edexcel

INTERNATIONAL ADVANCED LEVEL

BIOLOGY

SAMPLE ASSESSMENT MATERIALS

Pearson Edexcel International Advanced Subsidiary in Biology (XBI11)
Pearson Edexcel International Advanced Level in Biology (YBI11)
First teaching September 2018
First examination from January 2019
First certification from August 2019 (International Advanced Subsidiary)
and August 2020 (International Advanced Level)

Pearson

Edexcel, BTEC and LCCI qualifications

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Contents

Introduction

The Pearson Edexcel International Advanced Subsidiary in Biology and the Pearson Edexcel International Advanced Level in Biology are part of a suite of International Advanced Level qualifications offered by Pearson.

These sample assessment materials have been developed to support these qualifications 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. However different examples of responses will be provided at standardisation.
- 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.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected

- how individual marks are to be awarded

- the total mark for each question

- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

ecf (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Write your name here

Surname		Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

Biology

International Advanced Subsidiary/Advanced Level
Unit 1: Molecules, Diet, Transport and Health

Sample Assessment Materials for first teaching September 2018
Time: 1 hour 30 minutes

Paper Reference
WBI11/01

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name,
  centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need*.
- **Show all your working in calculations and include units where**
  appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question*.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability
  to structure your answer logically, showing how the points that you make are
  related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Sample Assessment Materials – Issue 1 – September 2017 © Pearson Education Limited 2017

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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 cell membrane is important in the control of which substances can enter and leave the cell.

(a) The cell membrane consists of a phospholipid bilayer.

(i) Why do phospholipids form a bilayer?

(1)

☒ **A** the hydrophobic heads dissolve in the aqueous (water) environment

☒ **B** the hydrophobic heads move away from the aqueous (water) environment

☒ **C** the hydrophobic tails dissolve in the aqueous (water) environment

☒ **D** the hydrophobic tails move away from the aqueous (water) environment

(ii) This diagram shows part of a cell membrane.
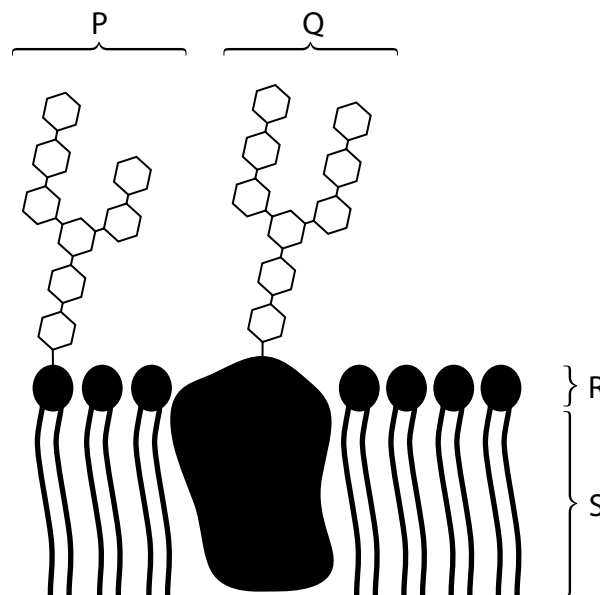
Which letter represents a membrane glycoprotein?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(b) State what is meant by the term **osmosis**.

(1)

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(c) Compare and contrast exocytosis and endocytosis.

(3)

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(d) Explain why oxygen molecules can pass directly through the cell membrane.

(3)

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(Total for Question 1 = 9 marks)

2 The enzyme OMP decarboxylase is involved in the synthesis of the mononucleotide uridine monophosphate.

(a) The diagram shows the reaction catalysed by OMP decarboxylase.

orotidine monophosphate (OMP)   uridine monophosphate
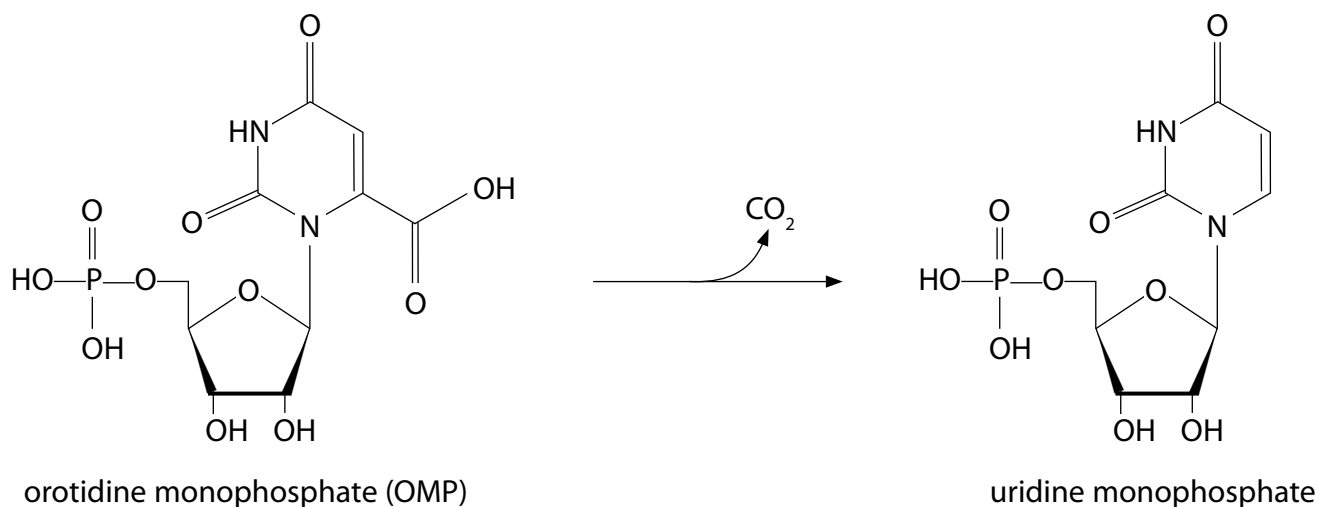
(i) Which sugar is present in uridine monophosphate?

(1)

☒ **A** deoxyribose

☒ **B** galactose

☒ **C** glucose

☒ **D** ribose

(ii) Draw a circle around the base in uridine monophosphate.

(1)

(iii) Suggest one way in which cells use uridine monophosphate.

(1)

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(b) The enzyme OMP decarboxylase increases the rate of carbon dioxide removal from orotidine monophosphate by 10^{17} times.

   (i) State how OMP decarboxylase increases the rate of this reaction.

(2)

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   (ii) Explain why OMP decarboxylase catalyses this reaction only.

(3)

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(Total for Question 2 = 8 marks)

3 Mammals have a heart that pumps blood through a network of blood vessels.

(a) The drawing shows a human heart.

B

A

C

D
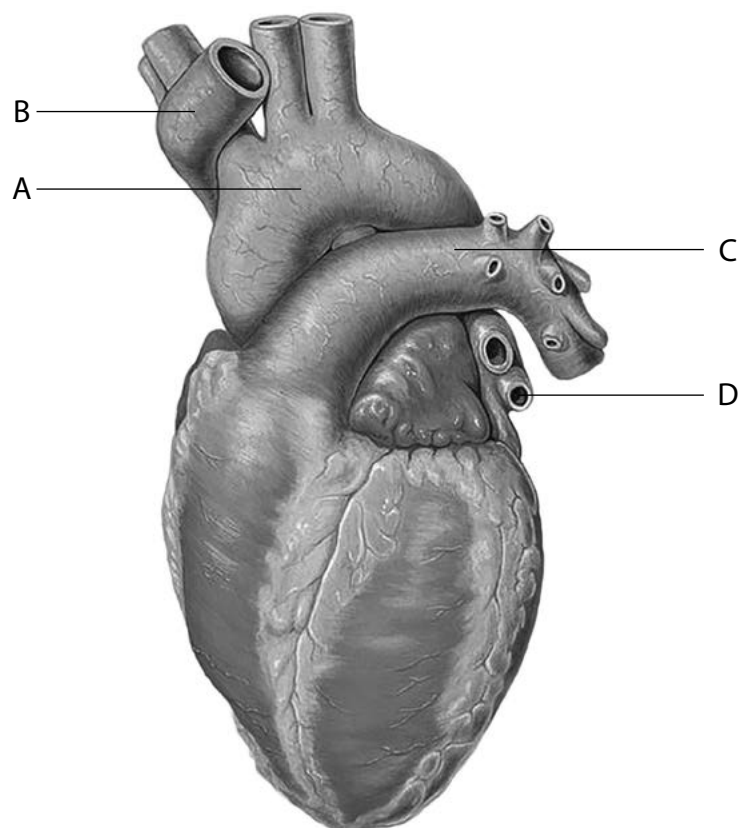
Used under Creative Commons Attribution-ShareAlike License - Patrick J Lynch

(i) Which blood vessel takes blood from the heart to the body?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) Which blood vessel has semilunar valves and contains blood with the highest concentration of carbon dioxide?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) The graph shows the change in volume of the left ventricle during the cardiac cycle.
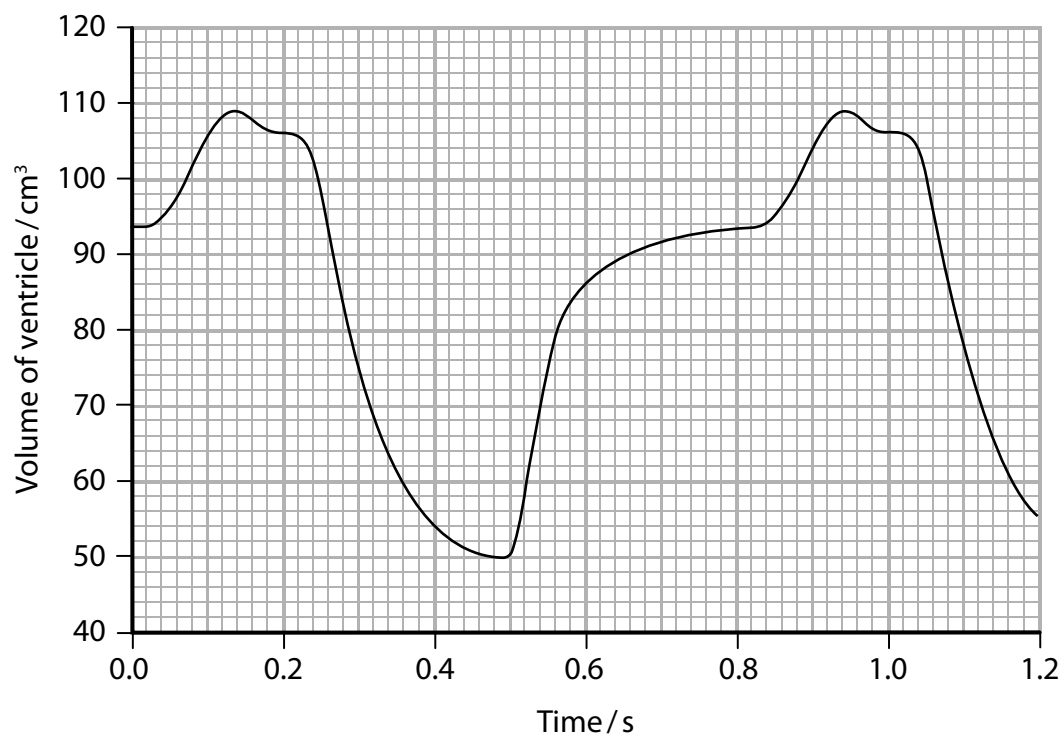
(i) When is this heart in ventricular systole?

(1)

☒ **A** at 0.1 seconds

☒ **B** at 0.4 seconds

☒ **C** at 0.6 seconds

☒ **D** at 0.8 seconds

(ii) Calculate the volume of blood in dm³ that will be pumped out of this heart by the left ventricle each minute.

(3)

Answer .... dm³

(c) As altitude (height above sea level) increases, the partial pressure of oxygen in the air decreases.

Llamas are mammals that are adapted to living at high altitudes.

The graph shows the oxygen dissociation curves for llama haemoglobin and human haemoglobin.

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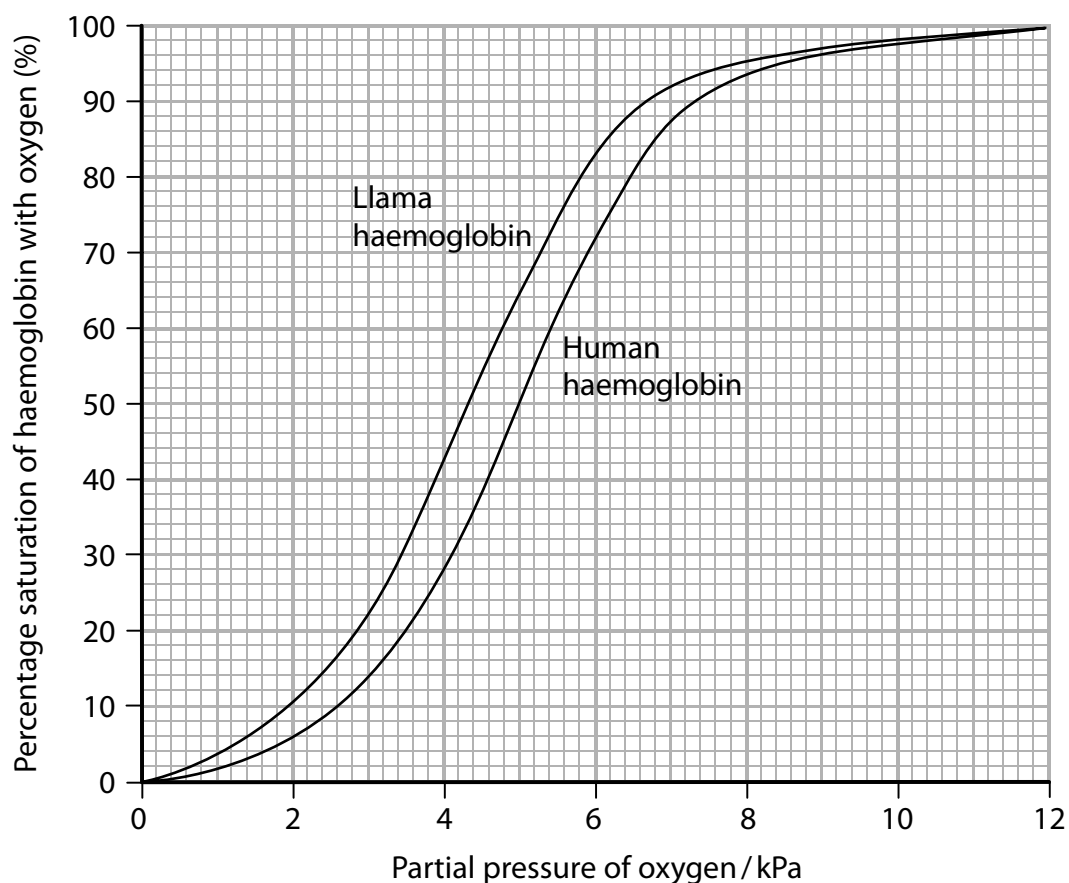
Explain the differences between the dissociation curves. Use the information in the graph to support your answer.

(4)

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(Total for Question 3 = 10 marks)

4 Lipids and carbohydrates can be used as energy storage molecules.

(a) Lactose is an important energy source in milk.

(i) What type of chemical reaction is involved in breaking a lactose molecule into two monosaccharides?

(1)

☒ **A** condensation

☒ **B** esterification

☒ **C** hydrogen bonding

☒ **D** hydrolysis

(ii) Milk contains 4.9 g of lactose per 100 g of milk.

Each gram of lactose provides 16 kJ of energy.

Calculate the energy available from the lactose in 200 g of milk.

(1)

Answer .... kJ

(b) Carbohydrates used as energy storage molecules include glycogen and starch.

Compare and contrast the structures of glycogen and starch.

(4)

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(c) (i) State one difference between the structure of a saturated lipid and an unsaturated lipid.

(1)

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(ii) Describe how a triglyceride is synthesised.

(3)

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(Total for Question 4 = 10 marks)

5 Red-green colour blindness is a common trait in humans.

(a) The gene for red-green colour blindness is located on the X chromosome.

State what is meant by the term **gene**.

(1)

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(b) Describe how the two strands of DNA forming the double helix in a gene are held together.

(2)

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(c) Explain why each codon for the DNA genetic code must contain at least three bases.

(3)

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(d) A red-green colour blind father and an unaffected heterozygous mother had a child.

Determine the probability of this child being red-green colour blind.

Use a genetic diagram to support your answer.

(3)

Probability ....

(Total for Question 5 = 9 marks)

6 (a) Explain how human lungs are adapted for rapid gas exchange.

(3)

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(b) Cystic fibrosis is an inherited condition which reduces gas exchange.

The most frequently observed CFTR allele associated with cystic fibrosis carries the ΔF508 mutation.

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

(1)

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(ii) The CFTR protein coded for by this mutation has one missing amino acid compared to the functioning protein.

Explain how this mutation results in a non-functioning CFTR protein.

(4)

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(iii) Explain why people with cystic fibrosis may develop lung infections.

(4)

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(Total for Question 6 = 12 marks)

7 Collagen is an insoluble, fibrous protein.

(a) Describe the roles of RNA in the synthesis of collagen.

(5)

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(b) Explain how the primary structure of collagen determines its properties.

