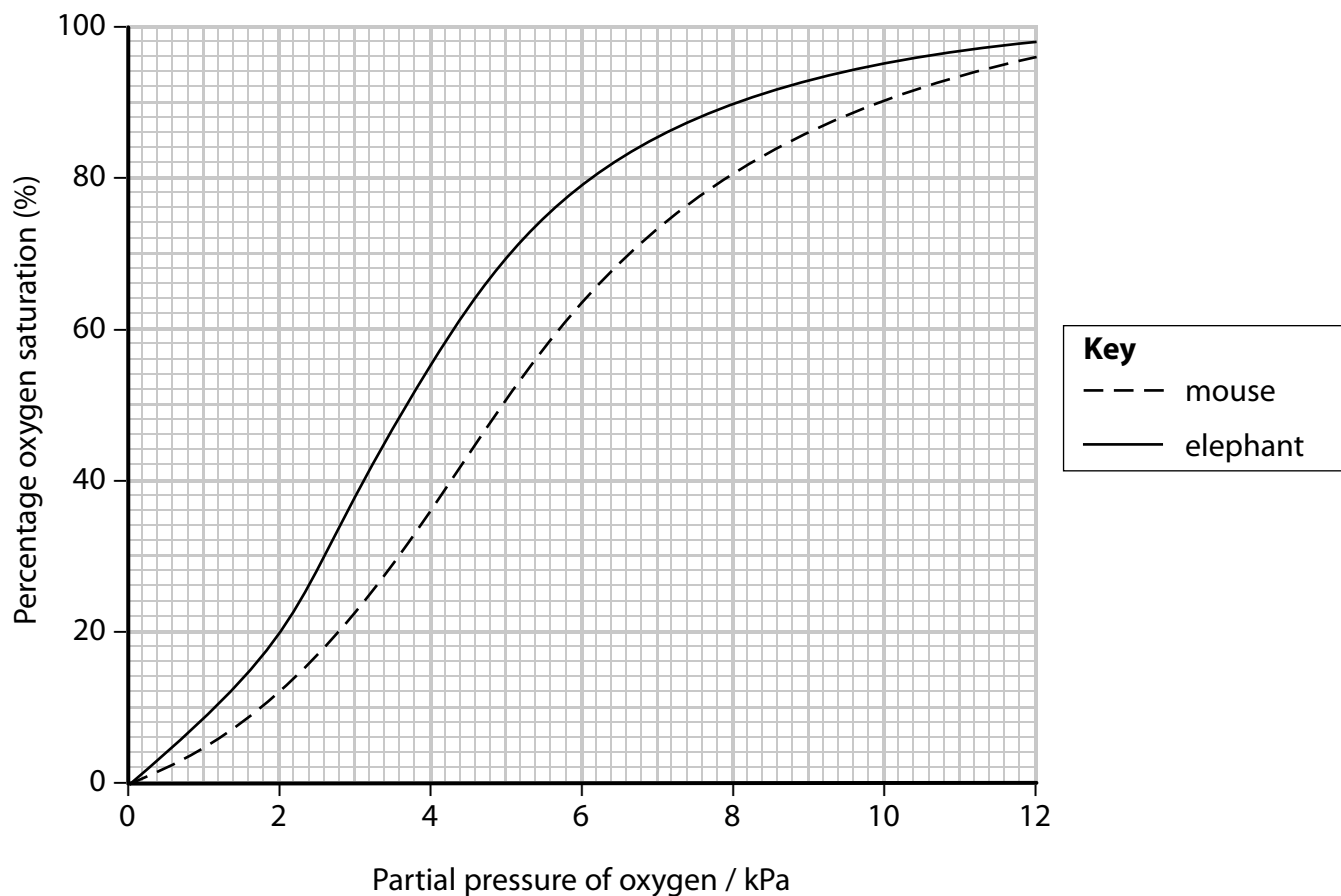
(4)

(c) Explain how distinguishing *Tapirus kabomani* as a separate species could affect the index of diversity of the area.

(2)

(Total for Question 5 = 7 marks)

- 6 The graph below shows the oxygen haemoglobin dissociation curves for a blood sample from an elephant and a mouse.



- (a) Use the information in the graph to determine the difference in percentage saturation between elephant haemoglobin and mouse haemoglobin at a partial pressure of oxygen of 4 kPa.

(1)

Answer

*(b) Explain the effect that body size has on the metabolic rate of these two mammals.

(6)

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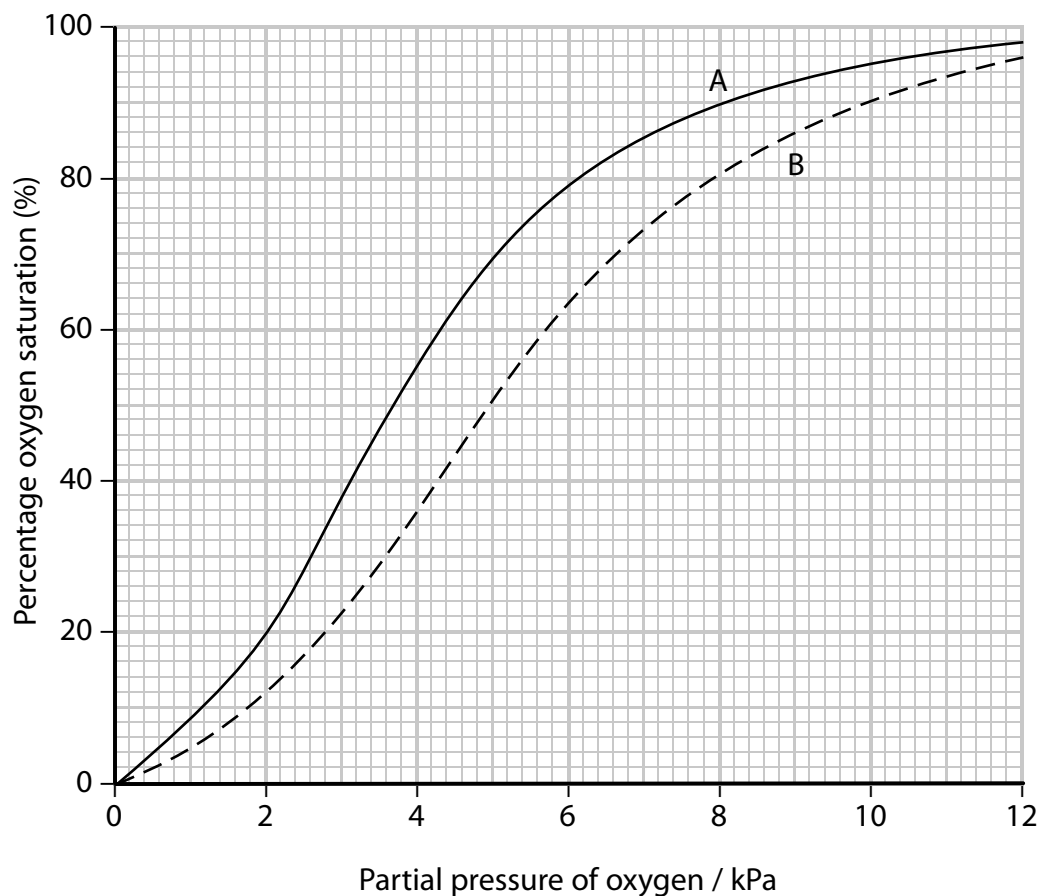
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- (c) The graph below shows the oxygen haemoglobin dissociation curves when two different blood samples, A and B, are compared.



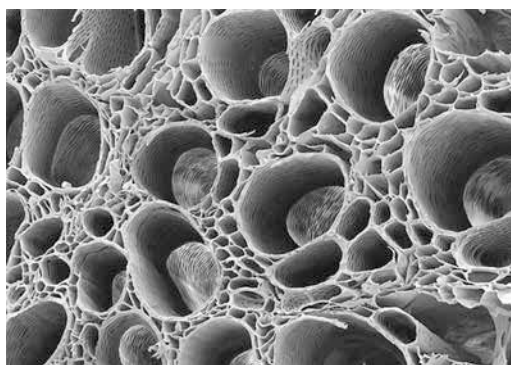
Which row of the table below shows the correct comparison of the blood samples?

(1)

	Blood sample A	Blood sample B
☐ A	blood before exercise	blood after exercise
☐ B	adult blood	fetal blood
☐ C	blood at lower pH	blood at higher pH
☐ D	blood at higher temperature	blood at lower temperature

(Total for Question 6 = 8 marks)

7 The photograph below shows an electronmicrograph of xylem tissue.



© B705/0112 Xylem tissue, SEM Steve Gschmeissner/Science Photo Library

(a) Give **three** ways in which xylem tissue is adapted for its functions.