(4)

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(Total for Question 7 = 9 marks)

8 Many studies have linked the development of atherosclerosis with cardiovascular disease (CVD).

(a) The photograph shows a section through an artery with a plaque (atheroma) from a patient with atherosclerosis.

plaque

X

Y
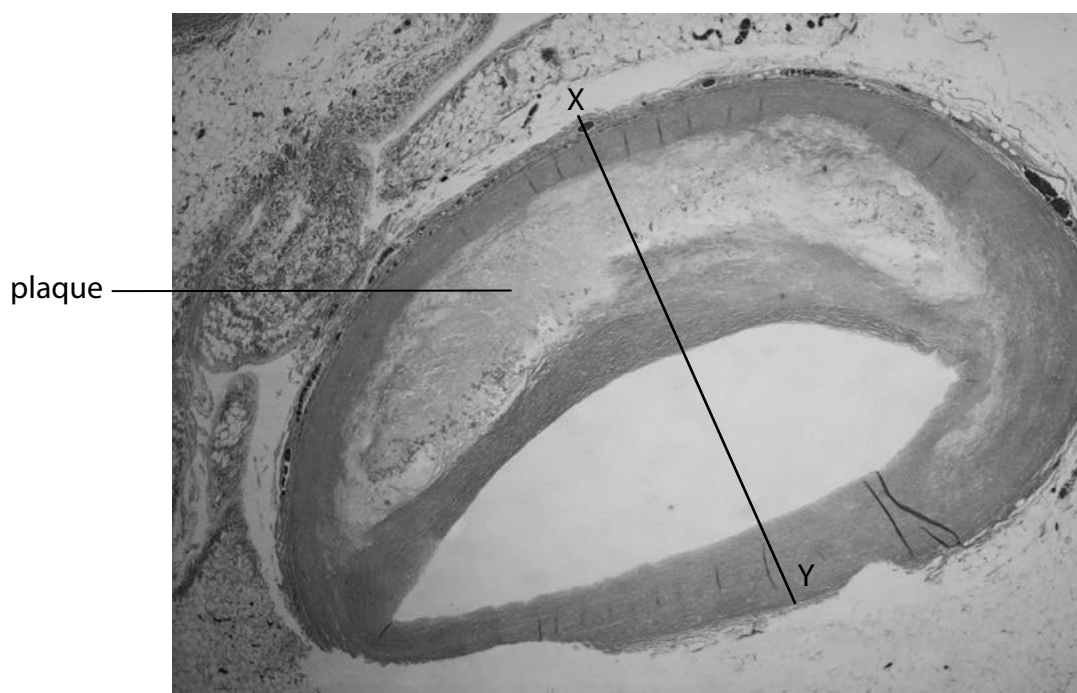
© Ogphoto/iStock

Calculate the percentage increase in the thickness of the artery wall where the plaque is located.

Take your measurements along the line labelled X–Y.

(3)

Answer ....%

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

(4)

*(c) Cholesterol is transported in the blood as lipoproteins LDL and HDL.

In one study, the relationship between total blood cholesterol and the risk of death from CVD was investigated.

The results are shown in the graph.

Key

··○·· Northern-Europe

—●— United States

-▽- Southern-Europe, inland

··▼·· Southern-Europe, mediterranean
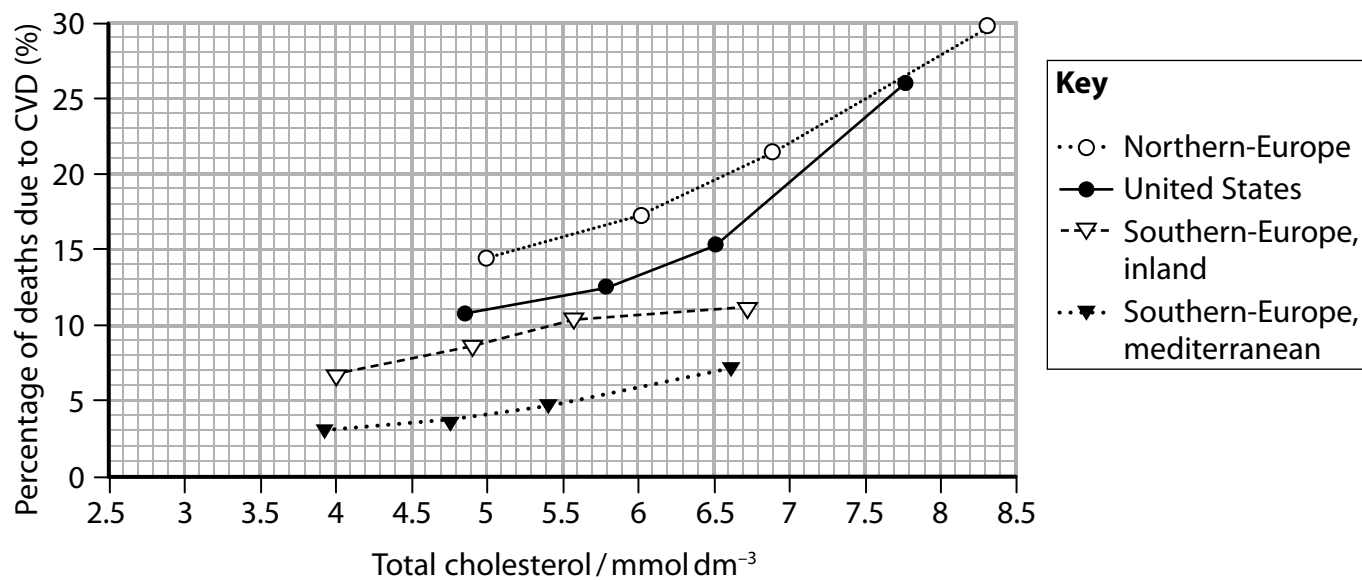
Graph 1

In another study, the effect of the size of LDL and the ratio of total blood cholesterol to HDL on the relative risk of CVD was investigated.

The results are shown in the graph.

Ratio of total blood cholesterol to HDL

Key

▨ < 6

☐ > 6
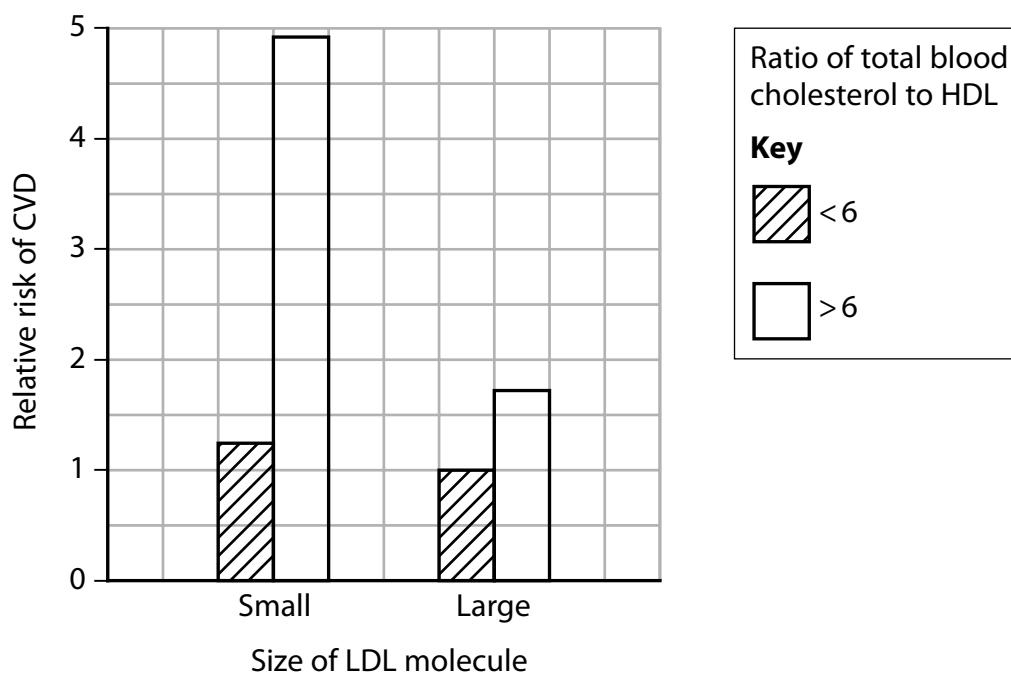
Graph 2

Assess the contribution of lipoproteins to the risk of developing CVD. Use the information in the graph to support your answer.

(6)

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(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 80 MARKS

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Unit 1 - Mark scheme

Question number	Answer	Mark
1(a)(i)	D the hydrophobic tails move away from the aqueous (water) environment	**(1)**
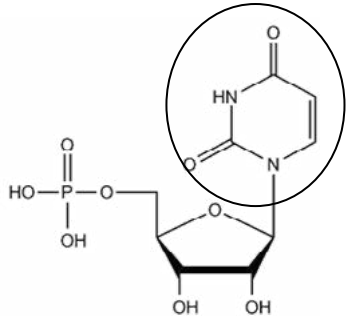
Question number	Answer	Mark
1(a)(ii)	B Q	**(1)**

Question number	Answer	Mark
1(b)	• diffusion of water molecules down a water potential gradient through a partially permeable membrane	**(1)**

Question number	Answer	Additional guidance	Mark
1(c)	An answer that includes the following points: similarities: • both used to transport large particles / large quantities of material (1) • both involve (phospholipid) membrane vesicles (1) difference: • exocytosis is export and endocytosis is import of material (1)	Accept a description of both processes	**(3)**

Question number	Answer	Mark
1(d)	An explanation that includes the following points: • oxygen molecule is small (1) • oxygen molecule is non-polar (1) • (it can, therefore) pass between gaps {in cell membrane / between hydrophobic tails} (1)	**(3)**

Question number	Answer	Mark
2(a)(i)	D ribose	**(1)**

Question number	Answer	Mark
2(a)(ii)		(1)

Question number	Answer	Mark
2(a)(iii)	• synthesis of RNA	(1)

Question number	Answer	Additional guidance	Mark
2(b)(i)	An answer that includes the following points: • OMP decarboxylase acting as a biological catalyst (1) • it lowers the activation energy of this reaction (1)	Allow forms an enzyme – substrate complex	(2)

Question number	Answer	Mark
2(b)(ii)	An explanation that includes the following points: • OMP decarboxylase is specific (for this substrate) (1) • because the active site of this enzyme has a particular shape (1) • therefore binds only with orotidine monophosphate (1)	(3)

Question number	Answer	Mark
3(a)(i)	A	(1)

Question number	Answer	Mark
3(a)(ii)	C	(1)

Question number	Answer	Mark
3(b)(i)	B at 0.4 seconds	(1)

Question number	Answer	Additional guidance	Mark
3(b)(ii)	A calculation in which: • volume of blood per beat from graph = 59 cm^3 (1) • heart rate calculated from graph = 75 bpm (1) • volume of blood converted into dm^3 (1) Example of calculation: (59 × 75) ÷ 1000 = 4.425 dm^3	Accept 109 – 50 Correct answer with no working shown gains all three marks	(3)

Question number	Answer	Mark
3(c)	An explanation that includes the following points: • dissociation curve for the llama is to the left of that for the human (1) • therefore llama haemoglobin has a higher affinity for oxygen (1) • llama haemoglobin will be fully saturated with oxygen at lower partial pressures (1) • this is necessary as there is less oxygen available in the atmosphere at high altitudes where llamas live (1)	(4)

Question number	Answer	Mark
4(a)(i)	D hydrolysis	(1)

Question number	Answer	Mark
4(a)(ii)	A calculation in which: kJ of energy = mass of lactose in 200 g of milk × energy per gram Example of calculation: 4.9 × 2 × 16 = 156.8 kJ	(1)

Question number	Answer	Additional guidance	Mark
4(b)	An answer that includes the following points: similarities: • both polysaccharides / formed from many (alpha) glucose monomers (1) • joined by glycosidic bonds (1) differences: • starch is composed of two polysaccharides, glycogen only one (1) • amylose is a {straight / helical} chain, amylopectin and glycogen are both branched molecules (1)	Allow description of glycosidic bonds as 1,4 and 1,6	(4)

Question number	Answer	Additional guidance	Mark
4(c)(i)	An answer that includes one of the following points: • saturated lipids have no carbon – carbon double bonds **and** unsaturated lipids have a carbon – carbon double bond or • saturated lipids have straight chains **and** unsaturated lipids have bent chains or • saturated lipids have a great**er** ratio of hydrogen to carbon / unsaturated lipids have a low**er** ratio of hydrogen to carbon	Answer must be comparative	(1)

Question number	Answer	Mark
4(c)(ii)	An description that includes the following points: • one glycerol molecule and three fatty acid molecules (1) • which react via a condensation reaction (1) • and are joined by ester bonds (1)	(3)

Question number	Answer	Mark
5(a)	• sequence of bases of DNA that code for a polypeptide	(1)

Question number	Answer	Mark
5(b)	A description that includes the following points: • complementary bases / named pair of complementary bases (1) • it enables the formation of {two hydrogen bonds between adenine and thymine / three hydrogen bonds between cytosine and guanine} (1)	(2)

Question number	Answer	Additional guidance	Mark
5(c)	A explanation that includes the following points: • enough codons needed for 20 different amino acids (1) • four bases are used in the genetic code (1) • (triplet code) provides {enough / 43 / 64} possible codons (1)	Allow descriptions of single and doublet code providing insufficient alternatives	(3)

Question number	Answer	Additional guidance	Mark
5(d)	A answer that includes the following points: • correct genotypes of parents (1) • affected genotype of children correctly identified (1) • correct calculation of probability is 0.5 (1)	Accept 50%, 1 in 2, ½	(3)

Question number	Answer	Marks
6(a)	An explanation that includes the following points: • many small alveoli to provide a large surface area to increase the rate of diffusion (1) • thin epithelium to increase rate of diffusion (1) • good blood supply to maintain diffusion gradient (1)	(3)

Question number	Answer	Mark
6(b)(i)	• a version of a gene	(1)

Question number	Answer	Mark
6(b)(ii)	An explanation that includes the following points: • there will be a different sequence of R groups (1) • therefore the CFTR protein has a different tertiary structure (1) • because of different {types of / position of} bonds between the R groups (1) • therefore the movement of chloride ions through the cell membrane is affected (1)	(4)

Question number	Answer	Mark
6(b)(iii)	An explanation that includes any four of the following points: • produces very thick, sticky mucus (1) • because of reduced water transport from cells (1) • cilia lining airways are unable to move mucus (1) • therefore microorganisms get trapped in the mucus (1) • mucus provides suitable growth conditions for growth of microorganisms (1)	(4)

Question number	Answer	Mark
7(a)	A description that includes any five of the following points: • an mRNA molecule codes for each of the polypeptide chains in collagen (1) • mRNA carries a copy of the genetic code for collagen out of the nucleus to ribosome (1) • each tRNA carries its own specific amino acid to the {ribosome / mRNA} (1) • anticodon on tRNA binds to codons on the mRNA (1) • tRNA holds the amino acid in place while peptide bonds form (1) • reference to start and stop codons on mRNA (1)	(5)

Question number	Answer	Mark
7(b)	An explanation that includes any four of the following points: • insoluble because there are hundreds of amino acids (1) • insoluble because there are many hydrophobic R groups (1) • strong because of the triple helix (1) • therefore there are many repeating amino acid sequences (1) • many small R groups so that the triple helix can form (1)	**(4)**

Question number	Answer	Additional guidance	Mark
8(a)	A calculation which: • measured widths of wall as 10 mm and 30 mm (1) • shows the difference between widths, divided by smaller value (1) • × 100% (1) Example of calculation: (30 − 10) = 20 mm (20 ÷ 10) × 100 = 200%	Accept measurements consistent with printed image Correct answer with no working gains all 3 marks	**(3)**

Question number	Answer	Mark
8(b)	An explanation that includes the following points: • formation of blood clot / thickening of artery wall (1) • therefore {blocks / narrows} coronary arteries (1) • therefore reduces blood flow (1) • therefore deprives heart muscle of {oxygen / nutrients} (1)	**(4)**

Question number	Answer	Additional guidance	Mark
8(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • increased cholesterol increases chance of dying from CVD • cholesterol concentrations are different in different countries • same cholesterol level does not confer same risk in different countries • greater the cholesterol to HDL ratio, the greater the risk of CVD • the smaller the diameter the LDL, the greater the risk of CVD • individuals at greatest risk of CVD are those with a large cholesterol to HDL ratio and small LDL diameter and a high cholesterol concentration • not possible to say if different risks for a particular cholesterol concentration in the first study are due to differences in cholesterol to HDL ratio / diameter of LDL	Allow differences in the first study may be due to differences in cholesterol to HDL ratio / diameter of LDL	(6)

Level	Marks	Descriptor
	0	No awardable content.
1	1-2	A scientific assessment is made of a factor, supported by the application of limited relevant evidence from the scientific information provided. No conclusion is attempted.
2	3-4	A scientific assessment is made of some of the factors, supported by the application of some relevant evidence from the analysis and with some interpretation of the scientific information. A conclusion, where needed, is made, demonstrating linkages to elements of biological knowledge and understanding, with some evidence to support the assessment being made.
3	5-6	A scientific assessment is made of the factors, supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion, where needed, is made, demonstrating sustained linkages to biological knowledge and understanding, with sufficient evidence to support the assessment being made.

Write your name here

Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

Biology

International Advanced Subsidiary/Advanced Level
Unit 2: Cells, Development, Biodiversity and
Conservation

Sample Assessment Materials for first teaching September 2018
Time: 1 hour 30 minutes

Paper Reference
WBI12/01

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name,
  centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need*.
- **Show all your working in calculations and include units where**
  appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*****), marks will be awarded for your ability
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  related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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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 phenotype of an organism is affected by a number of factors.

(a) State what is meant by the term **phenotype**.

(1)

....

....

....

(b) Coat colour in rabbits is determined by multiple alleles.

The table gives some information about coat colour in rabbits.

Type of rabbit	Coat colour of rabbit	....
Black	black all over	CC
Chinchilla	grey all over	$c^{ch}c^{ch}$
Himalayan	white body black ears, face, feet and tail	$c^h c^h$
Albino	white all over	cc

(i) Complete this table by writing a suitable heading for the right-hand column.

(1)

(ii) Which row of the table gives the correct number of genes and alleles for coat colour in these rabbits?

(1)

	Number of genes for coat colour	Number of alleles for coat colour
☒ **A**	1	1
☒ **B**	1	4
☒ **C**	4	1
☒ **D**	4	4

(c) Height is one phenotype of an elephant.

The photograph shows an African elephant.

Source: Caroline Wilcox

Male African elephants range in height from 3.2 m to 4.0 m.

Female African elephants range in height from 2.2 m to 2.6 m.

(i) Which row of the table names the types of graph that should be drawn to show sex and height variation in a population of African elephants?

(1)

	Sex	Height
☒ **A**	bar chart	bar chart
☒ **B**	bar chart	histogram
☒ **C**	histogram	bar chart
☒ **D**	histogram	histogram

(ii) Calculate how many times bigger the male African elephant is than the female African elephant.

(2)

Answer ....

(Total for Question 1 = 6 marks)

2 There are 18 species of puffer fish found in the Maldives.

The photograph shows one of these species, *Canthigaster valenti*.

© kaschibo/Shutterstock

Magnification ×0.5

(a) The markings on the skin of *Canthigaster valenti* are warnings to predators. It also protects itself from predators by producing poisons and by inflating its body.

Which row of the table describes these types of adaptations?

(1)

	Markings on the skin	**Production of poison**	**Inflating the body**
☒ **A**	anatomical	behavioural	physiological
☒ **B**	anatomical	physiological	behavioural
☒ **C**	physiological	anatomical	behavioural
☒ **D**	physiological	behavioural	anatomical

(b) Another fish found in the Maldives is *Paraluteres prionurus*.

This fish is not poisonous. It grows to about 10 cm in length.

The photograph shows *Paraluteres prionurus*.