(3)

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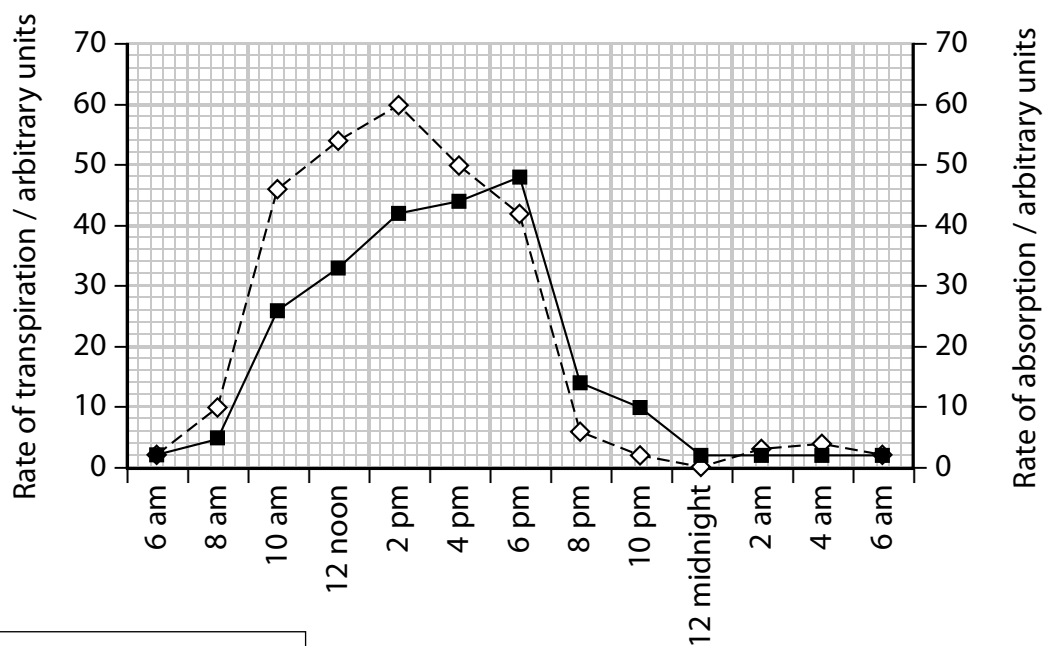
(b) Which statements describe some properties of water that are useful to plants?

- 1 Hydrogen bonding makes water a polar solvent.
- 2 Cohesive forces between water molecules allow the water to move in an unbroken stream.
- 3 Weak hydrogen bonds between water molecules attract the molecules to each other and allow water molecules to move easily in relation to one another.

(1)

- ☐ **A** 1 and 2 only
- ☐ **B** 2 and 3 only
- ☐ **C** 1 and 3 only
- ☐ **D** 1, 2 and 3

(c) The graph below shows the rates of transpiration and water absorption by a Jerusalem pine tree (*Pinus halepensis*), during a 24-hour period.



Key

- ◇-- rate of transpiration
- rate of absorption

Analyse the data to explain the relationship between these two rates during this 24-hour period.

(4)

(Total for Question 7 = 8 marks)

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Turn over for question 8

8 The velocity of the conduction of nerve impulses along an axon can be studied.

(a) Describe the structure of the cell surface membrane of an axon.

(4)

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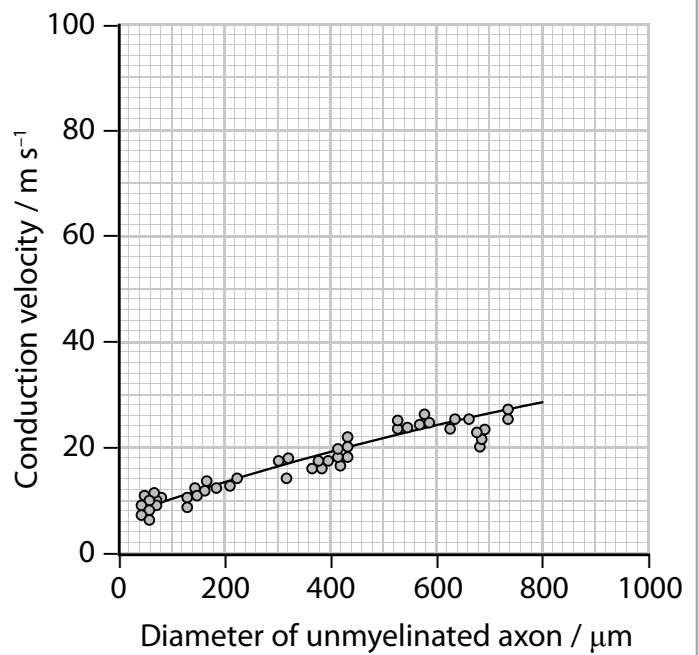
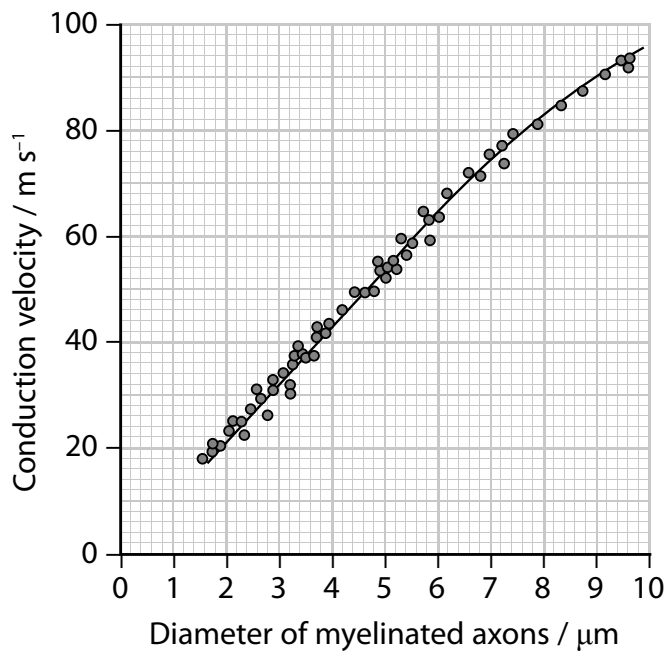
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(b) The graphs below show the conduction velocity and diameter of myelinated and unmyelinated axons.



(Source: <http://blp6.atw.hu/BLP6/HTML/C0059780323045827.htm>)

- (i) Calculate the time it would take for a nerve impulse to travel 80 cm in a myelinated axon with a diameter of 7 μm.

(2)

Answer s

* (ii) Analyse the data to explain the conduction velocity in the myelinated and the unmyelinated axons.

(6)

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(Total for Question 8 = 12 marks)

- 9 The photograph below shows a desert mammal.



(Source: <http://www.ardea.com>)

Some desert mammals do not drink water. They obtain water from the food they eat and from respiration.

- (a) Explain how water is formed in respiration.

(2)

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- (b) The table below shows the percentage of plant roots and insects in the diet of two different species of desert mammal.

Food	Percentage of food in diet (%)	
	<i>M. hurrianae</i>	<i>T. indica</i>
Plant roots	40	20
Insects	10	25

- (i) The desert mammals eat 8 g of food in one day. Calculate how many more grams of insects are eaten by *T. indica* than by *M. hurrianae*.

(2)

Answer g

- (ii) Which species has kidneys that will produce the most concentrated urine?
Justify your answer.

(2)

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- (c) Which row of the table below shows the correct changes to the concentration of sodium ions as fluid moves along the descending and ascending loop of Henle?

(1)

	Concentration of sodium ions (Na^+) in descending loop of Henle	Concentration of sodium ions (Na^+) in ascending loop of Henle
☐ A	increases	increases
☐ B	increases	decreases
☐ C	decreases	increases
☐ D	decreases	decreases

- (d) The concentration of urine is controlled by osmoreceptors and the secretion of ADH.

Which row of the table below shows the location of the osmoreceptors and the correct level of ADH secretion in a desert mammal that produces concentrated urine?

(1)

	Location of osmoreceptors	Level of ADH
☐ A	carotid body	high
☐ B	carotid body	low
☐ C	hypothalamus	high
☐ D	hypothalamus	low

(e) Explain how the nephrons of desert mammals enable them to survive in a dry environment.

(4)

(Total for Question 9 = 12 marks)

10 A defect in the cone cells of the retina can result in colour blindness.

(a) Which is the visual pigment found in cone cells?

(1)

- ☐ **A** iodopsin
- ☐ **B** opsin
- ☐ **C** retinol
- ☐ **D** rhodopsin

(b) The table below shows the distribution of different cones involved in colour blindness.

Population	Distribution of different cones / percentage of population (%)			
	Normal cones	L-cone defect	M-cone defect	S-cone defect
Men	91.40	2.45	6.14	0.01
Women	99.52	0.04	0.36	0.04

(i) The population of London is 12 million, of which 55% are men.

Calculate the number of men in London who are colour blind.

(3)

Answer

(ii) The allele for one defect in cone cells is recessive and carried on the X chromosome.

Explain why more men than women are colour blind.

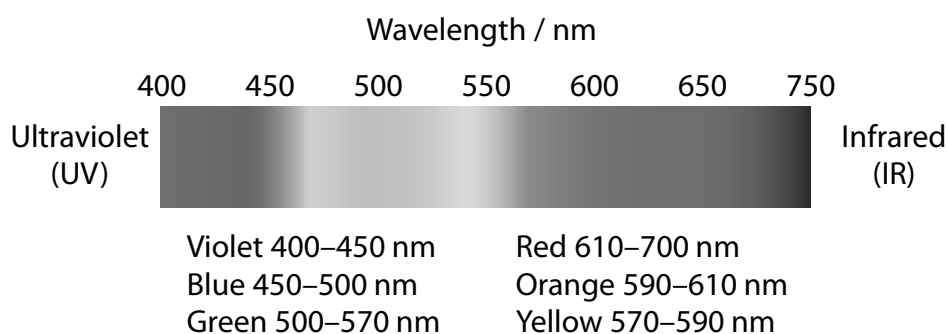
(2)

(iii) L-cones respond to long wavelengths of light.

M-cones respond to medium wavelengths of light.

S-cones respond to short wavelengths of light.

The visible light spectrum is shown below.



Analyse the data to explain why red/green colour blindness is the most common throughout the population.

(4)

(Total for Question 10 = 10 marks)

11 Light is involved in the germination of lettuce seeds. This is an example of photomorphogenesis.

The germination is affected by the wavelength of light the seeds receive.

The table below shows the percentage germination of lettuce seeds when exposed to light of different wavelengths.

Wavelength of light	Percentage germination (%)
red only	97
far red only	4
period of red followed by a period of far red	4
period of far red followed by a period of red	96

(a) Explain how red and far red light affects the germination of lettuce seeds.

(4)

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- (b) Sea plantain and bog sedge grow at a range of latitudes. A student carried out an investigation into the effect of temperature on the growth of seedlings of these two species.