Source: http://www.underwaterkwaj.com/uw-misc/file/Paraluteres-prionurus.htm

Explain how the appearance of *Paraluteres prionurus* shows it is adapted to its habitat.

(3)

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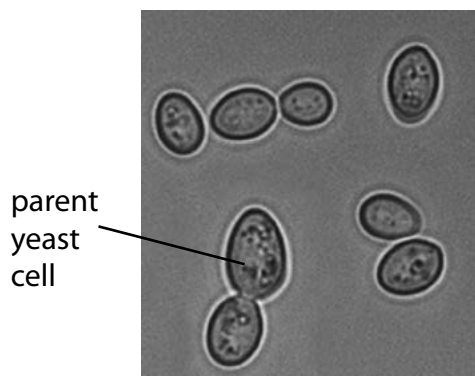..

(c) Explain why *Canthigaster valenti* and *Paraluteres prionurus* are unable to reproduce with each other.

(2)

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(Total for Question 2 = 6 marks)

3 The photographs show yeast cells, seen using a light microscope and an electron microscope.

parent yeast cell

nucleus

J

K

L

M
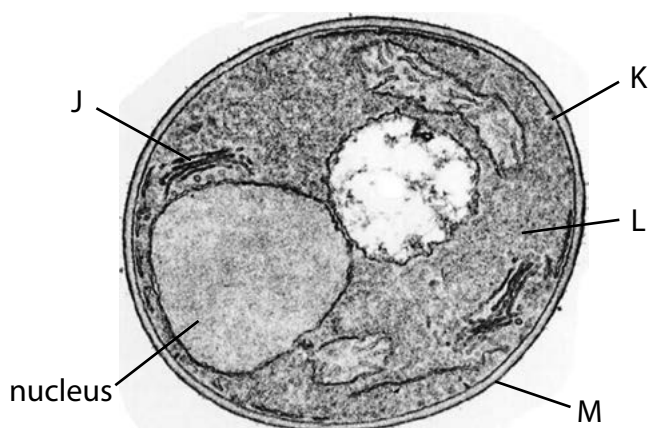
Yeast cells seen using a light microscope   Yeast cell seen using an electron microscope

Used under CC License from: https://commons.wikimedia.org/wiki/File:Zygosaccharomyces_bailii_cells.jpg

(a) Which structure identifies yeast as a eukaryotic organism?

(1)

☒ **A** J

☒ **B** K

☒ **C** L

☒ **D** M

(b) Explain why structure J can be seen using the electron microscope but not the light microscope.

(2)

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(c) Explain why the nuclear envelope cannot be seen as two membranes using this electron microscope.

(2)

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(d) Yeast cells reproduce asexually by a process called budding.

The parent yeast cell produces a bud.

(i) Explain the importance of mitosis in budding.

(3)

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(ii) Once the bud is large enough, it separates from the parent yeast cell.

The rate at which budding happens depends on the availability of oxygen and nutrients.

Suggest why the availability of oxygen and nutrients determines the rate of budding.

(3)

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(Total for Question 3 = 11 marks)

4 The photograph shows a Baird's tapir.

Source: https://www.biolib.cz/IMG/GAL/171566.jpg

(a) Baird's tapir is endemic to countries in Central America.

State what is meant by the term **endemic**.

(1)

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(b) Baird's tapir is classified as endangered.

In 2006, it was estimated that there were 5500 Baird's tapirs. This number had fallen to 3000 in 2016.

(i) Calculate the percentage decrease in the number of Baird's tapirs from 2006 to 2016.

(2)

Answer ....%

(ii) Explain how human activity, other than hunting, could have caused this decrease in the number of Baird's tapirs.

(3)

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(c) Preservation of sperm collected from Baird's tapir may help captive breeding programmes.

Scientists investigated the effect of freezing on sperm from Baird's tapir.

The sperm were frozen and then thawed.

The results of this investigation are shown in the table.

Sperm	Percentage of sperm capable of moving (%)	Ability of sperm to swim in a straight line / a.u.	Percentage of sperm with an undamaged acrosome (%)
Freshly collected	63	3.5	80
Frozen and then thawed	38	2.5	48

(i)   Describe how each of these effects of freezing could be determined.

(3)

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(ii) Explain how freezing sperm could affect the success of captive breeding programmes.

(4)

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(Total for Question 4 = 13 marks)

5 The photograph shows a pumpkin.
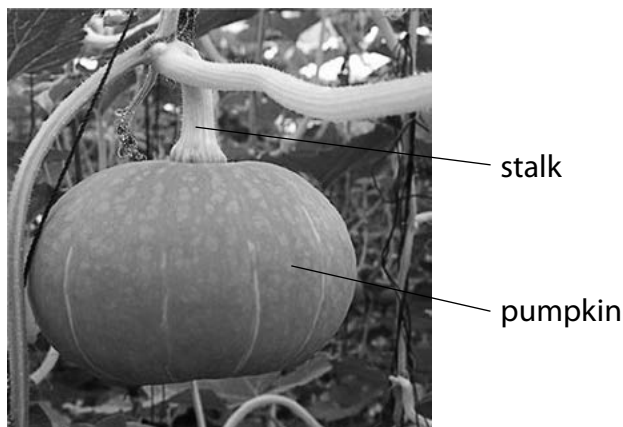
stalk

pumpkin

The scientists Crafts and Lorenz investigated the rate of translocation through the phloem in pumpkins.

The flow chart shows the method used in this investigation.

Step 1
The mean increase in dry mass of a pumpkin after 792 hours of growth was estimated

Step 2
The cross-sectional area of the phloem tissue in the stalk was determined

Step 3
The cross-sectional area of the sieve tubes in the stalk was estimated

Step 4
The rate of translocation was calculated

(a) (i) Suggest how the mean increase in dry mass of a pumpkin could be estimated in **Step 1**.

(3)

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(ii) Explain why Crafts and Lorenz used dry mass in this investigation.

(2)

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(b) (i) The photograph shows a cross-section through part of a stalk, as seen using a light microscope.
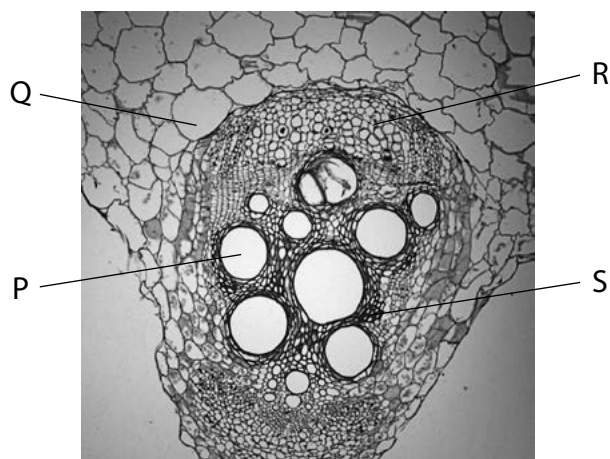
Which letter is pointing to the phloem?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(ii) Describe a method that could be used to determine the cross-sectional area of the phloem in **Step 2**.

(2)

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(c) Give a reason why only the cross-sectional area of the sieve tubes, rather than the phloem tissue, was estimated in **Step 3**.

(1)

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(d) What are the units for the rate of translocation calculated in **Step 4**?

(1)

☒ **A** $g\,cm^{-2}\,hr^{-1}$

☒ **B** $g\,cm^{2}\,hr^{-1}$

☒ **C** $g\,cm^{-3}\,hr^{-1}$

☒ **D** $g\,cm^{3}\,hr^{-1}$

(Total for Question 5 = 10 marks)

6 Organisms can be classified into one of three domains.

(a) Organisms belonging to two of these domains have prokaryotic cells.

(i) Bacteria are one of these domains.

Name the other domain that has prokaryotic cells.

(1)

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(ii) The diagram shows the outline of a bacterial cell.

Draw **three** labelled features on this diagram that may be found in a prokaryotic cell.

(3)

cell wall
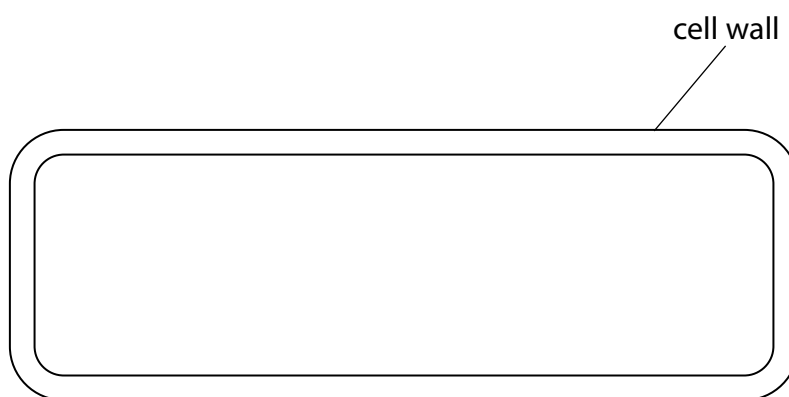
*(b) A variety of different types of bacteria is found in the human digestive system.

The diagram shows part of the human digestive system and the number and types of bacteria that can be found in each organ.

Duodenum

10^3 bacteria cm^{-3}

Lactobacillus
Streptococcus

Stomach

10^3 bacteria cm^{-3}

Lactobacillus
Helicobacter
Veillonella

Ileum

10^7 bacteria cm^{-3}

Streptococcus
Clostridium
Corynebacterium
Bacteroides

Colon

10^{12} bacteria cm^{-3}

Clostridium
Bacteroides
Enterobacterium
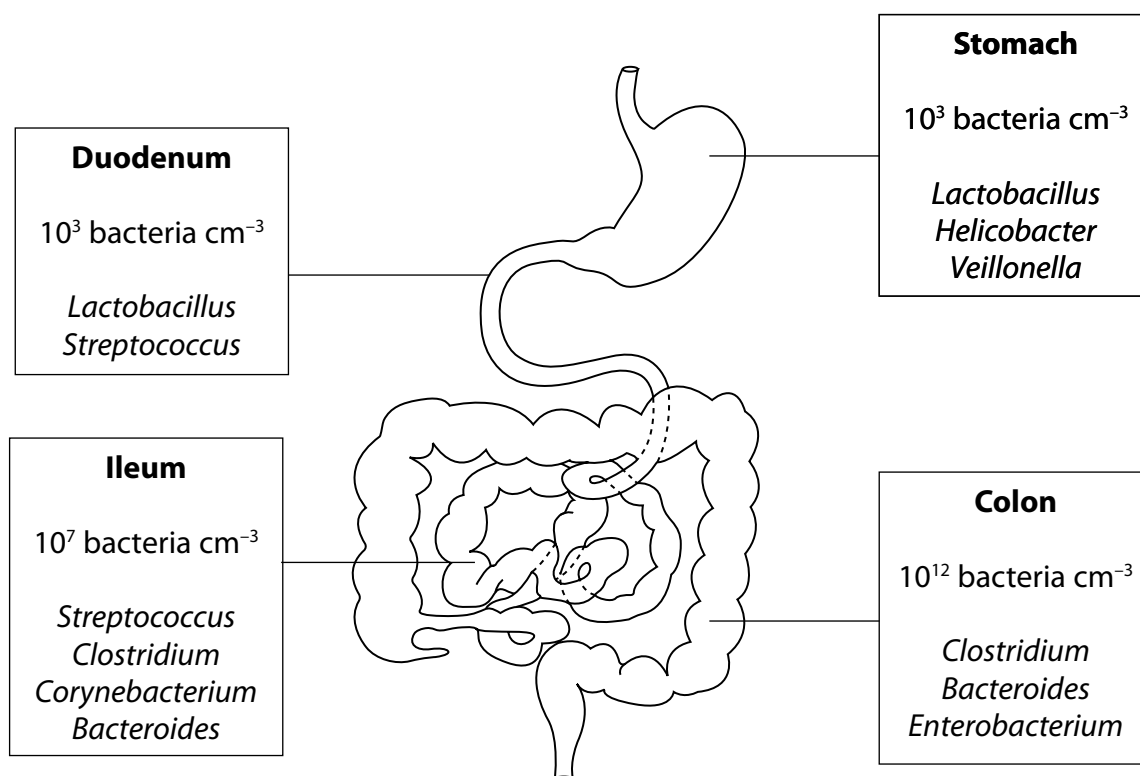
The table gives some information about conditions in the digestive system.

Organ	pH	Oxygen content
Stomach	1 to 3	High
Duodenum	6 to 7	
Ileum	6 to 8	
Colon	5 to 7	Low

Explain the distribution of bacteria in the digestive system. Use the information in the diagram and table to support your answer.

(6)

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(Total for Question 6 = 10 marks)

7 Red blood cells are produced from pluripotent stem cells found in bone marrow.

(a) Which statement about these stem cells is correct?

(1)

☒ **A** they can produce all types of cell

☒ **B** they can produce all types of cell except extraembryonic cells

☒ **C** they can produce some types of cell

☒ **D** they can produce red blood cells only

(b) Red blood cells contain haemoglobin.

A molecule of haemoglobin is made of four polypeptides. Each polypeptide has a haem group attached to it. The haem group is **not** made of amino acids.

In most adult haemoglobin, there are two α polypeptides and two β polypeptides.

The diagram shows the structure of adult haemoglobin.
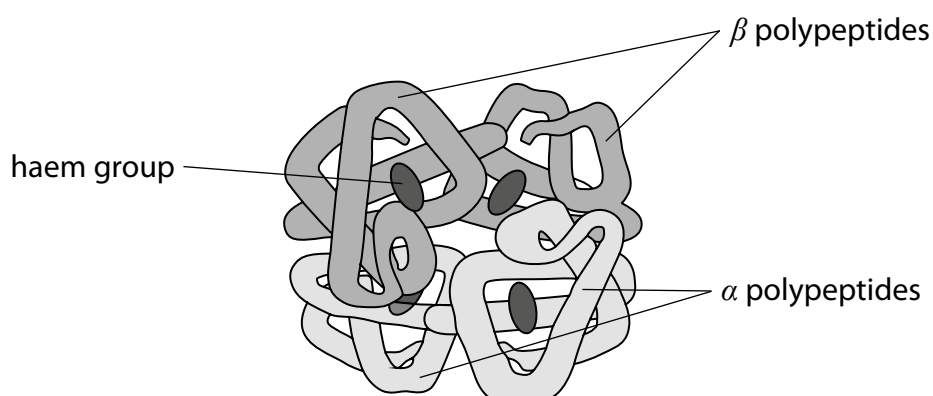
Describe the role of the rough endoplasmic reticulum in the synthesis of haemoglobin.

(3)

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(c) Fetal haemoglobin has a similar structure to adult haemoglobin. Fetal haemoglobin has two α polypeptides and two γ polypeptides.

The graph shows the percentage of each polypeptide present in red blood cells in an individual before and after birth.
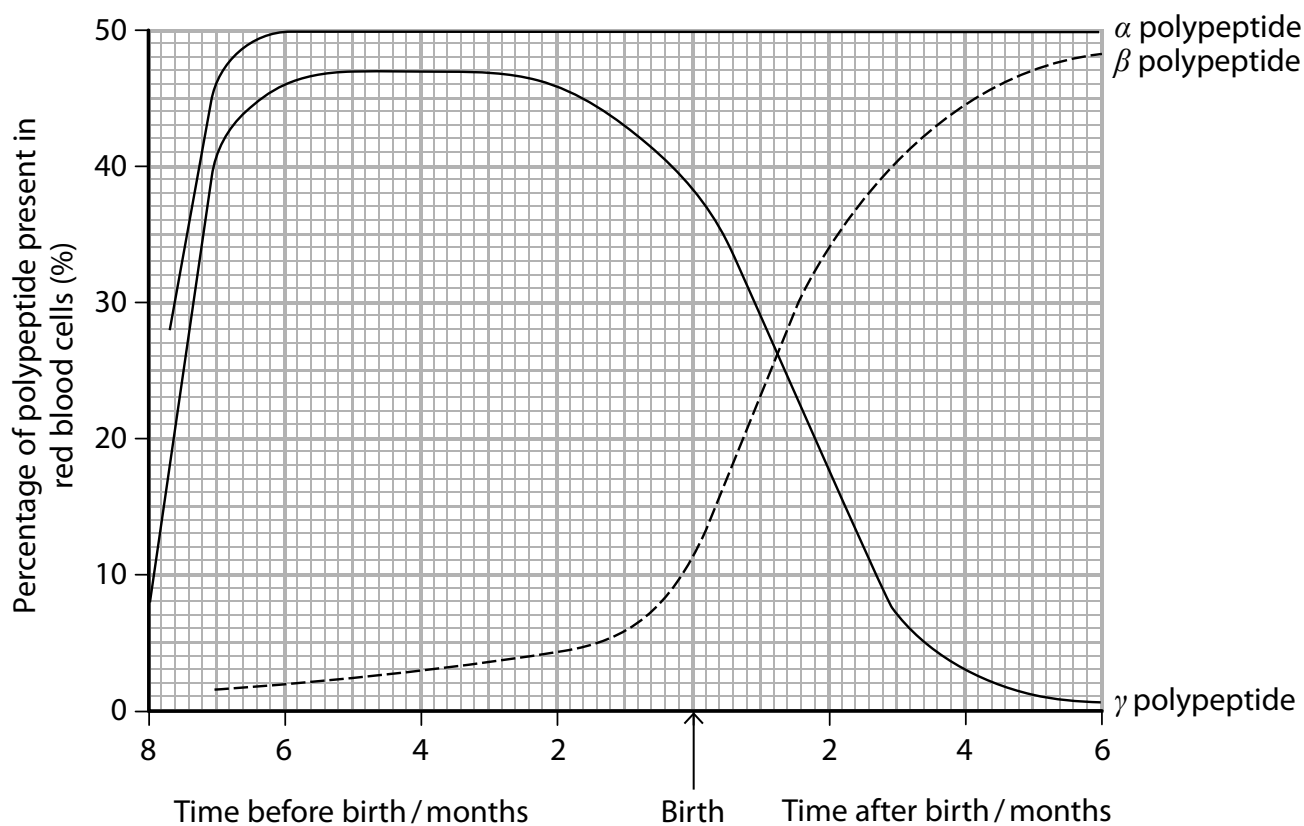
(i) Describe the changes in the percentages of polypeptides present in red blood cells. Use the information in the graph to support your answer.

(3)

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(ii) Explain how epigenetic modification could result in these changes.

(4)

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(Total for Question 7 = 11 marks)

8 The biodiversity of four groups of organisms – birds, fish, mussels and aquatic plants – was studied along four sections of the Rideau River in Canada.