Sets of seeds from each species were germinated at 18 °C. As soon as they germinated, the seedlings were placed in three temperature-controlled rooms at 10 °C, 14 °C and 18 °C.

They were allowed to grow for 50 days. Samples of seedlings were taken at 10-day intervals and their mean dry masses were recorded.

The results of this investigation are shown in the tables below.

Table 1 – Sea plantain

Day	Mean dry mass / mg		
	10 °C	14 °C	18 °C
10	3	4	6
20	7	12	20
30	13	25	47
40	20	40	109
50	28	80	210

Table 2 – Bog sedge

Day	Mean dry mass / mg		
	10 °C	14 °C	18 °C
10	1	1	1
20	1	2	2
30	2	3	5
40	3	5	12
50	5	7	22

Analyse the data to explain which of the two species is better for growth at a wider range of latitudes (distance from the equator).

(4)

(Total for Question 11 = 8 marks)

TOTAL FOR PAPER = 90 MARKS

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Biology B Paper 2 Mark Scheme

Question Number	Correct Answer	Additional guidance	Mark
1(a)	cerebrum (1)		(1)

Question Number	Correct Answer	Additional guidance	Mark
1(b)	An explanation that makes reference to one of the following pairs: • less cerebral cortex (1) • so individual has inability to do everyday tasks (1) or • smaller hippocampus (1) • so loss of memory / incapacity or inability to perform everyday tasks (1)	control movement	(2)

Question Number	Correct Answer	Additional guidance	Mark
1(c)	A description that makes reference to three of the following: • binds to active site of cholinesterase (1) • acetylcholine remains / not broken down (1) • depolarisation of post synaptic membrane continues (1) • nerve impulse continues / action potential continues (1)		(3)

(Total for Question 1 = 6 marks)

Question Number	Correct Answer	Additional guidance	Mark
2(a)	B		(1)

Question Number	Correct Answer	Additional guidance	Mark
2(b)(i)	A		(1)

Question Number	Correct Answer	Additional guidance	Mark
2(b)(ii)	C		(1)

Question Number	Correct Answer	Additional guidance	Mark
2(c)	5 squares = 1 beat 1 beat per second x 60 (1) 60 beats per minute (1)	Correct answer gains full mark	(2)

Question Number	Correct Answer	Additional guidance	Mark
2(d)	A description that makes reference to four of the following points: - increased pressure / CO₂ concentration / decreased pH detected by baroreceptors / chemoreceptors (1) - medulla oblongata (1) - sympathetic nerve stimulated (1) - release of noradrenaline (1) - excitation at SAN (1)		(4)

(Total for Question 2 = 9 marks)

Question Number	Correct Answer	Additional guidance	Mark
3(a)	An answer that makes reference to one of the following: • poached by humans for their horn (1) • <i>Arenga pinnata</i> outcompetes the food source/less food for rhino (1) • disease (1)		(1)

Question Number	Correct Answer	Additional guidance	Mark
3(b)	An explanation that makes reference to two of the following: • difficulty in finding mates (1) • so population growth is affected (1) or • loss of genetic diversity / small gene pool (1) • so less resistance to environmental change (1)		(2)

Question Number	Correct Answer	Additional guidance	Mark
3(c)	An answer that makes a reference to two of the following: • habitat maintenance / restoration / clearing <i>Arenga pinnata</i> (1) • locate breeding sites for reproduction (1) • protect the rhinos from poachers (1) • ensuring that the food source is maintained/plant more food source (1) • breeding programme outside of national park (1)		(2)

(Total for Question 3 = 5 marks)

Question Number	Correct Answer	Additional guidance	Mark
4(a)	A		(1)

Question Number	Correct Answer	Additional guidance	Mark
4(b)	B		(1)

Question Number	Correct Answer	Additional guidance	Mark
4(c)	An explanation that makes reference to three of the following: • same energy in glucose molecule as in fructose molecule (1) • fructose is sweeter than glucose so less needs to be used (1) • produce products that reduce the risk of developing obesity (1) • cost savings for food industry (1)		(3)

(Total for Question 4 = 5 marks)

Question Number	Correct Answer	Additional guidance	Mark
5(a)	both species look alike and are active at night (1)	morphologically and behaviourally similar	(1)

Question Number	Correct Answer	Additional guidance	Mark
5(b)	A description that makes reference to the following: • sample of {cells / DNA} (1) • DNA polymerase chain reaction (1) • procedure repeated several times (1) • temperature requirements (1)	e.g. 55 °C, 72 °C, 95 °C	(4)

Question Number	Correct Answer	Additional guidance	Mark
5(c)	An explanation that makes reference to the following points: • increases biodiversity / index of diversity increases (1) • as the value for {N / numerator} increases in the index of diversity (1)	Accept justification consistent with formula Correct answer gains full marks	(2)

(Total for Question 5 = 7 marks)

Question Number	Correct Answer	Additional guidance	Mark
6(a)	56 - 36 = 20 (1)		(1)

Question Number	Indicative content		
6(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 • Dissociation curve for mouse haemoglobin is to the right of the curve for elephant haemoglobin • Mouse haemoglobin has a lower affinity for oxygen • Mouse haemoglobin allows more dissociation • Mouse has bigger surface area to volume ratio • Mouse loses more heat / needs to regenerate more heat • Maintenance of body temperature • Mouse has higher metabolic rate • Mouse needs more oxygen • Accept converse answers for elephant		
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).
Level 3	5-6	The explanation shows some linkages and lines of reasoning with some structure. 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.

Question Number	Correct Answer	Additional guidance	Mark
6(c)	A		(1)

(Total for Question 6 = 8 marks)

Question Number	Correct Answer	Additional guidance	Mark
7(a)	An answer that makes reference to three of the following: • wide/large cross-sectional area to transport large volume of water (1) • empty cells/no cytoplasm so low resistance to flow (1) • thickening of the wall / lignification that strengthens the wall to prevent collapse (1) • annular/spiral thickening to allow xylem tissue to stretch during growth (1)		(3)

Question Number	Correct Answer	Additional guidance	Mark
7(b)	D		(1)

Question Number	Answer	Additional guidance	Mark
7(c)	An explanation that makes reference to the following: • transpiration rate is greater than absorption rate from 6am to 5pm because stomata are open (1) • between 5pm and midnight, the absorption rate is greater than the transpiration rate because stomata are closed (1) • lag effect because the uptake of water depends on transpiration (1) • the cohesion-tension effect (1)		(4)

(Total for Question 7 = 8 marks)

Question Number	Correct Answer	Additional guidance	Mark
8(a)	A description that links the following: • phospholipid bilayer (1) • sodium-potassium pump (1) • voltage-gated sodium ion channels (1) • (voltage-gated) potassium ion channels (1)		(4)

Question Number	Correct Answer	Additional guidance	Mark
8(b)(i)	velocity of myelinated axon = 76 m s^{-1} (1) $0.8 \div 76 = 0.01$ (1)	Accept answer derived from range 74 to 76 m s^{-1} Accept 0.011 or answers with more decimal places Correct answer gains full marks	(2)

Question Number	Indicative content	
*8(b)(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. • Increase in diameter increases conduction velocity in both axon types • More surface area for ion movement and therefore depolarisation • Conduction velocity is greater in the myelinated axon compared to the unmyelinated axon • Myelinated axons have a much smaller diameter than unmyelinated • Greater efficiency of myelinated neurones compared to unmyelinated axons • Impulse jumps from node to node / saltatory conduction • The myelin insulates • The insulation is discontinuous at nodes of Ranvier • Depolarisation only at nodes	
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 piece of scientific information. 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 pieces of scientific information. 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.

(Total for Question 8 = 12 marks)

Question Number	Correct Answer	Additional guidance	Mark
9(a)	An explanation that makes reference to the following: • reference to electron transport chain (1) • oxygen as final proton and electron acceptor (1)		(2)

Question Number	Correct Answer	Additional guidance	Mark
9(b)(i)	• 25% of 8 g = 2 g and 10% of 8 g = 0.8 g (1) • 2 g – 0.8 g = 1.2 g (1)		(2)

Question Number	Correct Answer	Additional guidance	Mark
9(b)(ii)	An answer that makes reference to the following: • <i>T. indica</i> because eats fewer plant roots (1) • plant roots contain more water than insects (1)		(2)

Question Number	Correct Answer	Additional guidance	Mark
9(c)	B		(1)

Question Number	Correct Answer	Additional guidance	Mark
9(d)	C		(1)

Question Number	Correct Answer	Additional guidance	Mark
9(e)	An explanation that makes reference to the following: • desert mammals have long loops of Henle (1) • which allows for a greater counter current multiplier effect (1) • therefore a higher concentration of solute / sodium chloride at base of the medulla (1) • which causes greater amounts of water to be reabsorbed from collecting ducts (1)		(4)

(Total for Question 9 = 12 marks)

Question Number	Correct Answer	Additional guidance	Mark
10(a)	A		(1)

Question Number	Correct Answer	Additional guidance	Mark
10(b)(i)	55% of 12 million = 6,600,000 (1) 91.4% of men have normal vision so: 100 – 91.4 = 8.6% population with CB (1) 8.6% of 6,600,000 = 567, 600 (1)	Correct answer gains full marks	(3)

Question Number	Correct Answer	Additional guidance	Mark
10(b)(ii)	An explanation that makes reference to one of the following: - males inherit one X chromosome (1) - recessive allele will always be expressed in males (1) or - females inherit 2 X chromosomes (1) - so if they inherit one recessive and one dominant allele, the recessive allele will not be expressed (1)		(2)