A biodiversity index value was calculated for each group of organisms.

The graph shows the results of this study.

Key for biodiversity categories

☐ good biodiversity

▨ moderate biodiversity

■ poor biodiversity

＊ no data available
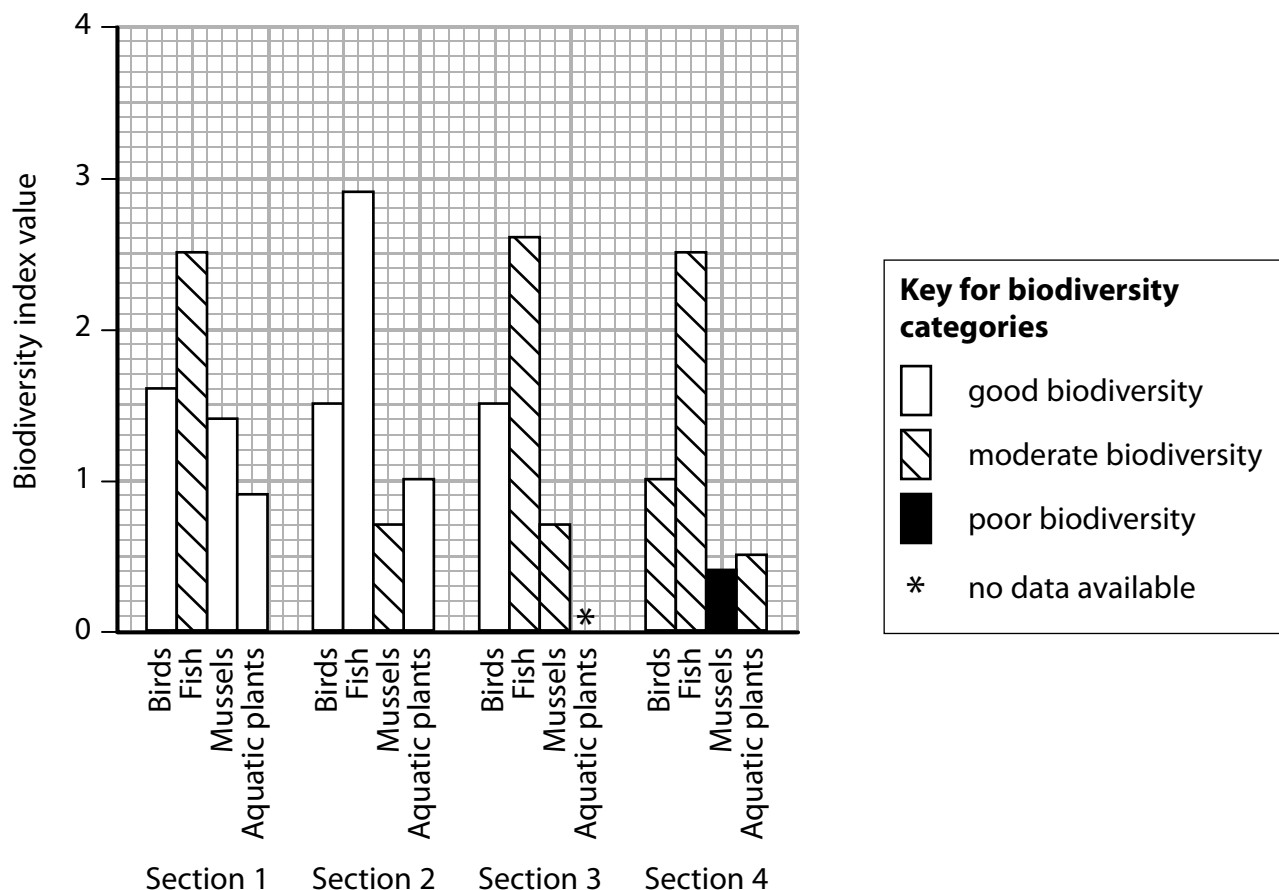
The biodiversity index value can be used to compare biodiversity within one group of organisms.

The biodiversity categories (good, moderate and poor) can be used to compare biodiversity between different groups of organisms.

(a) Which statement describes biodiversity?

(1)

☒ **A** species richness of only the endemic species within a habitat

☒ **B** species richness of all the species within a habitat

☒ **C** the role of only the endemic species within a habitat

☒ **D** the role of all the species within a habitat

*(b) Describe the changes in biodiversity along the Rideau River. Use the information in the graph to support your answer.

(6)

(c) In Section 1, birds have a biodiversity index value of 1.6 and fish have a biodiversity index value of 2.5.

Suggest why the fish are considered to have a moderate biodiversity and the birds have a good biodiversity, but the biodiversity index value of the fish is greater.

(2)

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(d) No data were available for aquatic plants in Section 3.

A student collected some data in Section 3 to calculate a biodiversity index value.

The equation that the student used is:

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

The data are shown in a table prepared by the student.

Species of aquatic plant	Number of aquatic plants counted	(n − 1)	n(n − 1)
Coontail	8		
Tape grass	6		
Common waterweed	3		
Northern water milfoil	2		
Star duckweed	9		
White water lily	2		
Water stargrass	2		
Eurasian water milfoil	6		
Curly pondweed	5		
European frogbit	2		
Flowering rush	3		

(i) Complete the table.

(1)

(ii) Calculate the biodiversity index value for the aquatic plants in Section 3 of this river.

(3)

Answer ....

(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 80 MARKS

Unit 2 - Mark scheme

Question number	Answer	Mark
1(a)	• {expressed / observable} characteristics	(1)

Question number	Answer	Mark
1(b)(i)	• genotype	(1)

Question number	Answer	Mark
1(b)(ii)	B 1, 4	(1)

Question number	Answer	Mark
1(c)(i)	B bar chart, histogram	(1)

Question number	Answer	Mark
1(c)(ii)	• calculation of one correct difference (1) or • mean height for male and female calculated Example of calculation: 3.2 ÷ 2.2 = 1.5 3.2 ÷ 2.6 = 1.2 4.0 ÷ 2.2 = 1.8 4.0 ÷ 2.6 = 1.5 3.6 and 2.4 • range of difference given 1.2 – 1.8 (1)	(2)

Question number	Answer	Mark
2(a)	B anatomical, physiological, behavioural	(1)

Question number	Answer	Mark
2(b)	An explanation that includes the following points: • mimics the *Canthigaster valenti* by having similar markings (1) • mimics the *Canthigaster valenti* by having similar {size / shape} (1) • therefore it still deters predators even though it does not produce poison (1)	(3)

Question number	Answer	Mark
2(c)	An explanation that includes the following points: • because they are different species (1) • therefore cannot produce fertile offspring (1)	(2)

Question number	Answer	Mark
3(a)	A J	(1)

Question number	Answer	Additional guidance	Mark
3(b)	An explanation that includes the following points: • because this structure is very small (1) • and only an electron microscope has the ability to magnify this much (1)	Accept converse statement	(2)

Question number	Answer	Mark
3(c)	An explanation that includes the following points: • because the two membranes are very close together (1) • and the resolution of this microscope is not high enough (1)	(2)

Question number	Answer	Mark
3(d)(i)	An explanation that includes the following points: • mitosis results in two cells that each have a nucleus (1) • each bud contains a full set of chromosomes (1) • so the buds are genetically identical to the parent yeast cell (1)	(3)

Question number	Answer	Mark
3(d)(ii)	An answer that includes the following points: • because new cell structures need to be made in order for the bud to grow (1) • therefore oxygen is needed to produce the ATP (1) • therefore {glucose is needed to produce the ATP / amino acids are needed to make proteins} (1)	(3)

Question number	Answer	Mark
4(a)	• {restricted / native} to a particular area	(1)

Question number	Answer	Additional guidance	Mark
4(b)(i)	• subtraction (1) • percentage (1) Example of calculation: 5 500 – 3 000 / 2 500 (2 500 ÷ 5 500) × 100 = 45.45	 Accept 45.5 and 45	(2)

Question number	Answer	Mark
4(b)(ii)	An explanation that includes three of the following points: • because of habitat destruction there is no food (1) • because of habitat destruction there is no shelter (1) • fragmentation of habitat makes it harder to find a mate (1) • therefore, there is a decrease in genetic diversity (1)	(3)

Question number	Answer	Mark
4(c)(i)	A description that includes the following points: • sperm observed under a microscope to assess {motility / ability to swim in a straight line} (1) • use of {stains / microscope} to observe the integrity of the acrosome (1) • comparisons need to be made to freshly collected sperm so that effects can be calculated (1)	(3)

Question number	Answer	Mark
4(c)(ii)	An explanation that includes any four of the following points: • because sperm can be frozen from different males to increase genetic diversity (1) • because frozen sperm will always be available if numbers of Baird's tapir decrease too far (1) • can freeze sperm so that they are available when females come in to season (1) • freezing could reduce the number of successful fertilisations because of poor viability (1) • more sperm would need to be used as viability is low, reducing stocks (1)	(4)

Question number	Answer	Mark
5(a)(i)	An answer that includes the following points: • growing many pumpkins so that a mean can be calculated (1) • dry mass of one batch taken at start of growth period and one batch used after growing for 792 hours (1) • give credit for details of how to obtain dry mass (1)	(3)

Question number	Answer	Mark
5(a)(ii)	An explanation that includes any two of the following points: • because water content is variable (1) • do not include the water content (1) • as this is due to transport by the xylem (1)	(2)

Question number	Answer	Mark
5(b)(i)	C R	(1)

Question number	Answer	Mark
5(b)(ii)	A description that includes the following points: • taking a photograph and overlaying with graph paper / using a computer package / measuring diameter with a graticule and calculating area (1) • calculate a mean for several {areas of phloem / vascular bundles} (1)	(2)

Question number	Answer	Mark
5(c)	• because {the contents of the phloem flow through the sieve tubes only / phloem includes companion cells}	(1)

Question number	Answer	Mark
5(d)	A $g\ cm^{-2}\ hr^{-1}$	(1)

Question number	Answer	Mark
6(a)(i)	• Archaea	(1)

Question number	Answer	Mark
6(a)(ii)	A diagram that includes any three of the following structures: • circular DNA (1) • plasmid (1) • (70S) ribosomes (1) • membrane (1) • flagellum (1) • pili (1) • capsule (1)	(3)

Question number	Answer	Mark
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 indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • numbers of bacteria increase along the digestive system • *Veillonella* can tolerate only low pHs • *Streptococcus* found in pH 6 – 8 with reasonably high oxygen content • *Streptococcus* requires oxygen for aerobic respiration • *Enterobacterium* can tolerate low oxygen concentrations • *Enterobacterium* requires less ATP or can respire anaerobically • pH affects enzyme activity • pH affects the ionisation of R groups • small change in pH drastically affects enzyme activity	**(6)**

Level	Marks	Descriptor
	0	No awardable content.
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and 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.
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.
3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.

Question number	Answer	Mark
7(a)	C they can produce some types of cell	(1)

Question number	Answer	Mark
7(b)	A description that includes the following points: • ribosomes involved in translation resulting in two different polypeptides (1) • endoplasmic reticulum involved in folding each polypeptide into tertiary structure (1) • endoplasmic reticulum involved in transporting each polypeptide (1)	(3)

Question number	Answer	Mark
7(c)(i)	A description that includes the following points: • α polypeptide increases to maximum by 6 months before birth and then stays constant (1) • β polypeptide rises slowly during pregnancy but then increases rapidly after birth (1) • γ polypeptide increases to maximum by 6 months before birth and then drops rapidly after birth (1)	(3)

Question number	Answer	Additional guidance	Mark
7(c)(ii)	An explanation that includes the following points: • gene for α polypeptide remains switched on as this polypeptide is present both before and after birth (1) • gene for γ polypeptide is switched off at birth so levels fall (1) • gene for ß polypeptide switched on during pregnancy so levels rise (1) • credit given for an epigenetic mechanism that switches {on / off} gene expression (1)	For example, {DNA / histone} methylation switches off {genes / gene for γ polypeptide} or transcription factors switch on {genes / gene for ß polypeptide}	(4)

Question number	Answer	Mark
8(a)	B species richness of all the species within a habitat	(1)

Question number	Answer	Mark
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 indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • good diversity for birds in all sections except Section 4, which decreases to moderate • good diversity for birds is very similar in Sections 1, 2 and 3 • moderate diversity for fish in Section 1, which increases in Section 2 but then decreases again in Sections 3 and 4 • moderate diversity is very similar in the three sections • good diversity for aquatic plants in Sections 1 and 2, which has decreased by Section 4 • good biodiversity for mussels in stretch 1, decreasing to moderate biodiversity in stretch 2 and poor diversity in stretch 4 • no overall trends as you move down the river	(6)

Level	Marks	Descriptor
	0	No awardable content.
1	1-2	Demonstrates isolated elements of biological knowledge related to the given context with generalised comments made. The description will contain basic information with some attempt made to link knowledge and understanding to the given context.
2	3-4	Demonstrates adequate knowledge by selecting and applying some relevant biological facts/concepts to provide the description being presented. The description shows some linkages and lines of reasoning with some structure.
3	5-6	Demonstrates comprehensive knowledge by selecting and applying relevant knowledge of biological facts/concepts to provide the description being presented. The description is clear, coherent and logically structured.

Question number	Answer	Mark
8(c)	An answer that includes the following points: • there are more species of fish than birds (1) • therefore a value of 2.5 has a relatively lower biodiversity than a value of 1.6 (1)	(2)

Question number	Answer	Mark
8(d)(i)		(1)

Species of aquatic plant	Number of aquatic plants counted	(n-1)	n(n-1)
Coontail	8	7	56
Tape grass	6	5	30
Common waterweed	3	2	6
Northern water milfoil	2	1	2
Star duckweed	9	8	72
White water lily	2	1	2
Water star-grass	2	1	2
Eurasian water milfoil	6	5	30
Curly pondweed	5	4	20
European frogbit	2	1	2
Flowering rush	3	2	6

Question number	Answer	Mark
8(d)(ii)	• $\Sigma n(n-1)$ is 228 (1) • value for $N(N-1)$ is $(11 \times 10) = 110$ (1) • diversity index is 0.48 (1)	(3)

Write your name here

Surname		Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

Biology
**International Advanced Subsidiary/Advanced Level
Unit 3: Practical Skills in Biology I**

Sample Assessment Materials for first teaching September 2018
Time: 1 hour 20 minutes

Paper Reference
WBI13/01

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need*.
- **Show all your working in calculations and include units where appropriate.**

Information

- The total mark for this paper is 50.
- 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

S58689A0116

Pearson

Answer ALL questions.

Write your answers in the spaces provided.

1 A student made observations of plant cells and tissues through a microscope.

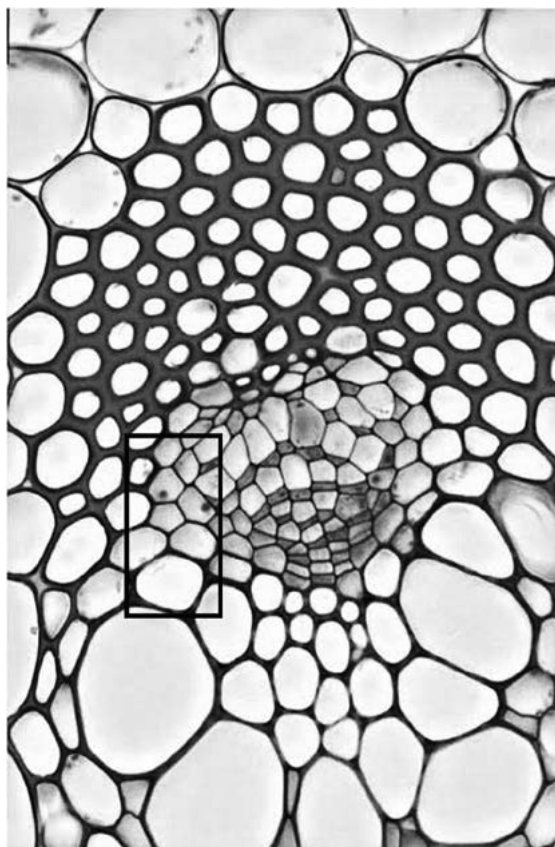(a) (i) Photograph A shows part of a transverse section of a stem at a magnification of ×40.
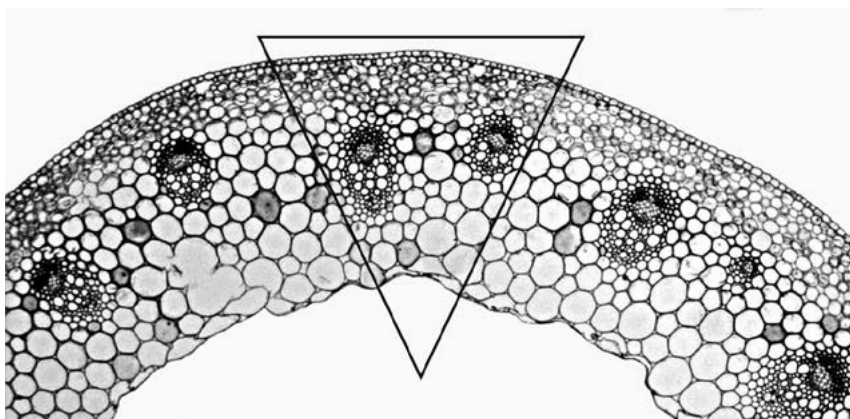
Source: John Adds

Photograph A

Draw a low-power plan of the area within the triangle shown on Photograph A **and** label two tissues on your drawing.

(3)

(ii) Photograph B shows part of a transverse section of the same stem at a magnification of ×400.

Source: John Adds

Photograph B

Draw the cells within the box shown on Photograph B.