Question Number	Correct Answer	Additional guidance	Mark
10(b)(iii)	An explanation that makes reference to the following: • the highest percentage of defects in cones are in the L and M cones (1) • L cone is sensitive to long wavelengths of light in the red part of the visible spectrum (1) • M cone is sensitive to medium wavelengths of light in the green/ red part of the visible spectrum (1) • therefore a defect in these cones will lead to a person not being able to see light in the red/green spectrum (1)	Accept manipulation of data regarding percentage of cone defects	(4)

(Total for Question 10 = 10 marks)

Question Number	Correct Answer	Additional guidance	Mark
11(a)	An explanation that makes reference to four of the following: • red stimulates by converting P_R to P_{FR} (1) • far red inhibits by converting P_{FR} to P_R (1) • the last wavelength received determines the form of phytochrome present because the process is reversible (1) • P_{FR} is the active phytochrome (1) • genes involved in germination are switched on (1) • enzymes involved in germination are synthesised (1)		(4)

Question Number	Correct Answer	Additional guidance	Mark
11(b)	An explanation that makes reference to the following: • sea plantain (1) • idea of different latitudes have different (mean) temperatures (1) • sea plantain grows {better / eq} at all (three) temperatures / bog sedge does not grow very well at {lower temperatures / 10 °C and 14 °C} (1) • credit appropriate comparative manipulated figures (1)		(4)

(Total for Question 11 = 8 marks)

Write your name here

Surname	Other names
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Pearson Edexcel

Level 3 GCE

Centre Number

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Candidate Number

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Biology B

Advanced

Paper 3: General and Practical Principles in Biology

Sample Assessment Material for first teaching September 2015
Time: 2 hours 30 minutes

Paper Reference
9BI0/03

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

Total Marks

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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 question(s) 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 120.
- 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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Answer ALL questions.

Write your answers in the spaces provided.

- 1** The photograph below shows a mosquito net which is used in areas where malaria is common.



(Source: <http://malariaanomore.org.uk/news/uk-leads-fight-against-malaria-in-southern-sudan>)

- (a) State **two** other methods that can be used to reduce the number of new cases of malaria.

(2)

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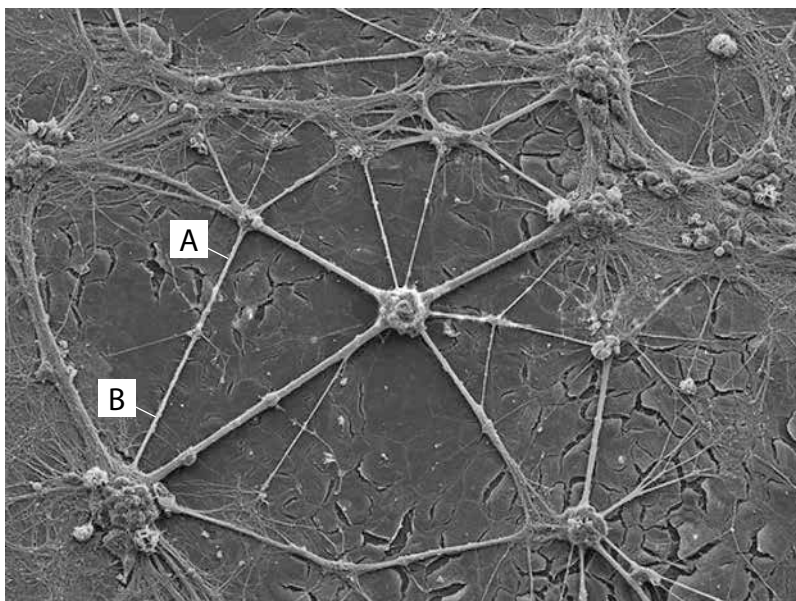
- (b) Malaria causes serious problems for pregnant women. They often suffer from a condition known as anaemia in which the ability of the blood to carry oxygen is significantly reduced.

Explain how malaria causes anaemia.

(2)

(Total for Question 1 = 4 marks)

2 The photomicrograph below shows myelinated neurones.



© C016/7131 David Scharf/Science Photo Library

Magnification $\times 226$

- (a) The time taken for an impulse to travel between two electrodes placed at the points labelled **A** and **B** was measured as 0.02 milliseconds.

Calculate the speed of the impulse.

(3)

Answerms⁻¹

- (b) The neurones of the retina are not usually myelinated. However in some eye conditions, myelination does occur.

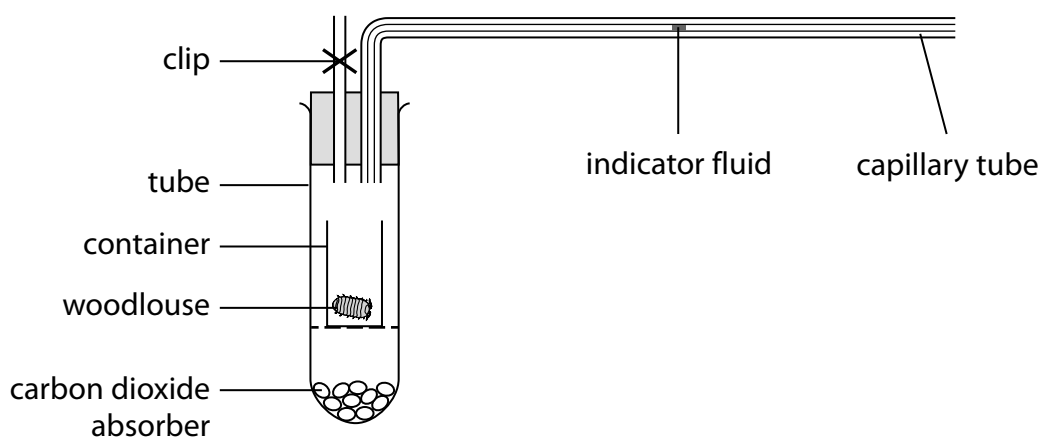
Explain why the presence of myelinated neurones in the retina might mean that a clear image will not be formed.

(3)

(Total for Question 2 = 6 marks)

- 3** The diagram below shows a simple respirometer used by a student to measure the rate of respiration of a small invertebrate called a woodlouse.

The rate was measured by observing the distance the indicator fluid moved in a known time.



- (a) Give one way in which the student could modify the procedure to obtain a better measurement of the rate of respiration.

(1)

- (b) Explain what would happen to the indicator fluid after five hours if a culture of green algae was added to the container and the tube was completely covered in light-proof paper.

(4)

- (c) (i) The student wanted to compare the rate of respiration of a mouse with that of a woodlouse.

Explain how you could modify the procedure used to measure the rate of respiration of the woodlouse so that it could be used to compare with the rate of respiration of a mouse.

Your answer should explain the reasons for the modifications and include reference to the ethical treatment of the animal, and show how you could produce valid results.

(5)

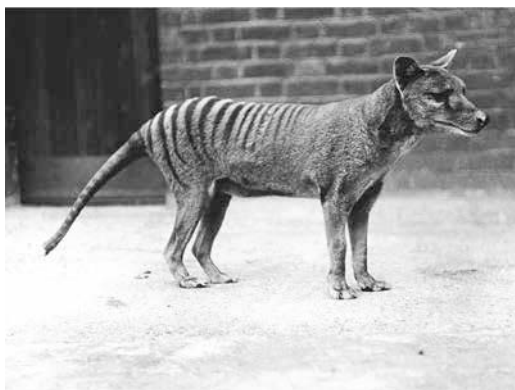
- (ii) Comment on how the results you would expect to obtain for a mouse would differ from the results for a woodlouse.

(2)

(Total for Question 3 = 12 marks)

4 The photographs below show three mammals.

Tasmanian wolf (*Thylacinus cynocephalus*)



© The Zoological Society

Grey wolf (*Canis lupus*)



(Source: http://www.animalgalleries.org/Large-Land-Mammals/Wolf/Grey+Wolf+Mexican_Wolf_065+Canis+Lupus.jpg.php)

Dunnart (*Sminthopsis crassicaudata*)



5 cm

(Source: apscience.org.au)

The evolutionary relationships between these three mammals were investigated. The DNA base sequence of part of the gene for 12S ribosomal RNA from each mammal was analysed.

Tasmanian wolf	CCTGGCCTTACTGTTAATTCTTATTAGACCTAC
Grey wolf	CCTAGCCTTCCTATTAGTTTTTAGTAGACTTAC
Dunnart	CCTAGCCTTACTGTTAATTTTTATTAGACCTAC

- (a) Explain which two of these mammals are most closely related in their evolutionary history.

(2)

- (b) The Tasmanian wolf is a marsupial mammal. In marsupials, the young are born in a tiny, immature form and move into a pouch on the abdomen of the mother to develop further.

The grey wolf is a placental mammal. The fetus develops inside the uterus and the larger young are born in a more mature form.

The ancestors of Tasmanian wolves and grey wolves once shared similar habitats.

Explain why grey wolves and their close relatives are now found in many parts of the world but Tasmanian wolves only survived on isolated islands.

(3)

(Total for Question 4 = 5 marks)

5 Streak plating is used in microbiology to separate individual species of bacteria from a mixed liquid culture.

(a) Describe how streak plating can be used to isolate individual bacterial colonies from a mixed liquid culture.

You may use a diagram in your answer.

(5)

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(b) Explain why agar plates should be incubated below 30°C in a school laboratory.

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(Total for Question 5 = 7 marks)

- 6 A student carried out an investigation to test the hypothesis that the surface area to mass ratio of leaves is affected by the amount of light they receive.

A nettle plant growing in sunlight and a second nettle plant growing in shade in a wood were selected.

The surface area and mass of several leaves were measured and the surface area to mass ratio was calculated. The table below shows the results.

Leaf	Surface area to mass ratio / $\text{cm}^2 \text{g}^{-1}$	
	Nettle plant growing in sunlight	Nettle plant growing in shade
1	114.5	118.9
2	114.0	117.8
3	115.2	118.1

- (a) Explain how the data shows how nettle plant leaves grown in the shade are adapted to growing in low light intensities.

(3)

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- Give five ways in which the student could modify the investigation to address these concerns.

(5)

[illegible]

(Total for Question 6 = 8 marks)

- 7 An investigation was carried out to determine the effect of substrate concentration on the initial rate of an enzyme-controlled reaction.

The substrate used was powdered milk, which is made up of a protein called casein. A solution of powdered milk is a cloudy white colour.

Protease enzymes will break down the casein in powdered milk to form a clear solution.

A colorimeter can be used to measure the amount of light absorbed by a solution in a tube. A cloudy solution absorbs more light.

5 cm³ of 0.1% solution of powdered milk was added to a colorimeter tube and mixed with 0.1 cm³ of a protease enzyme. The mixture was quickly placed in the colorimeter and the absorption of the solution was then recorded every 10 seconds for 30 seconds.

This was then repeated using different concentrations of casein.

- (a) Explain why it is important to measure the initial rate of enzyme-catalysed reactions.

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- (b) A student carrying out this investigation recorded the data shown in the table below.

Casein concentration (%)	Absorption (arbitrary units)			
	0 s	10 s	20 s	30 s
0.1	0.15	0.10	0.05	0.05
0.2	0.44	0.34	0.23	0.15
0.3	0.67	0.49	0.32	0.16
0.4	0.87	0.65	0.43	0.22
0.5	0.98	0.75	0.52	0.26

- (i) Explain why using all of the absorption data from every concentration of casein would not give a valid comparison of initial rates.

(2)

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- (ii) Explain how the results obtained could be used in the design of an investigation to compare the activity of proteases from different mammals.

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(Total for Question 7 = 7 marks)

- 8 A student investigating the factors affecting the heart rate of humans carried out a trial to find out the most reliable method of counting the number of heartbeats in one minute.

She counted the number of pulses in one minute of a single subject in identical conditions using two different methods.

Method A – she counted the number of pulses for 15 seconds and multiplied the result by 4.

Method B – she counted the number of pulses continuously for one minute.

The table below shows the results of six trials for each method.

Method	Pulse rate / beats min ⁻¹						Mean pulse rate / beats min ⁻¹	Standard deviation
A	64	60	68	76	64	72	67.3	5.9
B	63	59	69	58	71	74	65.7	

- (a) The student calculated the standard deviation for method A using the following formula:

$$\sigma = \sqrt{\frac{\sum [x - \bar{x}]^2}{n - 1}}$$

Calculate the standard deviation for method B.

(3)

Answer

(b) Explain why standard deviation is used for analysing the data.

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(c) Explain why both methods **A** and **B** can lead to inaccuracies.

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(Total for Question 8 = 9 marks)

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9 Antibiotics have been developed to control bacterial infections.

(a) Name **one** bacterium which causes symptoms of infection by producing exotoxins.

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(b) Explain how an antibiotic has a bacteriostatic effect on bacteria.

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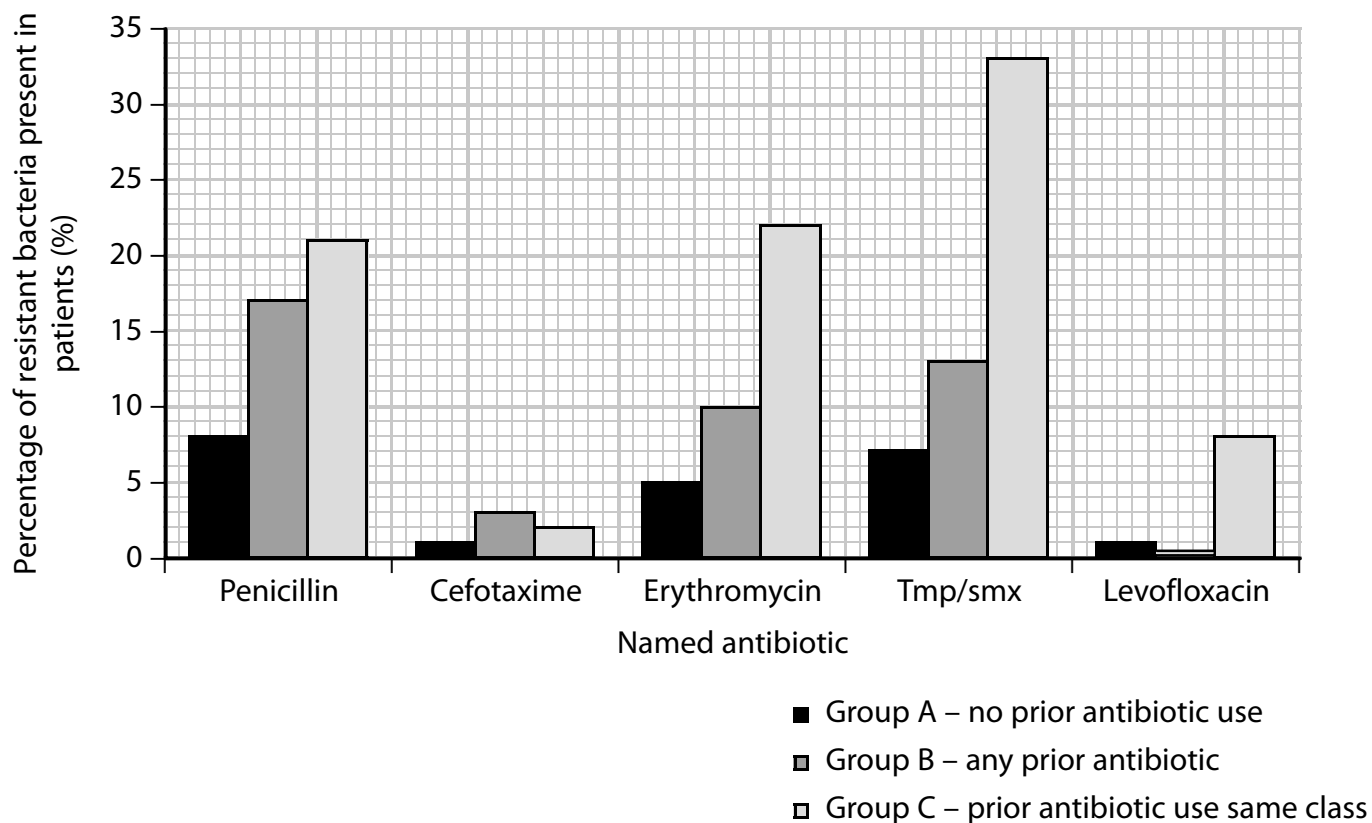
*(c) Bacterial resistance to common antibiotics is an increasingly serious problem facing doctors treating a wide range of infections.

The graph below shows the percentage of resistant bacteria in patients being treated with antibiotics for *Streptococcus pneumoniae* infections.

Group A had never been given antibiotics.

Group B had been previously treated with other antibiotics.

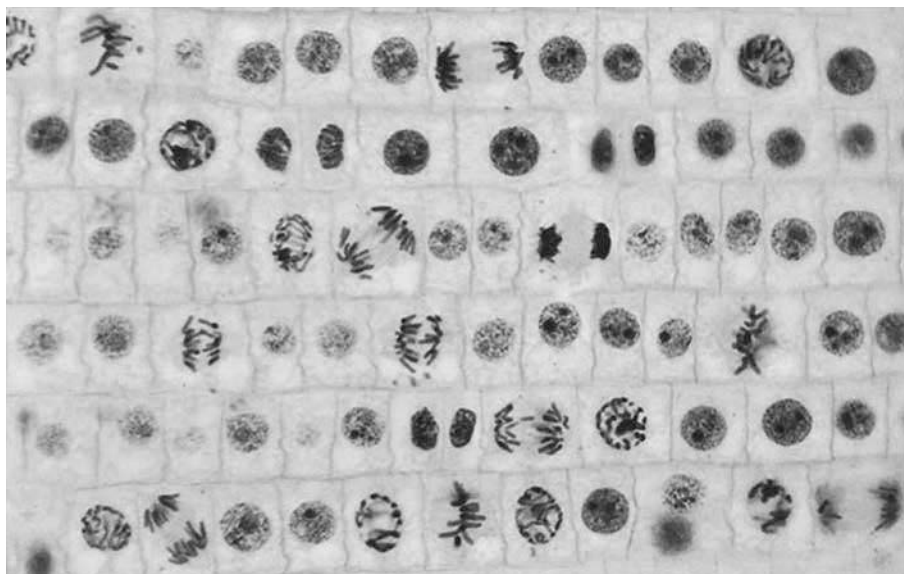
Group C had been previously treated with the named antibiotic.



(9)

119

10 The photomicrograph below shows a stained squash preparation of an onion root tip.



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- (a) Describe how you would prepare a root tip squash to observe the stages of mitosis under the light microscope.

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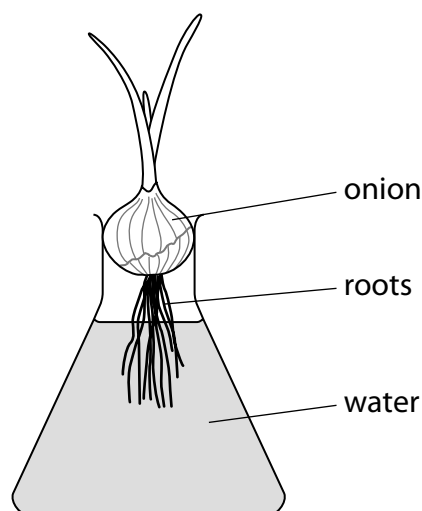
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- (b) A student decided to investigate how many cells were undergoing cell division in different areas of a root. She grew some onion roots in a conical flask containing water, as shown in the diagram below.