(3)

(b) The diagram shows part of a stage micrometer scale and part of a graticule scale.
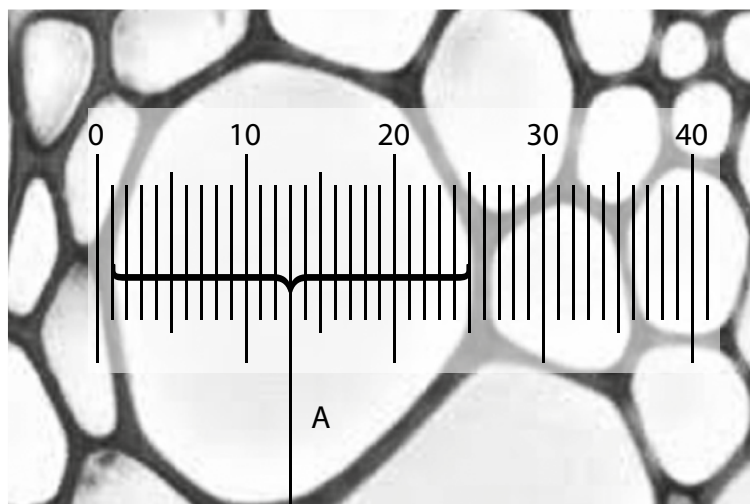
The smallest stage micrometer division is 10 μm.

stage micrometer scale
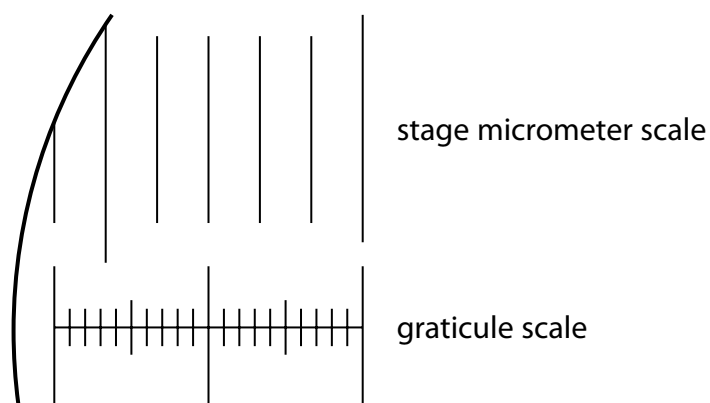
graticule scale

(i) Calculate the size of one small division of the graticule scale.

(2)

Answer.. μm

(ii) Using your answer to (b)(i), determine the internal diameter of the part labelled 'A'.

(2)

graticule scale

Source: John Adds

internal diameter of part A

Answer.. μm

(Total for Question 1 = 10 marks)

2 Mercerisation is a treatment used to increase the tensile strength of natural plant fibres. In this process, fibres are treated with sodium hydroxide solution.

A study was carried out to determine the concentration of sodium hydroxide solution to produce the strongest fibres.

Samples of fibres were obtained from four Nigerian plants: baobab, roselle, okra and kenaf.

All of these fibres were then mercerised by placing them in four different concentrations of sodium hydroxide solution.

The tensile strength of these fibres was then measured.

(a) (i) State the independent variable in this investigation.

(1)

....

(ii) State how one named variable could be controlled when mercerising the fibres.

(2)

Variable ....

How the variable could be controlled ....

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....

(iii) Devise a method that can be used to make a valid comparison of the tensile strength of fibres from the same plant, treated with different concentrations of sodium hydroxide solution.
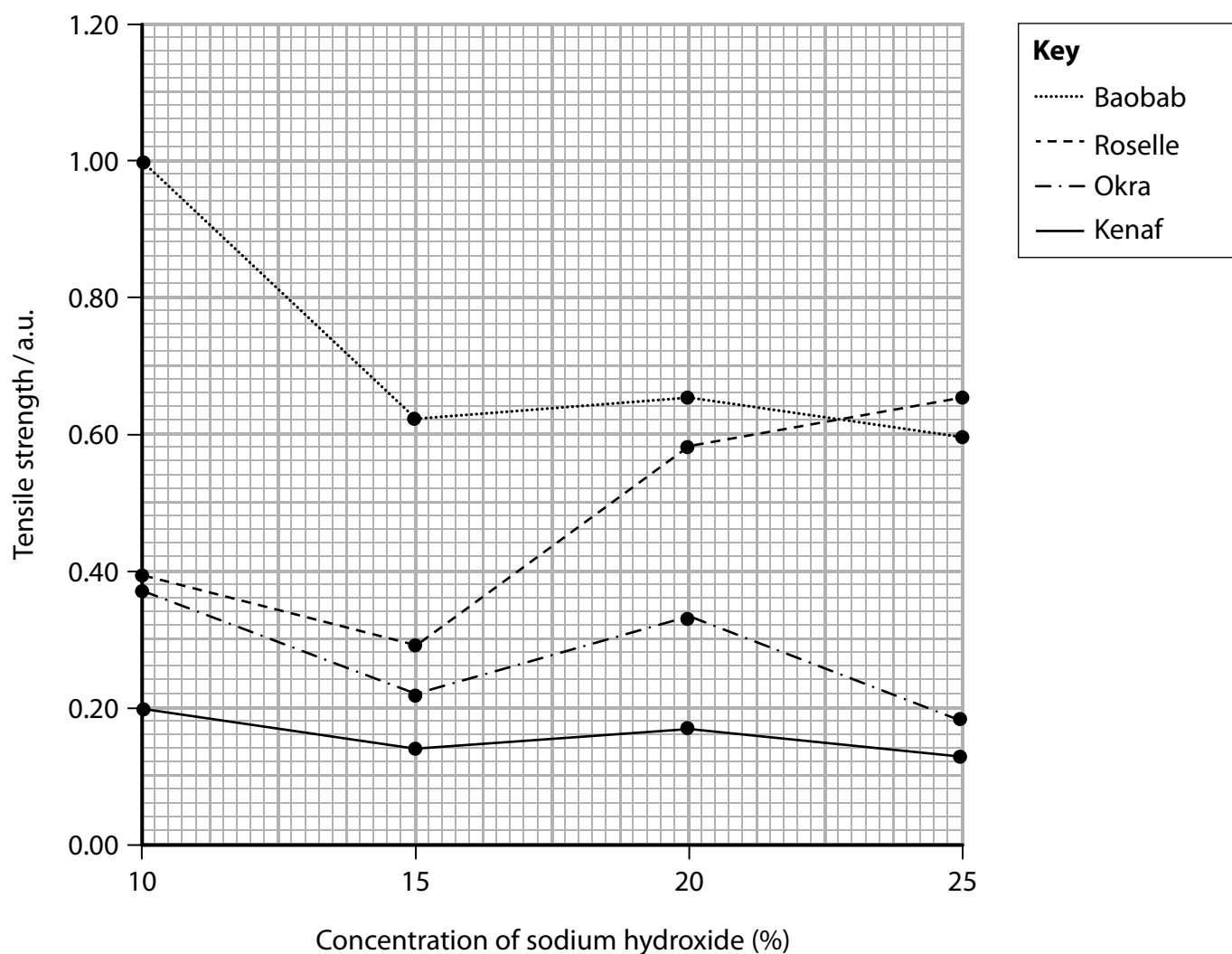
(5)

(b) The graph shows the tensile strength of fibres from these four plants, treated with sodium hydroxide solutions.

Key
.... Baobab
- - - - Roselle
— · — Okra
——— Kenaf

Concentration of sodium hydroxide (%)

(i) Using the graph, determine the concentration of sodium hydroxide solution that should be used for mercerisation of fibres from each of these four plants.

(2)

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(ii) Draw a suitable table to include the results for roselle and baobab only.

(3)

(c) Mercerisation causes plant fibres to swell.

A study was carried out on the effect of temperature and the concentration of sodium hydroxide on the degree of swelling of cotton fibres.

The graph shows the results of this study.

Key

Temperatures
- -·-·- 0 °C
- ············ 20 °C
- - - - - 60 °C
- ——— 100 °C
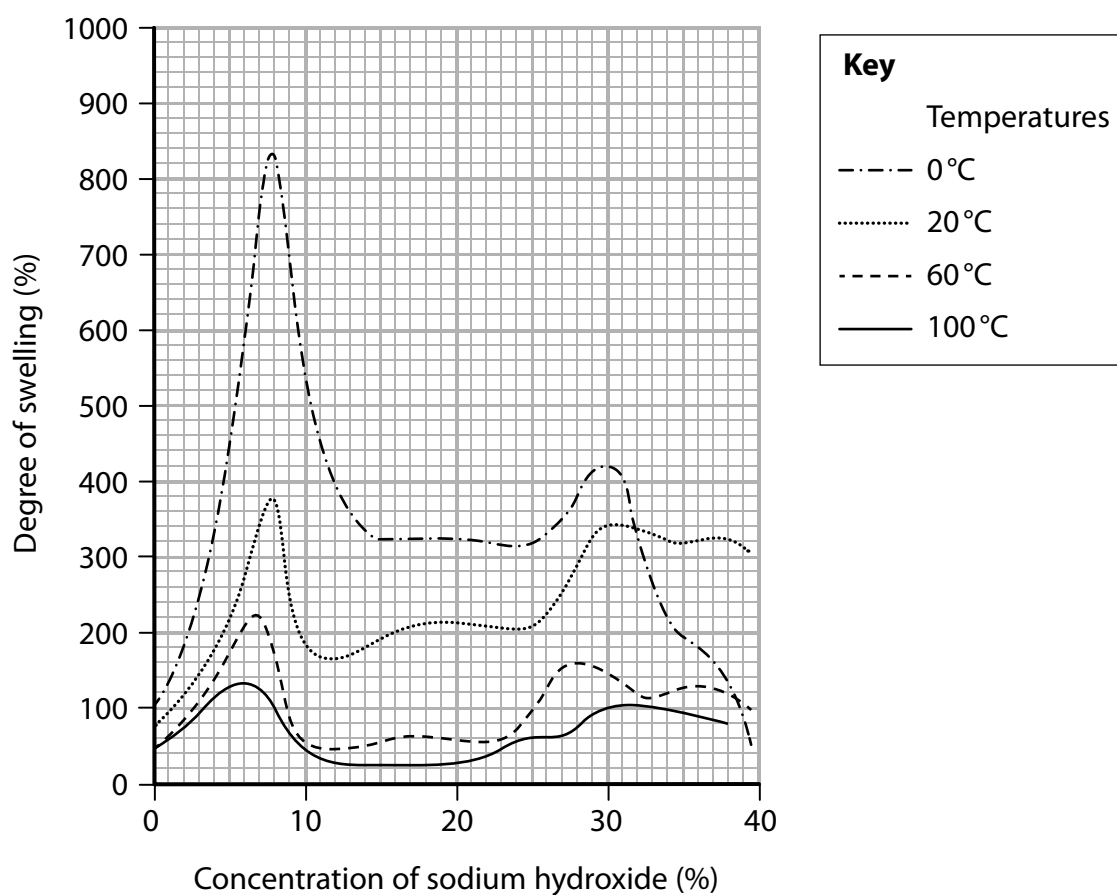
(i) Compare and contrast the trends shown by the results at 20 °C with those at 0 °C.

(2)

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(ii) Describe the effect of temperature on the degree of swelling of cotton fibres at a sodium hydroxide concentration of 5%.

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(Total for Question 2 = 17 marks)

3 A student studied the water potential of carrot tissue.

Pieces of weighed carrot tissue were placed in a range of sucrose solutions.

After two hours, the tissue was blotted and weighed again. The results are shown in the table.

Concentration of sucrose solution /mol dm⁻³	Original mass of carrot tissue /g	Final mass of carrot tissue /g	Percentage change in mass of carrot tissue (%)
0.0	2.40	3.10	29.17
0.2	2.48	2.68	8.06
0.4	2.48	2.42	−2.42
0.6	2.31	1.96	−15.15
0.8	2.41	1.78	−26.14
1.0	2.75	1.92	

(a) (i) Calculate the percentage change in mass when the carrot tissue was in a sucrose solution of $1.0\,mol\,dm^{-3}$.

(2)

Answer.. %

(ii) Plot a suitable graph to show the relationship between sucrose concentration and percentage change in mass. Join the points with straight lines.

(4)
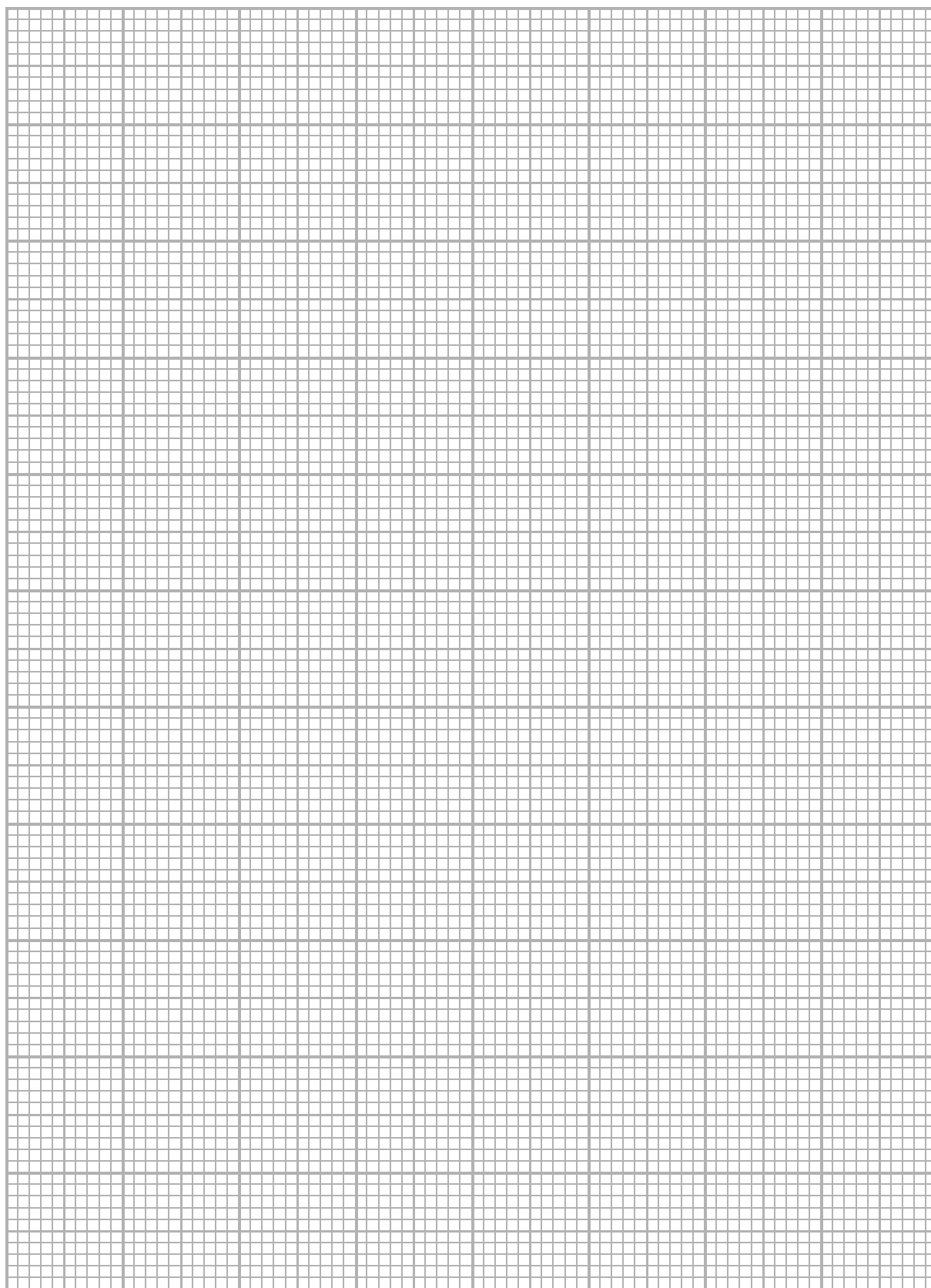
(iii) Using your graph, determine the concentration of sucrose solution which caused no change in mass of the carrot tissue.

(2)

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(iv) Explain why there is no change in mass of the carrot at this concentration.

(2)

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(b) Five students investigated the effect of temperature on the movement of materials through the membranes of cells in a plant tissue. Beetroot was chosen for this investigation because the cells contain a red pigment called betalain.

One piece of beetroot was placed into a tube containing $15\,cm^3$ of water at $0\,°C$ and left for 15 minutes. The procedure was repeated for seven further temperatures between $10\,°C$ and $70\,°C$.

Each piece of beetroot was removed and a sample of the fluid was placed in a colorimeter. The colorimeter was used to determine the intensity of the red colour of the fluid.

(i) Name **two** variables, other than those mentioned above, which should be kept constant during this experiment.

(2)

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(ii) State the dependent variable in this investigation.

(1)

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(iii) The table shows the results of this investigation.

Temperature /°C	Intensity of the red colour / a.u.						
	Student 1	Student 2	Student 3	Student 4	Student 5	Mean	Standard deviation
0	0.20	0.15	0.30	0.00	0.13	0.16	0.11
10	0.00	0.14	0.06	0.03	0.12	0.07	0.06
20	0.03	0.08	0.04	0.04	0.02	0.04	0.02
30	0.20	0.04	0.04	0.04	0.06	0.08	0.07
40	0.18	0.04	0.04	0.04	0.07	0.07	0.06
50	0.10	0.26	0.00	0.60	0.18	0.23	0.23
60	0.60	0.89	0.80	0.80	0.55	0.72	0.15
70	0.75	0.50	0.75	0.75	0.70	0.69	0.11

The graph showing the relationship between temperature and the mean intensity of red colour is incomplete.

Complete the graph.

(3)
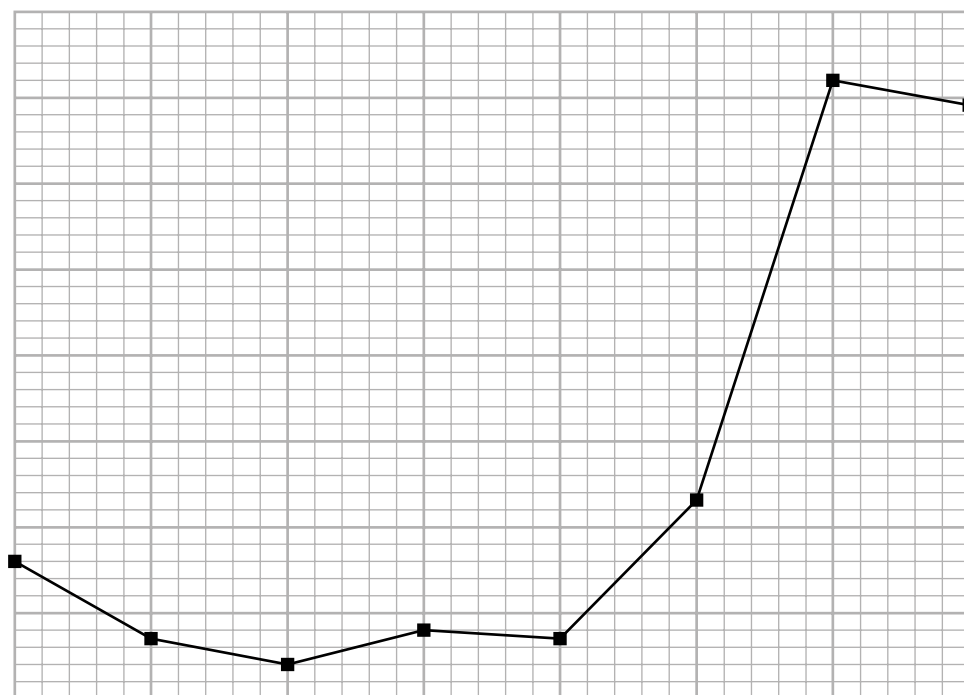
(iv) Suggest why four of the readings were above zero a.u. at 0 °C.