She examined a root tip squash and counted the number of cells undergoing mitosis and the total number of cells in the field of view and calculated the mitotic index using the following formula.

$$\text{Mitotic index in \%} = \frac{\text{Number of cells undergoing mitosis}}{\text{Total number of cells viewed}} \times 100$$

The student determined the mitotic index of cells at five distances from an onion root tip. She repeated this procedure six times.

Her results are shown in the table below.

Distance from root tip / mm	Mitotic index (%)							Standard deviation (SD)
	Root tip						Mean	
	1	2	3	4	5	6		
0.1	11.5	11.0	10.7	10.6	11.7	10.9	11.1	0.4
0.3	9.4	8.9	7.8	9.9	9.7	8.9	9.1	0.8
0.5	8.1	8.9	7.6	7.7	8.4	7.5	8.0	0.5
0.9	4.0	3.9	3.6	4.2	4.4	3.7	4.0	0.3
1.1	3.0	2.9	3.2	3.3	2.7	2.9	3.0	0.2

The student concluded that there is a negative correlation between the mitotic index and the distance from the root tip in plants.

However, this conclusion may not be valid because the investigation has limitations.

- (i) Give one way in which the student could modify her procedure to reduce the effect of a named limitation.

(1)

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- (ii) Weeds reduce the yield of commercial crops that grow in fields. Some herbicides that are sprayed onto soil kill weeds by preventing mitosis.

Explain how the student could modify her investigation to find the herbicide concentration that is most effective at preventing mitosis.

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- (c) In an investigation to determine the quantity of DNA in the nucleus of different cells from the plant *Tradescantia paludosa*, squash preparations of each tissue were stained for DNA in an identical manner.

The quantity of DNA in the nucleus of several cells was found by measuring the amount of light absorbed when the microscope was focused on a small area of the nucleus.

The results of this investigation are shown in the table below.

Nucleus of	Mean nuclear absorption / arbitrary units
Root tip cells in prophase	16.2
Root tip cells undergoing cytokinesis	8.3
Nucleus of pollen tube	4.2
Nucleus of endosperm	12.8

Analyse the data to explain the difference in the mean nuclear absorption of the nucleus of the different cells.

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(Total for Question 10 = 13 marks)

11 A student investigated the rate of uptake of nitrate ions (NO_3^-) into plant cells.

Discs of carrot were cut and half of them were immersed in a solution containing $10 \mu\text{mol dm}^{-3}$ nitrate ions. The other half were placed in the same nitrate ion solution to which 2,4-dinitrophenol (DNP) was added.

DNP inhibits the process of oxidative phosphorylation.

The nitrate ion concentration of the discs was determined every five minutes.

The student failed to pre-treat the carrot discs before placing them in the solution.

(a) Explain how the carrot discs should be pre-treated.

(3)

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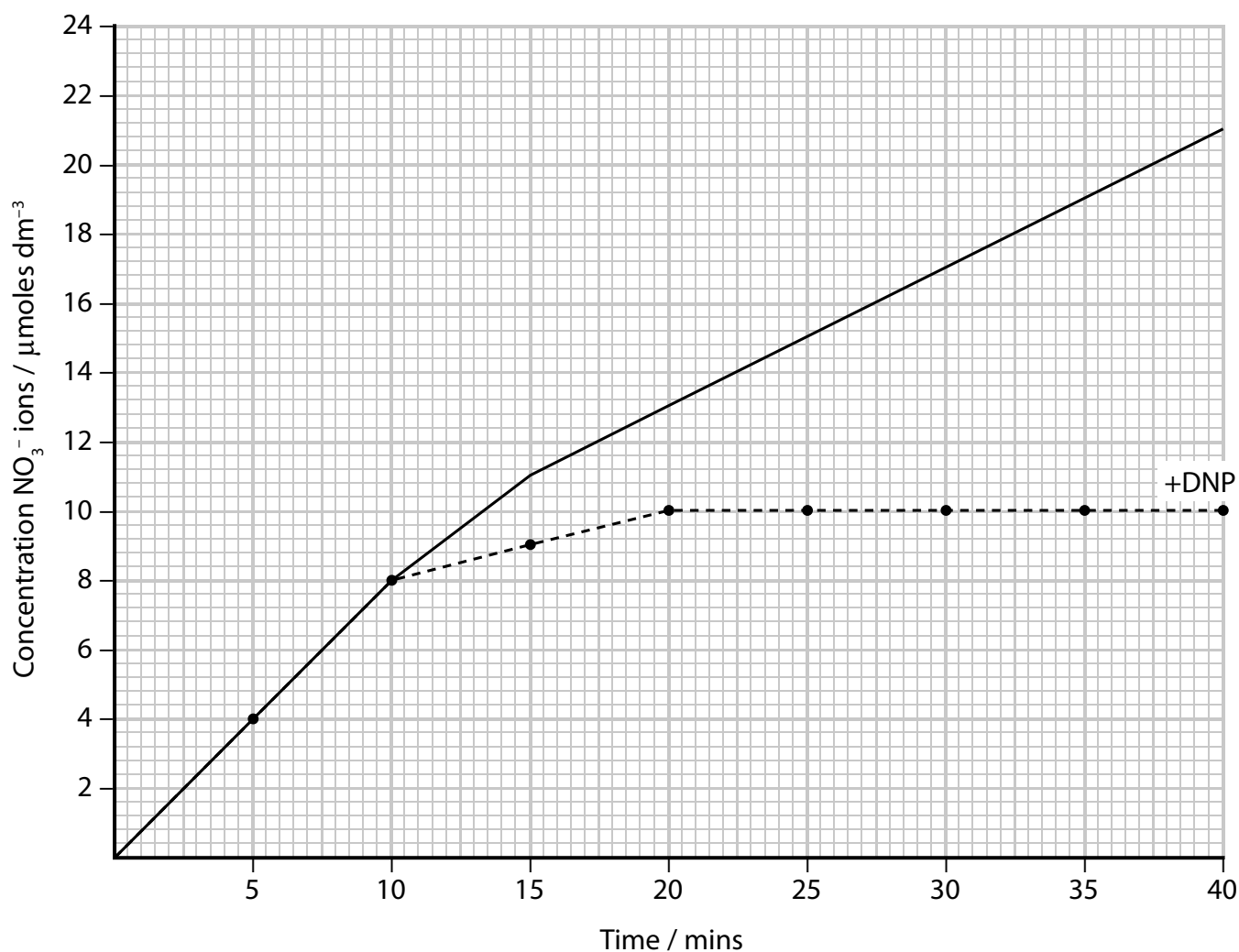
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The graph below shows the results of this investigation after the carrot discs were pre-treated.



(b) Calculate the mean rate of nitrate ion uptake of the carrot discs placed in the nitrate ion solution without DNP between 5 and 10 minutes.

(3)

Answer

(c) Analyse the data to explain the effect of DNP on the nitrate ion uptake of the carrot tissue between 0 to 10 minutes and 20 to 30 minutes.

(3)

(d) DNP acts by rapidly transferring protons (H^+ ions) across biological membranes.

Explain how this action will bring about the effect of DNP on oxidative phosphorylation.

(3)

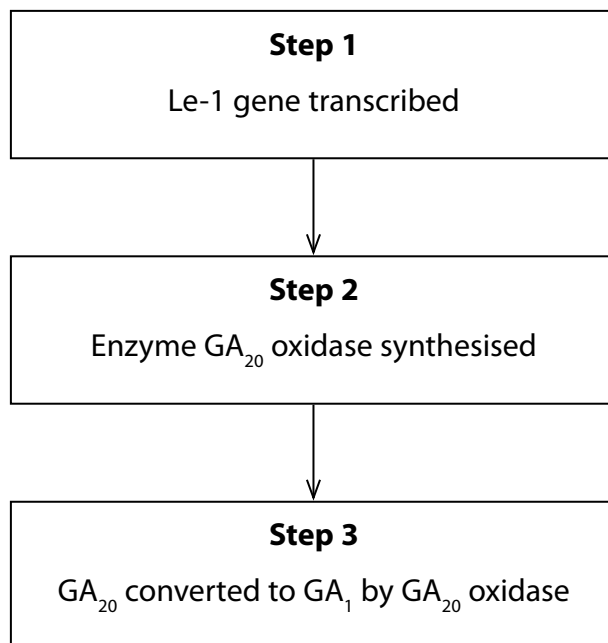
(Total for Question 11 = 12 marks)

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Turn over for question 12

- 12** 'DELLA' proteins normally prevent transcription factors from binding to important growth-stimulating genes in the cells of plant stems.

The diagram below shows part of the biochemical pathway leading to the synthesis of an active plant growth substance called gibberellin (GA_1). GA_1 reduces the effect of 'DELLA' proteins.



- (a) The Le-1 gene codes for the enzyme GA_{20} oxidase. A mutation of this gene forms a recessive allele which, when translated, leads to a single amino acid change in this enzyme. This change significantly reduces the activity of GA_{20} oxidase.

Explain how a single amino acid change can bring about a change in the structure and activity of GA_{20} oxidase.

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(b) (i) Explain why homozygous recessive plants will have short stems.

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(ii) An ecological survey of a stable population of one species of plant found that 36% had short stems.

Calculate the percentage of heterozygous individuals in this population.
Assume that there are only two alleles for this gene.

(4)

Answer

(Total for Question 12 = 12 marks)

13 The photograph below shows limpets *Patella vulgata* living on a rocky seashore.

Limpets are snail-like animals with a conical shell. The limpets live on a part of the shore which is covered by the sea twice each day. They feed on algae when the rocks are covered with sea water.

When they are uncovered at low tide they clamp against the rock to prevent desiccation.



A student investigated the relationship between the size of the limpets and their location on the shore.

A 40 m transect was used, beginning at the low water mark and extending up a sloping rocky shore. A 1 m² quadrat was placed every 5 m along this transect and the diameter of 10 randomly selected limpets was measured.

The table below shows data collected from this investigation.