(2)

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(v) The students concluded that as temperature increases, membrane permeability increases.
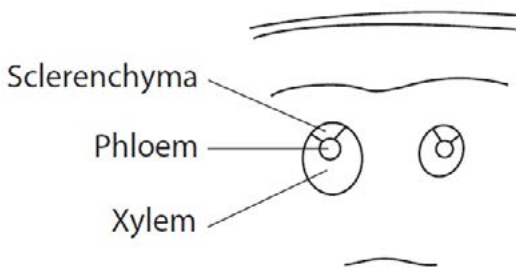
Using the information in the table and graph, criticise this conclusion.

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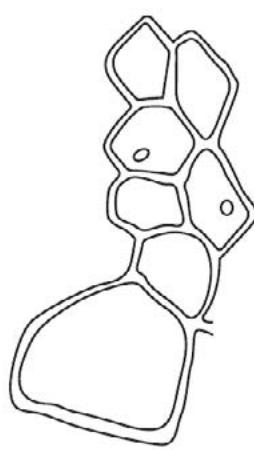
(Total for Question 3 = 23 marks)

TOTAL FOR PAPER = 50 MARKS

Unit 3 - Mark scheme

Question number	Answer	Mark
1(a)(i)	A drawing showing the following features: • neat lines and no cells drawn (1) • two vascular bundles drawn and three or four layers of tissue (1) • two tissues labelled (1) Example of labelled drawing: 	(3)

Question number	Answer	Mark
1(a)(ii)	A drawing showing the following features: • cells in the box drawn to the correct proportions (1) • nuclei drawn in the two cells (1) • cell walls shown correctly (1) Example of drawing: 	(3)

Question number	Answer	Mark
1(b)(i)	A calculation showing the following steps: • equivalent micrometer units and graticule units given (1) • 1 graticule unit calculated (1) Example of calculation: 6 stage micrometer units = 20 graticule units so 1 graticule unit = 60 ÷ 20 µm = 3 µm	**(2)**

Question number	Answer	Mark
1(b)(ii)	An answer showing the following steps: • reading diameter of A using scale (1) • actual diameter calculated (1) Example of calculation: A is 24 units wide so actual diameter is 24 × 3 = 72 µm	**(2)**

Question number	Answer	Mark
2(a)(i)	• concentration of sodium hydroxide solution	**(1)**

Question number	Answer	Mark
2(a)(ii)	An answer that includes any one of the following pairs: • temperature of solution (1) • carry out in a thermostatically controlled water bath (1) or • length of time in solution (1) • start them all at same time / stopwatch (1)	**(2)**

Question number	Answer	Mark
2(a)(iii)	An answer that includes any five of the following points: • a source material variable taken into account, e.g. length, width, age, mass, hydration level, part of plant extracted from (1) • environmental variable controlled, e.g. temperature, humidity (1) • named procedural variable controlled, e.g. size of masses used (1) • idea of adding masses until fibre breaks / measure the mass {that breaks the fibre / that the fibre can hold before breaking} (1) • repeat and find the {mean / average} (1) • reference to safety procedure (1)	**(5)**

Question number	Answer	Mark
2(b)(i)	An answer that includes the following points: • for {Baobab, Okra and Kenaf / three of the plants} concentration should be 10% (1) • for Roselle it should be 25% (1)	**(2)**

Question number	Answer	Mark
2(b)(ii)	A table, drawn showing: • suitable table drawn (1) • headings of sodium hydroxide concentration with units, tensile strength with units and the two species (1) • data correctly entered into it (1) Example of table drawn:	**(3)**

Sodium hydroxide concentration/%	Tensile strength/a.u.	
	Roselle	Baobab
10	0.40	1.00
15	0.30	0.63
20	0.59	0.65
25	0.65	0.60

Question number	Answer	Mark
2(c)(i)	An answer that includes the following comparative points: • both {peak at 8% (sodium hydroxide) / go down above 8% (sodium hydroxide) / rise at 25% (sodium hydroxide)} (1) • 0 $^{\circ}$C peaks at 30% (sodium hydroxide) but at 20 $^{\circ}$C {reaches a plateau / flattens off at 30% (sodium hydroxide)} (1)	(2)

Question number	Answer	Additional guidance	Mark
2(c)(ii)	A description that includes the following points: • an increase in temperature leads to a reduction in degree of swelling (1) • this effect is not linear (1)	Accept reverse argument	(2)

Question number	Answer	Mark
3(a)(i)	An answer showing the following steps: • change in mass calculated (1) • percentage change calculated (1) Example of calculation: 2.75 − 1.92 = -0.83 g (-0.83 ÷ 2.75) × 100 = -30.18%	(2)

Question number	Answer	Mark
3(a)(ii)	A graph showing the following features: • A axes correct (x – concentration of sucrose solution, y - percentage change in mass) (1) • L axes correctly labelled, and with units mol dm^{-3} and % (1) • P correct plotting (1) • S points joined with straight lines (1) Example of graph: 	(4)

Question number	Answer	Additional guidance	Mark
3(a)(iii)	An answer showing the following steps: • 0.35 (1) • mol dm^{-3} (1)	 Allow ecf from graph	(2)

Question number	Answer	Mark
3(a)(iv)	An explanation that includes the following points: • there is no (net) change in the quantity of water in the carrot tissue / the water potential in the carrot equals the water potential of the solution (1) • {because / therefore} the rate of water gain is equal to its loss (1)	**(2)**

Question number	Answer	Mark
3(b)(i)	Any two from the following: • surface area / volume / age / variety / storage conditions / source (of beetroot) / same {wavelength / filter} (1)	**(2)**

Question number	Answer	Mark
3(b)(ii)	• intensity of the red colour	**(1)**

Question number	Answer	Mark
3(b)(iii)	A graph showing the following features: • axes correctly labelled with units (x temperature/ °C and y intensity of the red colour/a.u.) (1) • scales correctly labelled (1) • standard deviations (SDs) all correctly plotted (1) Example graph: 	(3)

Question number	Answer	Additional guidance	Mark
3(b)(iv)	An answer that includes the following points: • {cells / membranes / eq} damaged (by cutting up of pieces) (1) • so pigment could leak out of {vacuoles / cells} (1)	Accept reference to condensation on cuvette at low temperature, leads to absorption of some of the light	(2)

Question number	Answer	Mark
3(b)(v)	An answer that includes any five of the following points: • (overall) the intensity of the red colour increases as temperature increases (1) • but from 0 °C to 40 °C, the SDs overlap so no significant effect (1) • at 50 °C the mean is higher than that at 40 °C but SDs overlap so there is no case for saying the difference is significant (1) • at 60 °C the mean is higher than that at 50 °C and the SDs do not overlap so this difference can be regarded as significant (1) • at 70 °C the mean degree of redness falls from that at 60 °C but the SDs overlap so temperatures above 60 °C appear to have no further effect (1) • there are no data above 70 °C so cannot say what any further rise in temperature would cause (1)	**(5)**

Write your name here

Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

Biology

International Advanced Level
Unit 4: Energy, Environment, Microbiology and Immunity

Sample Assessment Materials for first teaching September 2018
Time: 1 hour 45 minutes

Paper Reference
WBI14/01

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

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

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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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 (a) The diagram shows the structure of an Ebola virus.
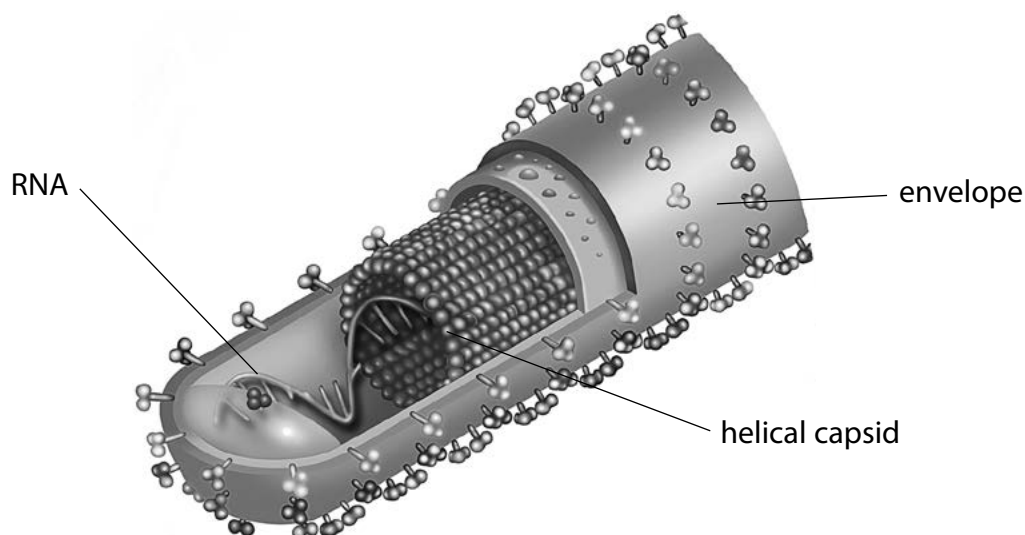
© Science History Images / Alamy Stock Photo

(i) Which of the following viruses contain the same type of nucleic acid as the Ebola virus?

(1)

☒ **A** human immunodeficiency virus (HIV) only

☒ **B** human immunodeficiency virus (HIV) and tobacco mosaic virus (TMV)

☒ **C** lambda phage (λ phage) only

☒ **D** lambda phage (λ phage) and tobacco mosaic virus (TMV)

(ii) Which of the following viruses have a helical capsid?

(1)

☒ **A** human immunodeficiency virus (HIV) and lambda phage (λ phage)

☒ **B** human immunodeficiency virus (HIV) only

☒ **C** lambda phage (λ phage) and tobacco mosaic virus (TMV)

☒ **D** tobacco mosaic virus (TMV) only

(iii) What type of molecule makes up the capsid of a virus?

(1)

☒ **A** carbohydrate

☒ **B** lipid

☒ **C** nucleic acid

☒ **D** protein

(iv) The volume of an Ebola virus is approximately $7.76 \times 10^4 \, nm^3$.

Tobacco mosaic virus (TMV) is approximately 300 nm long and 80 nm in diameter.

Calculate how many times larger Ebola virus is than TMV.

Assume that TMV is a cylinder in shape.

The volume of a cylinder is calculated using the formula

$$V = \pi r^2 l$$

(2)

Answer...

(b) Human immunodeficiency virus (HIV) contains two enzymes that are **not** found in most other types of virus.

(i) Name these two enzymes.

(1)

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(ii) Explain why HIV contains these two enzymes.

(3)

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(Total for Question 1 = 9 marks)

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2 Antibodies play an important role in the immune response.

(a) Explain the importance of antibodies.

(4)

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(b) There are different classes of antibody, including IgA, IgG and IgM.

The graph shows the changes in the concentration of IgA and IgG in the plasma of a fetus before birth and in a child after birth.

Key

——————

IgG produced by
the mother

– – – – –

IgG produced by
the child

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IgA produced by
the mother
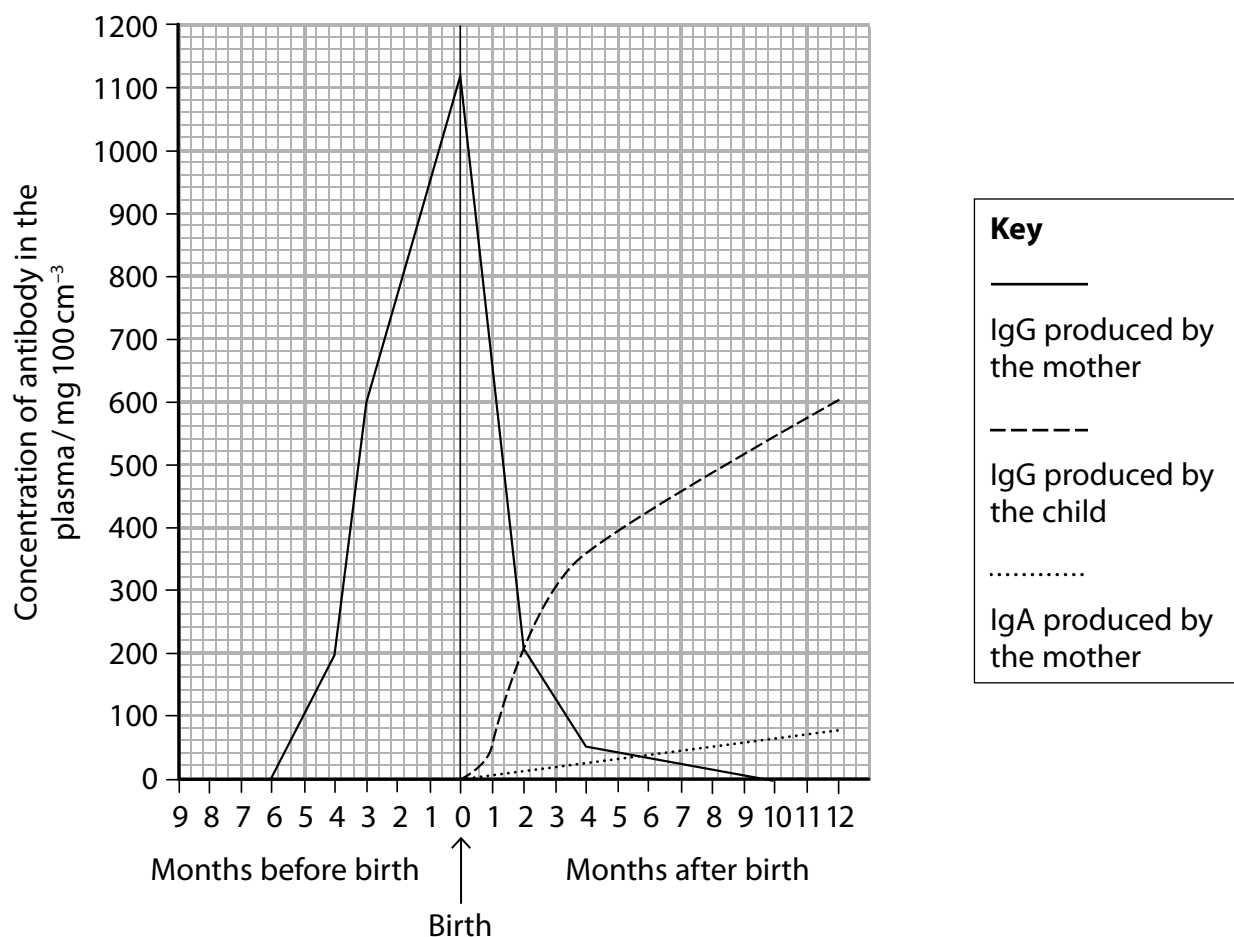
(i) Describe the changes in the classes of antibody in a fetus before birth and in a child after birth. Use the information in the graph to support your answer.

(3)

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(ii) Which type of immunity explains the presence of IgA?

(1)

☒ **A** artificial active

☒ **B** artificial passive

☒ **C** natural active

☒ **D** natural passive

(iii) Suggest why the concentration of antibodies is less in a child 12 months after birth than in an adult.

(2)

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(Total for Question 2 = 10 marks)

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3 (a) Explain the role of the products of the light-dependent reactions of photosynthesis in the Calvin cycle.

(3)

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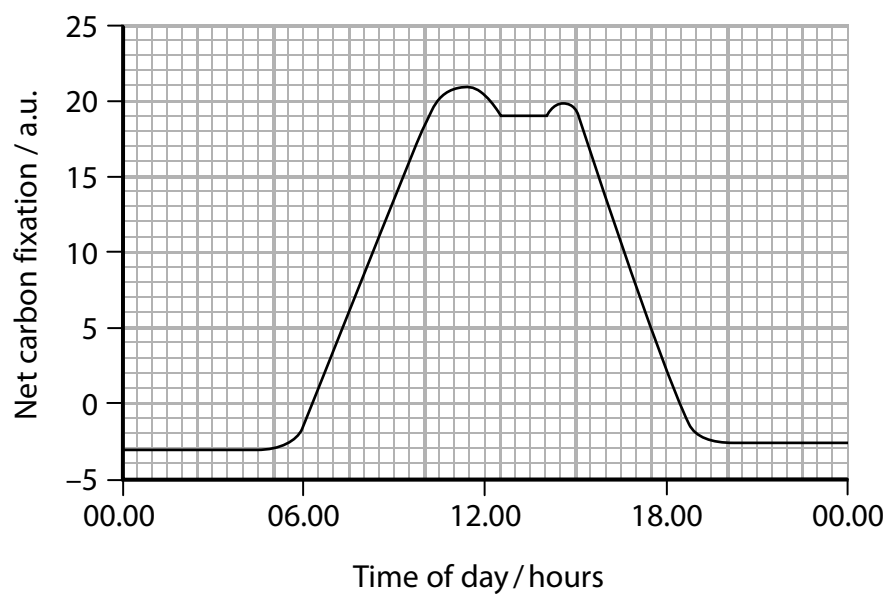
(b) The graph shows the net carbon fixation in a plant over a period of 24 hours.

(i) Calculate the rate of decrease of net carbon fixation at 12 00 hours.

Include units in your answer.

(3)

Answer...

(ii) Suggest an explanation for the decrease in net carbon fixation between 12 00 hours and 13 00 hours.

(3)

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(iii) Suggest why the net carbon fixation was negative before 05 00 hours and after 19 00 hours.

(3)

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(Total for Question 3 = 12 marks)

4 Anthropogenic climate change is considered to be a result of greenhouse gas emissions.

(a) State what is meant by the term **anthropogenic climate change**.

(2)

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(b) (i) Name **two** greenhouse gases.

(1)

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(ii) Explain the role of greenhouse gases in climate change.

(2)

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*(c) The pie chart shows the relative contribution of different sources of greenhouse gas emissions.