Distance from low water mark / m	Rank of distance	Mean diameter of limpets / mm	Rank of diameters	Difference in the two ranks (D)	D ²
0	9	19.8	3	6	36
5	8	20.2	1	7	49
10	7	19.6	4	3	9
15	6	18.8	5	1	1
20	5	20.1	2	3	9
25	4	17.4	6	-2	4
30	3	16.1			
35	2	16.9	8	-6	36
40	1	17.2			

(a) Complete the table on the previous page to show the missing data.

(2)

(b) (i) To test the strength of the relationship between these two variables, the student decided to apply a Spearman's rank correlation test.

Calculate the Spearman's rank correlation coefficient for these two variables.

(3)

$$r_s = 1 - \frac{6(\sum D^2)}{n(n^2 - 1)}$$

Answer

- (ii) A student formed the hypothesis that the size of the limpets would decrease as the distance up the shore increased.

The table below shows critical values of r_s at different significance levels.

Number of pairs	Significance levels			
	10%	5%	2%	1%
8	0.643	0.786	0.833	0.881
9	0.600	0.683	0.783	0.833
10	0.564	0.648	0.746	0.794

Use the calculated value of r_s and this table to comment on whether the student's hypothesis can be accepted.

(3)

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(c) The student carrying out the investigation wrote a further hypothesis:

'The limpets lower on the shore have a longer time to feed and will grow bigger.'

Design a laboratory experiment to test this hypothesis.

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(Total for Question 13 = 13 marks)

TOTAL FOR PAPER = 120 MARKS

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Biology B Paper 3 Mark Scheme

Question Number	Correct Answer	Additional guidance	Mark
1(a)	An answer that makes reference to two of the following: • drain land to reduce mosquito larvae habitats (1) • use of mosquito repellent to prevent bites (1) • reduce mosquito population by use of insecticides (1)		(2)

Question Number	Correct Answer	Additional guidance	Mark
1(b)	An explanation that makes reference to the following: • malarial {parasite/merozoite} {invades/destroys} red blood cells (1) • therefore reduced haemoglobin {red cell count} which causes anaemia (1)		(2)

(Total for Question 1 = 4 marks)

Question Number	Correct Answer	Additional guidance	Mark
2(a)	Measurement from diagram: 2.1 cm = 0.021 m (1) Actual distance: $0.021 \text{ m} \div 226 = 9.2 \times 10^{-4} \text{ m}$ (1) Calculate speed: $0.02 \text{ ms} = 2.0 \times 10^{-5} \text{ s}$ $9.2 \times 10^{-4} \text{ m} \div 2.0 \times 10^{-5} \text{ s} = 4.65 \text{ ms}^{-1}$ (1)	e.c.f. at any stage penalise once only Correct answer gains full marks with no working	(3)

Question Number	Correct Answer	Additional guidance	Mark
2(b)	An explanation that makes reference to the following: • myelin may absorb / reflect light (1) • therefore less light passes to light sensitive cells (1) • hence some rod / light sensitive cells not stimulated / bleached (1)		(3)

(Total for Question 2 = 6 marks)

Question Number	Correct Answer	Additional guidance	Mark
3(a)	An answer that makes reference to the following: • measure volume by use of {formula / three way tap and syringe} (1)		(1)

Question Number	Correct Answer	Additional guidance	Mark
3(b)	An explanation that makes reference to the following: • the indicator fluid movement would move to the left (1) • because there is lower pressure (1) • because there is respiration but no photosynthesis (1) • therefore the pressure is reduced because the carbon dioxide produced is absorbed (1)		(4)

Question Number	Correct Answer	Additional guidance	Mark
3(c)(i)	An explanation that makes reference to five of the following: • use of a larger container because mice are bigger (1) • need to use more carbon dioxide absorber to ensure all carbon dioxide is absorbed (1) • convert readings into units per gram for each animal (1) • attach a syringe to enable {repeat measurements / volume measurements}(1) • abiotic variables such as light / temperature to be same as in the woodlouse experiment (1) • barrier to protect mouse from carbon dioxide absorber / do not leave mouse in the container for a long time (1)		(5)

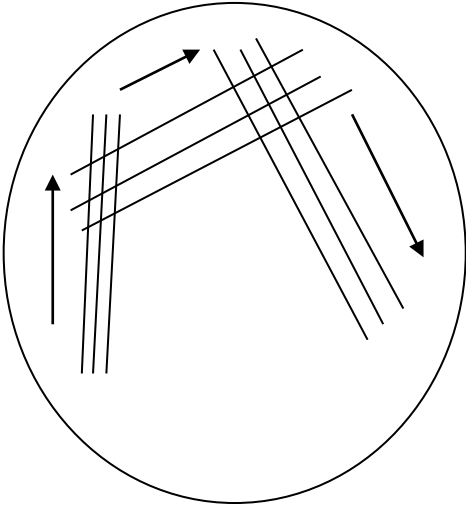
Question Number	Correct Answer	Additional guidance	Mark
3(c)(ii)	An answer that makes reference to the following: • mouse rate of respiration greater than woodlouse (1) • because mice are endotherms / metabolic rate greater / need to maintain body temperature because of heat loss (1)		(2)

(Total for Question 3 = 5 marks)

Question Number	Correct Answer	Additional guidance	Mark
4(a)	An explanation that makes reference to the following: • Tasmanian wolf and Dunnart more closely related (1) • because there are fewer base differences between Dunnart and the Tasmanian wolf than between the grey wolf and Tasmanian wolf (1)	For answers relating to grey wolf and Dunnart Base differences quantified {only 2 differences between Tasmanian wolf and Dunnart but 5 between grey wolf and Dunnart, and 7 between grey wolf and Tasmanian wolf}	(2)

Question Number	Correct Answer	Additional guidance	Mark
4 (b)	An explanation that makes reference to the following: • placental mammal/grey wolf has more successful reproduction than marsupial mammal/ Tasmanian wolf (1) • because young are born more {developed/mature}marsupial offspring very small so less likely to survive (1) • therefore grey wolves outcompete Tasmanian wolves unless Tasmanian wolves are geographically isolated (1)		(3)

(Total for Question 4 = 5 marks)

Question Number	Correct Answer	Additional guidance	Mark
5(a)	 A description that makes reference to the following: • <u>flame</u> a wire loop / use of <u>sterile</u> swab (cotton bud) (1) • first streaks of sample in straight /zig-zag lines on surface of <u>sterile</u> agar plate (1) • at least 3 streaks in total (1) • second and third streak must pass through lines of previous streak (1) • incubate and take off individual colonies with wire loop (1)	Accept points from an appropriately labelled diagram (must be labelled if not described in text)	(5)

Question Number	Correct Answer	Additional guidance	Mark
5(b)	An explanation that makes reference to the following: • above 30 °C close to human body temperature (1) • so risk of incubating human pathogens which could infect students (1)	Reject higher temperature might kill off some bacteria	(2)

(Total for Question 5 = 7 marks)

Question Number	Correct Answer	Additional guidance	Mark
6(a)	An explanation that makes reference to the following: - the shaded leaves have a larger surface area to mass ratio and are therefore bigger and thinner than leaves in the sun (1) - bigger allows more {chloroplasts / chlorophyll} for absorption of light (1) - thinner allows shorter diffusion path for entry of carbon dioxide (1)		(3)

Question Number	Correct Answer	Additional guidance	Mark
6(b)	An explanation that makes reference to five of the following: - growing nettles in {pots / eq} to ensure soil pH / {mineral/ named mineral} content in pots is the same (1) {measure / control} the {light intensity / duration} for both treatments to ensure light intensities are different (1) - watering regime is the same in both treatments to ensure same potential for leaf growth (1) - use {groups of pots / measure more leaves} so that data collected is reliable (1) - use genetically identical nettles in each treatment as some genes may affect growth (1) - make sure that all pathogens / consumers are prevented from access as they can reduce growth (1)		(5)

(Total for Question 6 = 8 marks)

Question Number	Correct Answer	Additional guidance	Mark
7(a)	An explanation that makes reference to the following: • initial concentration of casein will change quickly (1) • because enzymes cause large increase in reaction rates (1) • therefore only initial rate will measure the speed of reaction at the correct value of the independent variable/concentration of casein (1)	Active site occupation Substrate becomes limiting	(3)

Question Number	Correct Answer	Additional guidance	Mark
7(b)(i)	An explanation that makes reference to the following: • absorption has not decreased for 0.1% from 20 s to 30 s/reaction has stopped after 20 s/substrate has been used up (1) • but all other concentrations show a consistent change every 10 s for the whole 30 s (1)		(2)

Question Number	Correct Answer	Additional guidance	Mark
7(b)(ii)	An explanation that makes reference to the following: • an appropriate casein concentration chosen because substrate is not limiting (1) • absorption recorded in first 20s in order to obtain initial rates (1)		(2)

(Total for Question 7 = 7 marks)

Question Number	Correct Answer	Additional guidance	Mark
8(a)	- Numerator = 219.34 (1) - Denominator = 5 (1) - Standard deviation = 6.6 (1)	Correct answer gains full marks	(3)

Question Number	Correct Answer	Additional guidance	Mark
8(b)	An explanation that makes reference to the following: - S.D. shows variation from the mean (1) - a larger S.D. means greater spread, smaller S.D. is more reliable representation of the data (1) - therefore although ranges of A and B are the same, the S.D. shows there is more variation in the data for method B (1)	S.D. indicates spread of data	(3)

Question Number	Correct Answer	Additional guidance	Mark
8(c)	An explanation that makes reference to the following: - for method A if there is an error made it is multiplied by four, when calculating pulse rate per minute (1) - for method B counting for one minute may lead to inaccuracy due to loss of concentration (1) - both methods are measuring pulse rate rather than heart rate (1)		(3)

(Total for Question 8 = 9 marks)

Question Number	Correct Answer	Additional guidance	Mark
9(a)	<i>Staphylococcus</i> spp.		(1)

Question Number	Correct Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to the following: - the number of living bacteria does not increase (1) - because cell division is prevented (1)	Accept more sophisticated answers that give details of how cell division is prevented	(2)

Question Number	Indicative content
*9(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. Candidates are expected to reach a decision/conclusion on whether the development of bacterial resistance is so serious and rapid that antibiotics will become ineffective in the treatment of the majority of bacterial infections. • Prior use of antibiotics increases the percentage of resistant bacteria, supported by quantitative data • Prior use of the named antibiotic has the greatest effect, supported by quantitative data • Increasing use of antibiotics increases selection pressures so more resistant strains • Shows understanding that resistance mechanisms are inherited by sexual means and lateral gene transfer, e.g. via plasmids and this means they can spread rapidly and in some cases across species • Bacteria have high reproduction rates and mutations more likely within a short time • Understands current methods used to limit increase in resistant strains such as strict controls on antibiotic prescribing, problems of ensuring patients complete course of treatment when symptoms disappear, limit use of antibiotics in animal husbandry etc. • Comments on difficulties of developing new drugs • Methods of preventing spread of resistant strains especially hospital infection • Movement of humans means that transfer of resistant strains will spread to new hosts more easily

Level	Mark	Descriptor
	0	No awardable material
Level 1	1-3	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 2	4-6	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	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 9 = 12 marks)

Question Number	Correct Answer	Additional guidance	Mark
10(a)	A description that makes reference to the following: • use of named fixative, e.g. fixation in ethanoic (acetic) ethanol (1) • remove 2 mm (accept 1 mm > 3 mm) of the tip and place on a slide (1) • add named stain for DNA {acetic or propanoic orcein / toluidene blue / Feulgen} (1) • add cover slip and press firmly vertically / without moving the cover slip (1)		(4)

Question Number	Correct Answer	Additional guidance	Mark
10(b)(i)	An explanation that makes reference to one of the following: • species – use other plant roots (1) • water culture used – grow in soil (1) • light – cover conical flask with opaque material (1) • distance – look at cells further from the root tip (1)		(1)

Question Number	Correct Answer	Additional guidance	Mark
10(b)(ii)	An explanation that makes reference to five of the following: • use of weeds grown {in a range of herbicide concentrations and without herbicide / units for range of herbicide concentrations to be used} to allow valid comparison (1) • weed roots exposed to herbicide for same time because time of exposure may affect mitosis (1) • compare MI of cells at same distance(s) because MI is different at different distances from the root tip (1) • reference to same abiotic factor such as {light / temperature / soil / field} because any of these may affect MI (1) • use of root tips that are the same {age / length} because these may affect MI (1) • plot graph to show the relationship between herbicide concentration and MI to allow lowest concentration that works to be identified (1)		(5)

Question Number	Correct Answer	Additional guidance	Mark
10(c)	An explanation that makes reference to three the following: • prophase absorbs twice as much light as cytokinesis because DNA/chromosome has replicated prior to prophase so twice as much DNA present (1) • as pairs of chromatids have separated in cytokinesis therefore DNA is reduced by half (1) • endosperm nucleus has 3 x DNA in pollen tube nucleus because a pollen tube nucleus {has only one set of chromosomes / haploid chromosome number} is produced by meiosis (1) • and the endosperm tissue has a triploid set of chromosomes (1)		(3)

(Total for Question 10 = 13 marks)

Question Number	Correct Answer	Additional guidance	Mark
11(a)	An explanation that makes reference to the following: • wash immerse in water / water without nitrate ions (1) • at a suitable temperature / stated temperature (less than 25 °C) (1) • reference to sterile water (1)		(3)

Question Number	Correct Answer	Additional guidance	Mark
11(b)	An answer that makes reference to the following: • reading from graph 5 mins = 4 $\mu\text{mol dm}^{-3}$ 30 mins = 8 $\mu\text{mol dm}^{-3}$ (1) • mean rate = increase $\div$ time (4 $\div$ 5) (1) • correct answer with units = 0.8 $\mu\text{mol dm}^{-3} \text{ min}^{-1}$ (1)	Candidate must state units for full marks	(3)

Question Number	Correct Answer	Additional guidance	Mark
11(c)	An explanation that makes reference to the following: • rate the same for both solutions between 0–10 minutes because initial uptake in both by (passive) diffusion (1) • rate with DNP zero between 20–30 minutes because uptake requires {energy / ATP} for active transport (1) • DNP prevents formation of ATP by chemiosmosis (1)		(3)

Question Number	Correct Answer	Additional guidance	Mark
11(d)	An explanation that makes reference to the following: • DNP transports protons across the inner mitochondrial membrane (1) • therefore preventing the establishment of a gradient across the membrane (1) • which prevents the formation of ATP (1)	cristae Accept inhibits interaction between protons and ATP synthase	(3)

(Total for Question 11 = 12 marks)

Question Number	Correct Answer	Additional guidance	Mark
12(a)	An explanation that makes reference to the following: • {Active site changes shape / not correctly formed} and no longer an efficient 'fit' to substrate (1) • because if one amino acid is changed then these bonds cannot form (1) • because only certain amino acids (e.g. cysteine needed for S – S bonding) can form disulphide bridges/hydrogen bonds/ionic bonds (1) • and these bonds are important in the formation of a tertiary/3D protein structure (1)		(4)

Question Number	Correct Answer	Additional guidance	Mark
12(b)(i)	An explanation that makes reference to the following: • (reduced activity of GA₂₀ oxidase means) less active GA₂₀ is produced (1) • therefore less GA₂₀ means more DELLA proteins present (1) • hence more DELLA proteins means fewer transcription factors binding to growth regulator genes (1) • therefore resulting in growth regulator genes not expressed / growth less because transcription factors needed for expression of genes (1)	Less DELLA protein broken down	(4)

Question Number	Correct Answer	Additional guidance	Mark
12(b)(ii)	• equation $p^2 + 2pq + q^2 = 1$ (1) • $p^2 = 0.36$ so $p = 0.6$ (1) • $q = 0.4$ so $2pq = 2 \times 0.6 \times 0.4$ (1) • correct answer 48% (1)		(4)

(Total for Question 12 = 12 marks)

Question Number	Correct Answer	Additional guidance	Mark																																																																		
13(a)	<table><thead><tr><th>Distance from low water mark / m</th><th>Rank of distance</th><th>Mean diameter of limpets / mm</th><th>Rank of diameters</th><th>Difference in the two ranks (D)</th><th>D²</th></tr></thead><tbody><tr><td>0</td><td>9</td><td>19.8</td><td>3</td><td>6</td><td>36</td></tr><tr><td>5</td><td>8</td><td>20.2</td><td>1</td><td>7</td><td>49</td></tr><tr><td>10</td><td>7</td><td>19.6</td><td>4</td><td>3</td><td>9</td></tr><tr><td>15</td><td>6</td><td>18.8</td><td>5</td><td>1</td><td>1</td></tr><tr><td>20</td><td>5</td><td>20.1</td><td>2</td><td>3</td><td>9</td></tr><tr><td>25</td><td>4</td><td>17.4</td><td>6</td><td>-2</td><td>4</td></tr><tr><td>30</td><td>3</td><td>16.1</td><td>9</td><td>-6</td><td>36</td></tr><tr><td>35</td><td>2</td><td>16.9</td><td>8</td><td>-6</td><td>36</td></tr><tr><td>40</td><td>1</td><td>17.2</td><td>7</td><td>-6</td><td>36</td></tr><tr><td colspan="4"></td><td>$\Sigma D^2 =$</td><td>216</td></tr></tbody></table>	Distance from low water mark / m	Rank of distance	Mean diameter of limpets / mm	Rank of diameters	Difference in the two ranks (D)	D ²	0	9	19.8	3	6	36	5	8	20.2	1	7	49	10	7	19.6	4	3	9	15	6	18.8	5	1	1	20	5	20.1	2	3	9	25	4	17.4	6	-2	4	30	3	16.1	9	-6	36	35	2	16.9	8	-6	36	40	1	17.2	7	-6	36					$\Sigma D^2 =$	216		(2)
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	• differences in ranks of distance and diameter (1) • D² values correct (1)																																																																				

Question Number	Correct Answer	Additional guidance	Mark
13(b)(i)	• $6 \Sigma D^2 = 1296$ (1) • $n(n^2-1) = 720$ (1) • Correct r_s value = $-0.8(00)$ (1)	e.c.f. from (a) Correct answer (with minus sign) gains full marks Must be minus sign for marking point 3	(3)

Question Number	Correct Answer	Additional guidance	Mark
13(b)(ii)	An answer that makes reference to the following: • there is a <u>significant negative correlation</u> between diameter of a limpet and height up the rocky shore (1) • because calculated value is greater than critical value (1) • at 5% significance level / 0.683 quoted (1)	Accept 2% or 1% critical value for m.ps 1 and 2 only Where no value is calculated in (b)(i) then accept marks in b(ii) for MP2 and 3 for theoretical explanation E.g. 'if value of r_s was greater than critical value (0.683) then there would be a significant correlation' would gain 2 marks	(3)

Question Number	Correct Answer	Additional guidance	Mark
13(c)	An answer that makes reference to five of the following: • limpets kept in sea-water in tanks at the same {temperature / salinity} as they affect growth (1) • suitable number of {limpets in each tank / tanks containing limpets} to ensure reliability (1) • size of limpets in each tank selected to be within (narrow) range to start / or same distribution of sizes to ensure same potential for growth (1) • provision of food for limpets in equal amounts in each tank as food affects growth (1) • withdrawal of water from tanks for different periods of time (1) • size measured {mass / diameter / area of foot} because dependent variable must be quantitative to allow for statistical testing (1)		(5)

(Total for Question 13 = 13 marks)

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