Waste and wastewater
2.8%

Forestry
17.4%

Energy supply
25.9%

Agriculture
13.5%

Transport
13.1%

Industry
19.4%

Homes and business
buildings 7.9%
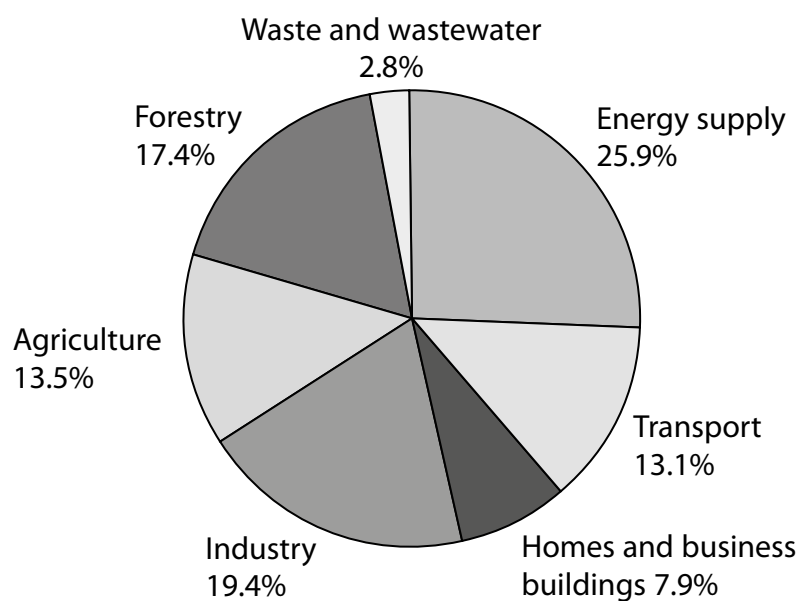
Explain the relative contribution of each source of greenhouse gas. Use the information in the pie chart and your own knowledge to support your answer.

(6)

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(Total for Question 4 = 11 marks)

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5 Some disorders are caused by mutations in the mitochondrial DNA and can be inherited.

Three-parent embryos have been developed to prevent the inheritance of these disorders.

Diagram 1 shows how three-parent embryos are made.

egg cell from
the mother

egg cell from
the donor

nucleus removed and used

nucleus removed and discarded

nucleus put inside the
empty egg cell from donor

sperm from the father

fertilisation

three-parent embryo
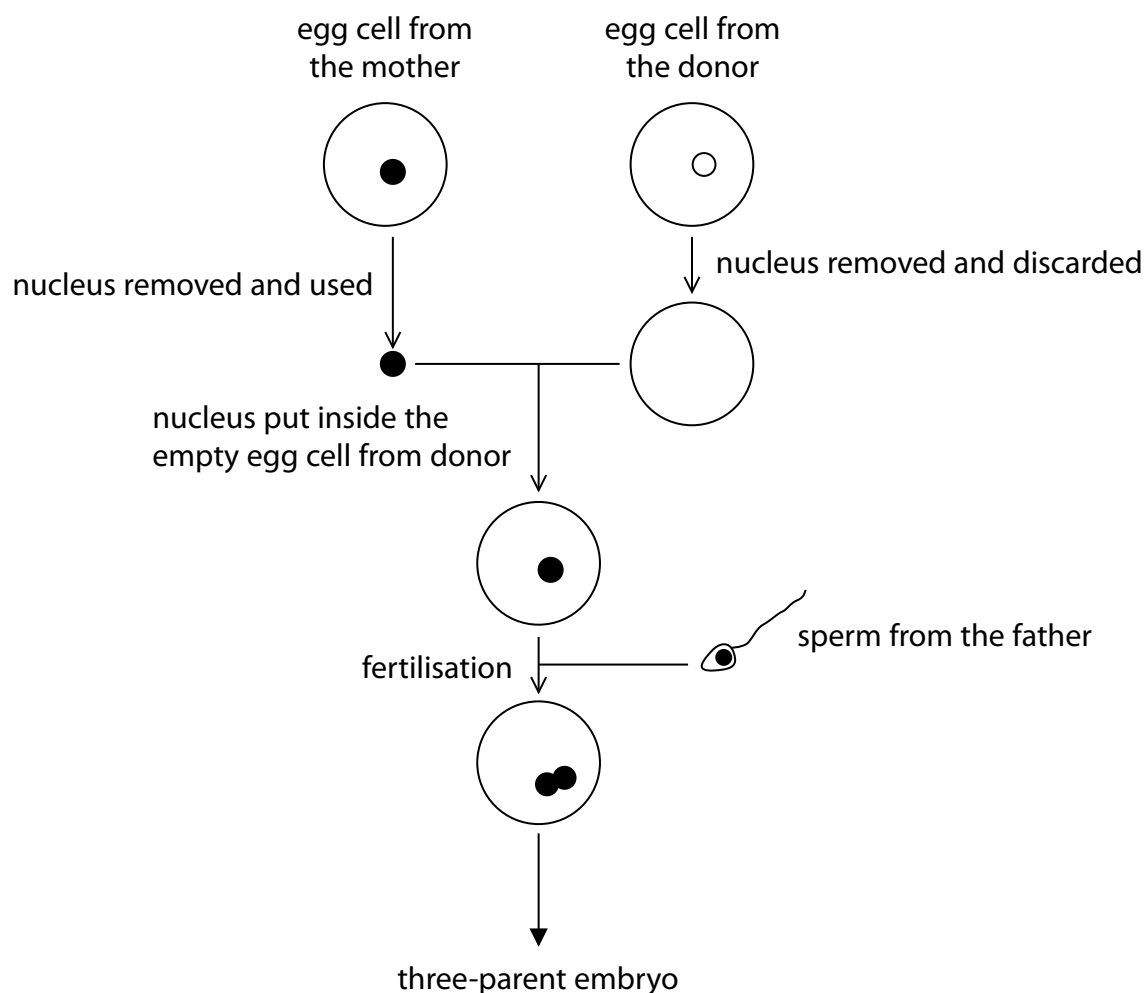
Diagram 1

(a) The cells in the three-parent embryo are totipotent stem cells.

State what is meant by the term **totipotent stem cells**.

(2)

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(b) Diagram 2 shows the results of separating the DNA from the three-parent embryo, the mother and the father, using gel electrophoresis.

The bands from the DNA of the embryo are labelled from 1 to 12.
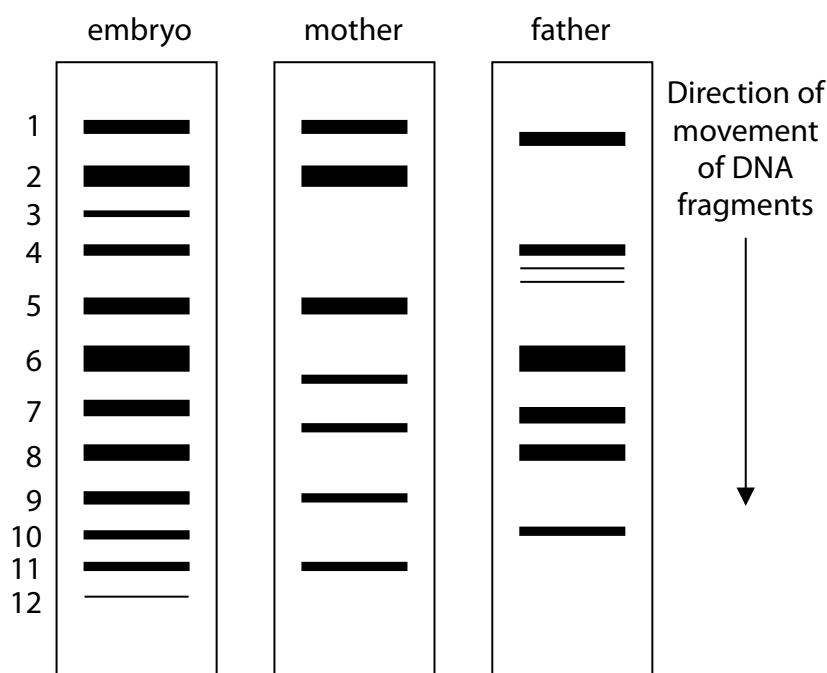
Diagram 2

(i) Which of the following is the reason for the movement of the DNA fragments?

(1)

☒ **A** negatively-charged fragments move towards the negative end of the gel

☒ **B** negatively-charged fragments move towards the positive end of the gel

☒ **C** positively-charged fragments move towards the negative end of the gel

☒ **D** positively-charged fragments move towards the positive end of the gel

(ii) Which band on the gel contains the heaviest DNA fragments?

(1)

☒ **A** 1

☒ **B** 3

☒ **C** 6

☒ **D** 9

*(iii) Explain the banding pattern of this three-parent embryo. Use information in Diagram 1 and Diagram 2 to support your answer.

(6)

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(Total for Question 5 = 10 marks)

6 Tuberculosis is a disease caused by infection with *Mycobacterium tuberculosis*.

The cell wall of *M. tuberculosis* is different from most other types of bacteria as it contains different types of mycolic acid.

Mycolic acid protects the bacteria from lysozyme action, dehydration and polar (hydrophilic) antibiotics.

The diagram shows part of one type of mycolic acid.
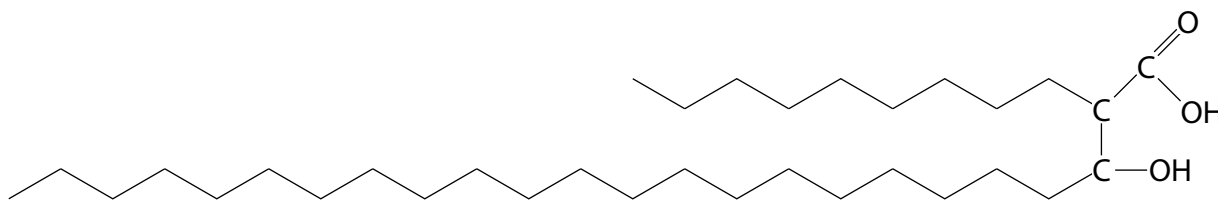
(a) What type of molecule is mycolic acid?

(1)

☒ **A** carbohydrate

☒ **B** fatty acid

☒ **C** nucleic acid

☒ **D** polypeptide

(b) Treatment for tuberculosis involves the use of different types of antibiotic, taken over several months.

The table gives details of four antibiotics used to treat tuberculosis.

Antibiotic	Mode of action
E	disrupts the formation of the cell wall
J	inhibits the synthesis of mycolic acids
P	activates an enzyme that inhibits the synthesis of fatty acids
R	binds to the active site of RNA polymerase

(i) Suggest why antibiotic E is effective only when *M. tuberculosis* bacteria are dividing.

(1)

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(ii) Explain why antibiotic J could result in an increase in antigen presentation by macrophages.

(2)

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(iii) Explain how antibiotic P could affect *M. tuberculosis*.

(3)

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(iv) Explain how antibiotic R could affect *M. tuberculosis*.

(3)

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(v) Explain why taking a combination of antibiotics for several months could increase the resistance of *M. tuberculosis* to these antibiotics.

(2)

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(Total for Question 6 = 12 marks)

7 Temperature affects the rate of growth of bacteria.

The diagram shows some information about the growth of bacteria in different ranges of temperature.
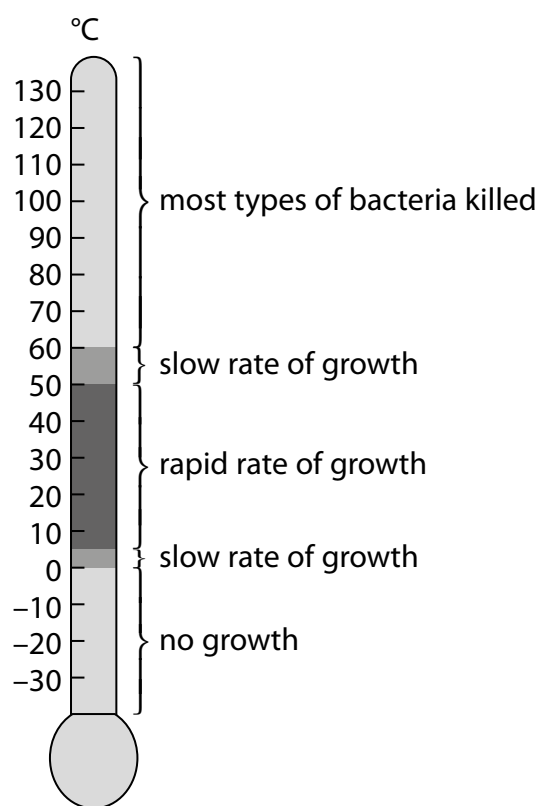
(a) Explain why most types of bacteria are killed at temperatures above 60 °C, but bacteria can grow slowly in a temperature range of 50 °C to 60 °C.

(4)

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(b) (i) The growth rate constant will be at its highest in the temperature range of 5 °C to 50 °C.

Calculate the growth rate constant (k) of bacteria that have increased from 5×10^3 cells per cm^3 to 1.3×10^5 cells per cm^3 in 4 hours.

(3)

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

Answer...

(ii) The formula used to calculate the growth rate constant can only be applied to one phase of bacterial growth.

To which phase of bacterial growth can the formula be applied?

(1)

☒ **A** death

☒ **B** exponential

☒ **C** lag

☒ **D** stationary

(c) (i) Explain why some foods are kept in refrigerators at a temperature between 0 °C and 5 °C.

(3)

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(ii) Explain why there is no growth of bacteria in a freezer at a temperature of −18 °C.

(2)

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(Total for Question 7 = 13 marks)

8 The photograph shows a wood frog.

Source: http://www.borealforest.org/reptiles/wood_frog.htm

Wood frogs are found throughout North America.

The shaded areas on the map shows the distribution of wood frogs in North America.

Information is also given about the climate in two areas, Alaska and Ohio.

Alaska

Range of temperatures in January: −28 °C to −19 °C

Annual snow fall: 174 cm

Ohio

Range of temperatures in January: −5 °C to 4 °C

Annual snow fall: 35 cm

Source: https://answersingenesis.org/natural-selection/adaptation/the-secret-lives-of-frozen-frogs/
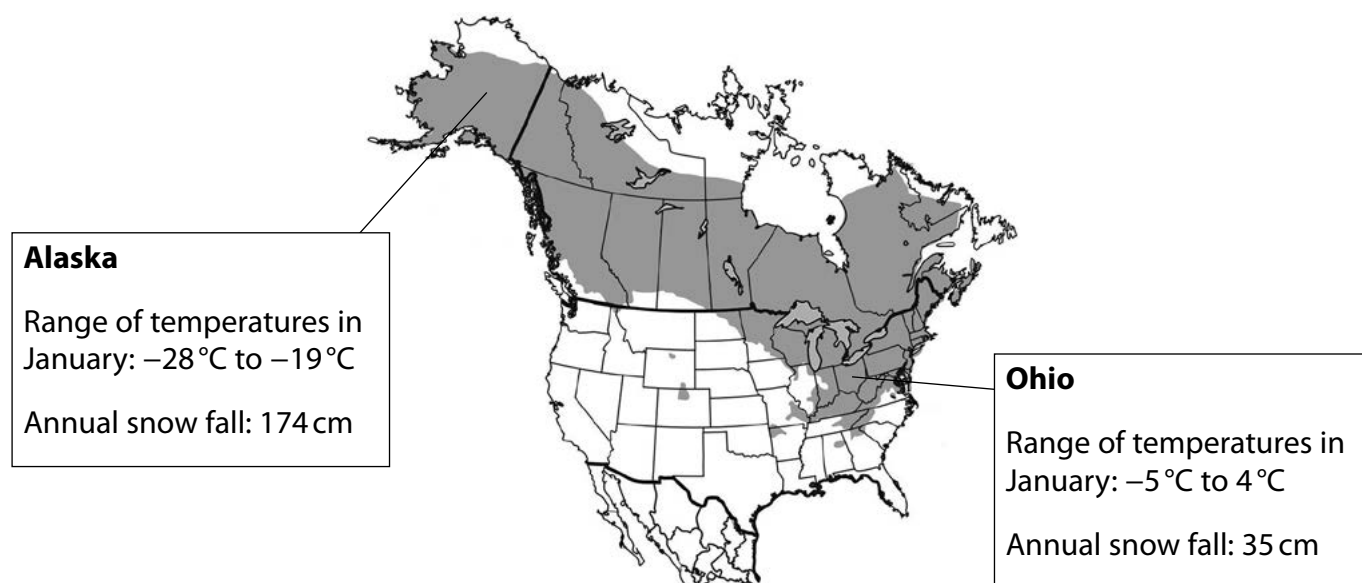
(a) Scientists kept a wood frog from Alaska at −16 °C. The scientists measured the concentration of glycogen in the liver and the concentration of glucose in the plasma over a period of 48 hours.

The graph shows the results.
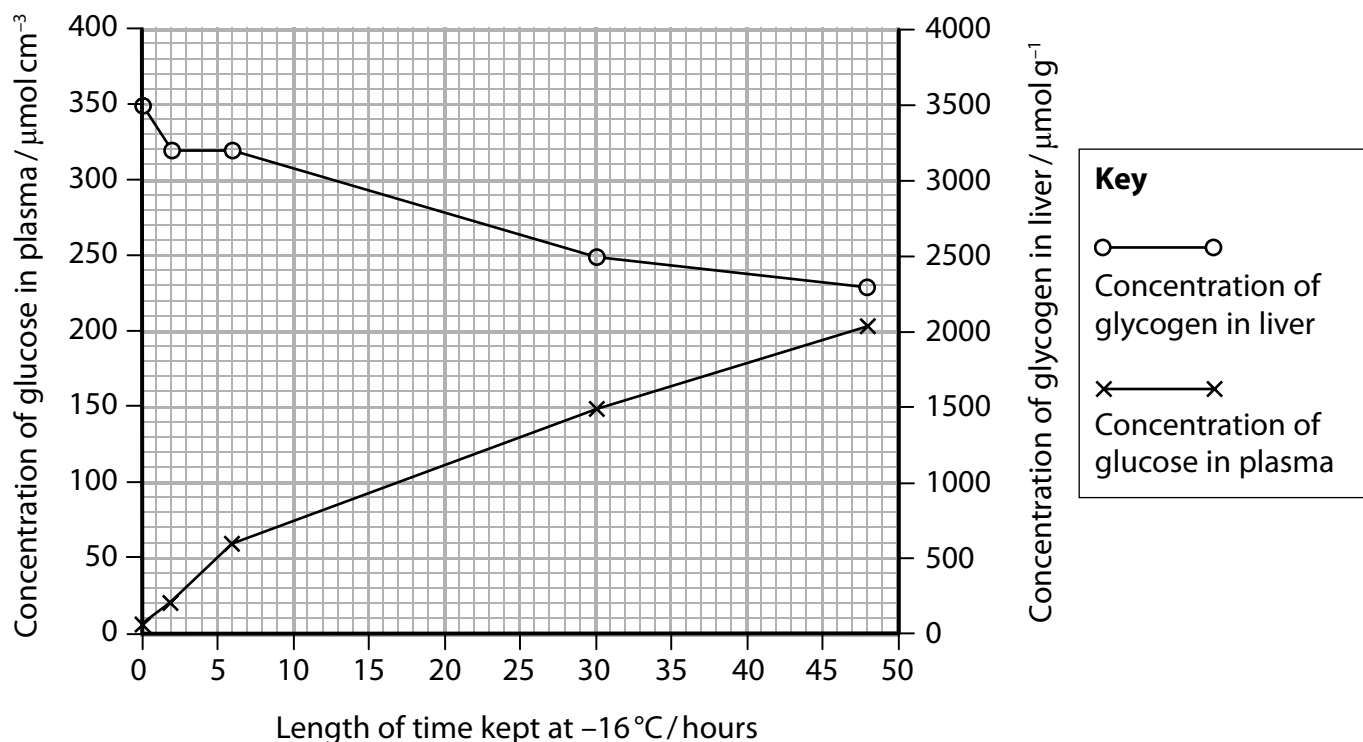
(i) How many of the following statements describe glycogen?

(1)

1. The monomer is β glucose

2. It is made from two different types of polymer

3. There are 1,4 and 1,6 glycosidic bonds

4. It is insoluble

☐ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(ii) Explain the changes in the concentration of glycogen and glucose.
Use the information in the graph to support your answer.

(2)

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(b) The scientists found that wood frogs from Alaska had higher concentrations of glucose in their plasma than wood frogs from Ohio.

The scientists also found that the wood frogs from Alaska had higher concentrations of other solutes, such as urea, in their plasma.

The table shows the mean concentration of urea in the plasma of these frogs. The table also shows the standard deviations.

Type of wood frogs	Mean concentration of urea in plasma / $\mu mol\ cm^{-3}$	Standard deviation
from Alaska	106	10
from Ohio	28	5

(i) Calculate the percentage difference in the mean concentration of urea in the plasma of the wood frogs from Alaska compared with the wood frogs from Ohio.

(1)

Answer... %

(ii) Explain why the data for the wood frogs from Alaska are more reliable than the data for the wood frogs from Ohio.

(2)

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(iii) Explain why a high concentration of solutes in the plasma could protect the wood frogs from Alaska in very cold temperatures.

(2)

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(c) Explain how these wood frogs evolved to occupy different niches in North America.

(5)

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(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

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Unit 4 - Mark scheme

Question number	Answer	Mark
1(a)(i)	B human immunodeficiency virus (HIV) and tobacco mosaic virus (TMV)	**(1)**

Question number	Answer	Mark
1(a)(ii)	D tobacco mosaic virus (TMV) only	**(1)**

Question number	Answer	Mark
1(a)(iii)	D protein	**(1)**

Question number	Answer	Additional guidance	Mark
1(a)(iv)	• calculation of volume of TMV (1) • calculation of size difference (1) Example of calculation: $3.14 \times 40 \times 40 \times 300 = 1\ 507\ 200$ 19 / 19.4 / 19.42	Allow ecf Correct answer with no working shown gains full marks	**(2)**

Question number	Answer	Mark
1(b)(i)	• reverse transcriptase and integrase	**(1)**

Question number	Answer	Mark
1(b)(ii)	An explanation that includes the following points: • because these enzymes are not present in the host cell (1) • because reverse transcriptase is needed to make a DNA copy of the viral RNA (1) • because integrase is needed to incorporate the DNA copy into the host cell genome (1)	**(3)**

Question number	Answer	Mark
2(a)	An explanation that includes the following points: • each antibody can bind to two bacteria resulting in agglutination (1) • antibody {can bind to both the phagocyte and the bacteria / causes opsonisation} (1) • therefore phagocytosis is enhanced (1) • toxins are neutralised (1)	**(4)**

Question number	Answer	Mark
2(b)(i)	A description that includes the following points: • IgG produced by mother increases in months before birth and then decreases after birth (1) • IgG produced by child increases rapidly after birth (1) • IgA increases slowly after birth (1)	**(3)**

Question number	Answer	Mark
2(b)(ii)	D natural passive	**(1)**

Question number	Answer	Mark
2(b)(iii)	An answer that includes the following points: • child has not been exposed to all types of antigen (1) • no {IgM / other classes of antibody} produced yet (1)	**(2)**

Question number	Answer	Mark
3(a)	An explanation that includes the following points: • GP is formed once carbon dioxide has bound to RuBP in the Calvin cycle (1) • and ATP is required to provide energy to convert GP to GALP (1) • and reduced NADP is used to reduce GP to GALP (1)	**(3)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	• tangent drawn to curve at 12 00 hours (1) • values to calculate gradient given (1) • answer with units (1)	Allow ecf Award full marks for correct numerical answer without working	(3)

Question number	Answer	Mark
3(b)(ii)	An answer that includes any three of the following points: • light intensity falls (1) • so less ATP is generated from light-dependent reaction (1) • temperature falls (1) • so enzymes are working slower (1)	(3)

Question number	Answer	Mark
3(b)(iii)	An answer that includes any three of the following points: • light intensity was low (1) • so {less / no} photosynthesis was taking place (1) • glucose was being used (1) • because respiration was taking place (1)	(3)

Question number	Answer	Mark
4(a)	An answer that includes the following points: • changes to {weather patterns / global temperatures} over a long period of time (1) • due to human activity (1)	(2)

Question number	Answer	Additional guidance	Mark
4(b)(i)	Any two from: • carbon dioxide • methane • water vapour • nitrogen oxides • CFCs	Accept correct chemical formulae	**(1)**

Question number	Answer	Mark
4(b)(ii)	An explanation that includes the following points: • accumulated gases in the atmosphere trap infrared radiation (1) • resulting in an increase in the temperature of the Earth's {atmosphere / surface} (1)	**(2)**

Question number	Answer	Mark
4(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 indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • carbon dioxide is released into atmosphere • because agriculture requires farm machinery powered by burning fossil fuels • because industry burns fossil fuels for energy • because homes and business buildings use fossil fuels for heating • transport uses fossil fuels • fossil fuels are burnt to produce electricity • forestry may decrease the number of trees • so less carbon dioxide removed from air by photosynthesis	**(6)**

Level	Marks	Descriptor
	0	No awardable content.
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and 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.
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.
3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.

Question number	Answer	Mark
5(a)	An answer that includes the following points: • can differentiate into all cell types (1) • have no Hayflick limit / can divide indefinitely (1)	(2)

Question number	Answer	Mark
5(b)(i)	B negatively-charged fragments move towards the positive end of the gel	(1)

Question number	Answer	Mark
5(b)(ii)	A 1	(1)

Question number	Answer	Mark
5(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 indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • Bands 1, 2, 5, 9 and 11 in the embryo are also found in the mother • therefore, they must have been present in the nucleus of the egg cell from the mother • Bands 4, 6, 7, 8 and 10 in the embryo are also found in the father • therefore they must have been present in the nucleus of the sperm from the father • Bands 3 and 12 in the embryo are not found in either the mother or the father • therefore they must have been the mitochondrial DNA from the donor • both mother and father have bands not found in the embryo • the bands in the mother could be her mitochondrial DNA	**(6)**

Level	Marks	Descriptor
	0	No awardable content.
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and 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.
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.
3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.

Question number	Answer	Mark
6(a)	B fatty acid	(1)

Question number	Answer	Mark
6(b)(i)	• bacteria make cell walls only following cell division	(1)

Question number	Answer	Mark
6(b)(ii)	An explanation that includes the following points: • if there is no mycolic acid the lysozymes will be able to digest the bacteria (1) • therefore antigens will be produced (1)	(2)

Question number	Answer	Mark
6(b)(iii)	An explanation that includes the following points: • if there is no mycolic acid in the cell wall, they will be more susceptible to lysozyme action (1) • the membrane structure will be affected (1) • therefore the cell will lose control of molecules entering and leaving (1)	(3)

Question number	Answer	Mark
6(b)(iv)	An explanation that includes the following points: • transcription will be inhibited (1) • therefore bacteria will not be able to synthesise proteins (1) • therefore {structure / function} of cell will be affected (1)	(3)

Question number	Answer	Mark
6(b)(v)	An explanation that includes any two of the following points: • greater exposure to antibiotics increases chances of resistance (1) • therefore bacteria could become resistant to a greater number of antibiotics (1) • greater chance that patients will not take antibiotics correctly (1)	(2)

Question number	Answer	Mark
7(a)	An explanation that includes the following points: • above 60°C the enzymes are denatured (1) • so there will be no metabolic reactions (1) • because between 50°C to 60°C the enzymes are working slowly (1) • because the enzymes are denaturing (1)	**(4)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	• $\log_{10}$ of 5×10^3 and 1.3×10^5 stated (1) • denominator calculated (1) • answer (1) Example of calculation: 3.7 and 5.1 0.301 × 4 = 1.204 1 / 1.2 / 1.16	Allow ecf Award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Mark
7(b)(ii)	B exponential	**(1)**

Question number	Answer	Mark
7(c)(i)	An explanation that includes the following points: • decomposition will be slower (1) • because the enzymes will be less active (1) • as there is less {heat / kinetic} energy (1)	**(3)**

Question number	Answer	Mark
7(c)(ii)	An explanation that includes the following points: • cytoplasm will be frozen (1) • therefore enzymes and substrates will not be able to {move / collide} (1)	**(2)**

Question number	Answer	Mark
8(a)(i)	B 2	(1)

Question number	Answer	Mark
8(a)(ii)	An explanation that includes the following points: • glucose increases as glycogen decreases (1) • because glycogen is being hydrolysed (1)	(2)

Question number	Answer	Mark
8(b)(i)	• calculation of percentage difference Example of calculation: ((106 − 28) ÷ 28) × 100 = 279 / 278.6 / 278.57	(1)

Question number	Answer	Mark
8(b)(ii)	An explanation that includes the following points: • data from the wood frog from Alaska are more reliable as standard deviation is relatively smaller (1) • 9.43% compared to 17.86% of mean (1)	(2)

Question number	Answer	Mark
8(b)(iii)	An explanation that includes the following points: • solutes lower the freezing point of the plasma (1) • prevents damage to the cells by {freezing / ice crystals} (1)	(2)

Question number	Answer	Mark
8(c)	An explanation that includes any five of the following points: • natural selection (1) • because a mutation in DNA occurred (1) • resulting in alleles for increased solutes in plasma (1) • therefore these wood frogs could survive in colder areas (1) • reducing competition with other wood frogs (1) • therefore survived and reproduced passing on these alleles (1)	(5)

Write your name here

Surname

Other names

**Pearson Edexcel
International
Advanced Level**

Centre Number

Candidate Number

Biology

**International Advanced Level
Unit 5: Respiration, Internal Environment,
Coordination and Gene Technology**

Sample Assessment Materials for first teaching September 2018
Time: 1 hour 45 minutes

Paper Reference
WBI15/01

You must have:
Scientific article (enclosed), scientific calculator, ruler, HB pencil

Total Marks

Instructions

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

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

S58691A0130

Answer ALL questions.

Write your answers in the spaces provided.

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

1   The diagram shows the sequence of electron carriers in the electron transport chain.
    The diagram also shows the stages where ATP is generated.

reduced NAD ────────→ NADH dehydrogenase
                                    │
                                    ├──────→ ATP
                                    ↓
reduced FAD ────────→ coenzyme Q
                                    │
                                    ↓
                            cytochrome b
                                    │
                                    ├──────→ ATP
                                    ↓
                           cytochrome c$_1$
                                    │
                                    ↓
                            cytochrome c
                                    │
                                    ↓
                        cytochrome (a + a$_3$)
                                    │
                                    ├──────→ ATP
                                    ↓
                              oxygen
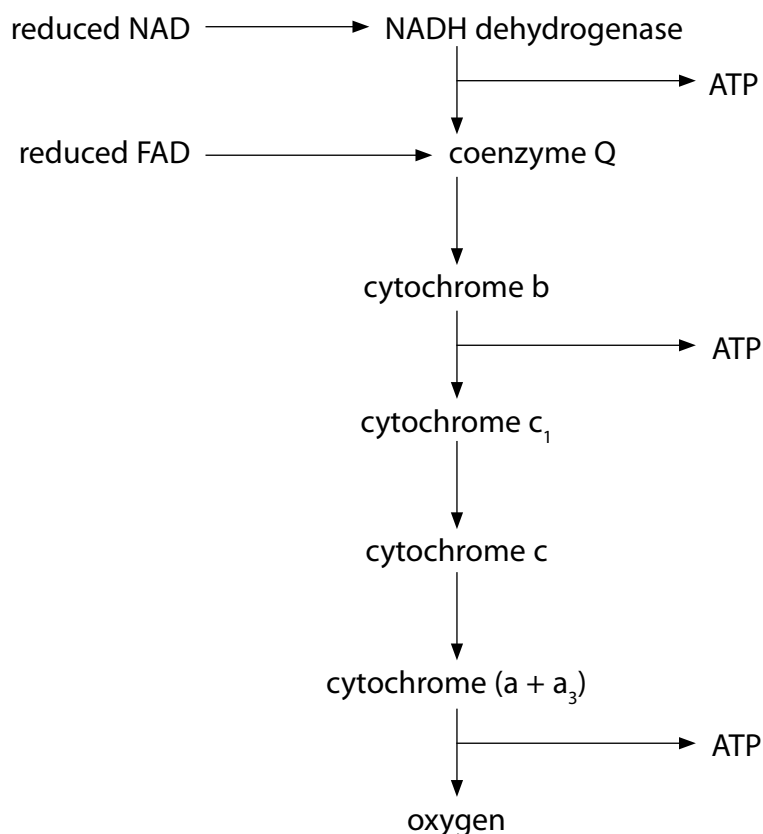
   (a) Where is the site of the electron transport chain?

   (1)

   ☒ **A** cytoplasm

   ☒ **B** inner mitochondrial membrane

   ☒ **C** matrix

   ☒ **D** outer mitochondrial membrane

(b) The table gives some information about inhibitors of the electron transport chain.

Inhibitor	Site of inhibition
Cyanide	between cytochrome (a + a$_3$) and oxygen
Rotenone	between NADH dehydrogenase and coenzyme Q

(i) Explain the effect that cyanide will have on ATP production by the electron transport chain.

(2)

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(ii) Metabolism of succinate results in the production of reduced FAD.

Explain the effect that rotenone will have on ATP production by the electron transport chain.

(2)

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(iii) Explain why these inhibitors will not affect the production of ATP from anaerobic respiration. Use the information in the table to support your answer.

(2)

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(Total for Question 1 = 7 marks)

2 (a) Negative feedback is important in maintaining homeostasis.

Control of the ventilation rate is an example of negative feedback.

The diagram summarises negative feedback.
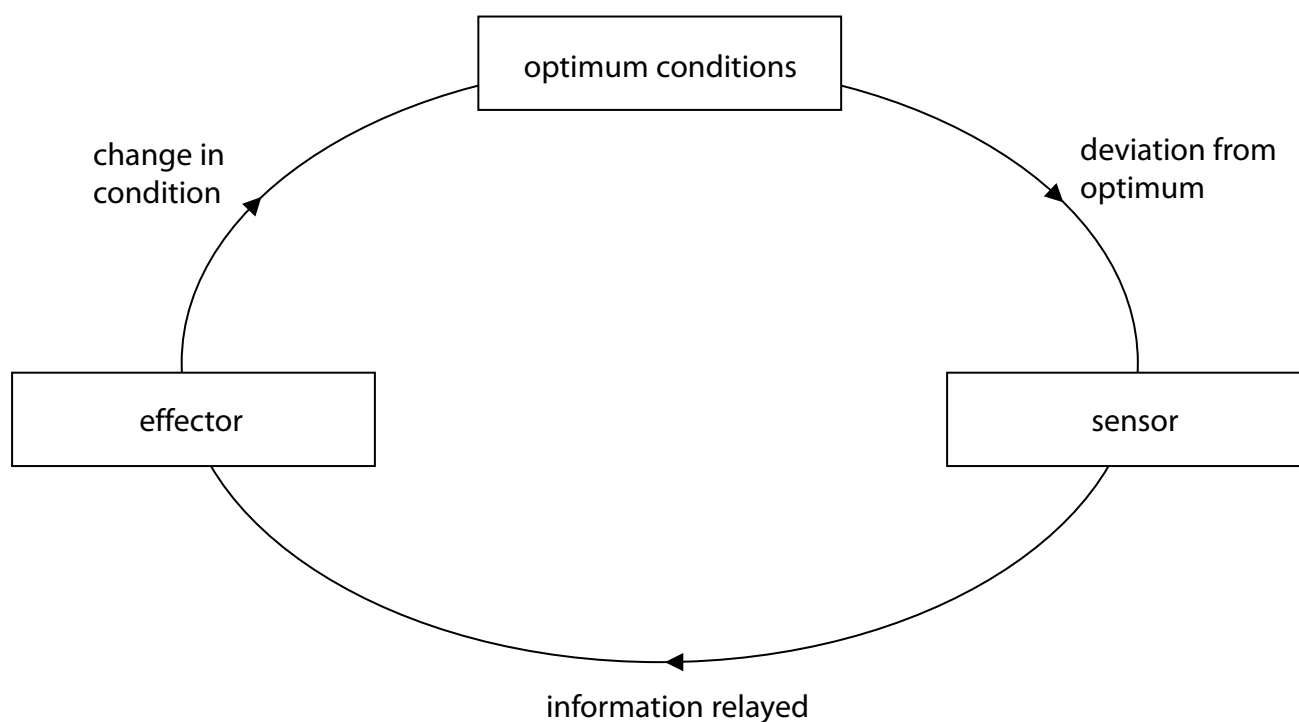
(i) Which row of the table shows the sensor and the location of the sensor involved in the control of ventilation?

(1)

		sensor	location of sensor
☒	**A**	baroreceptor	hypothalamus
☒	**B**	baroreceptor	medulla oblongata
☒	**C**	chemoreceptor	hypothalamus
☒	**D**	chemoreceptor	medulla oblongata

(ii) Explain why the control of ventilation rate is an example of negative feedback.
Use the information in the diagram to support your answer.

(4)

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(b) The ripening of apples is an example of positive feedback.

Ethene is a gas that causes apples to ripen. Ripe apples release ethene.

Complete the diagram to show positive feedback in the ripening of apples.

(3)

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┌─────────────────────┐
│   One apple on the  │
│     tree ripens     │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│                     │
│                     │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│     Neighbouring    │
│    apples ripen     │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│                     │◄──┐
│                     │   │
└─────────────────────┘   │
           │              │
           ▼              │
┌─────────────────────┐   │
│                     │   │
│                     │───┘
└─────────────────────┘
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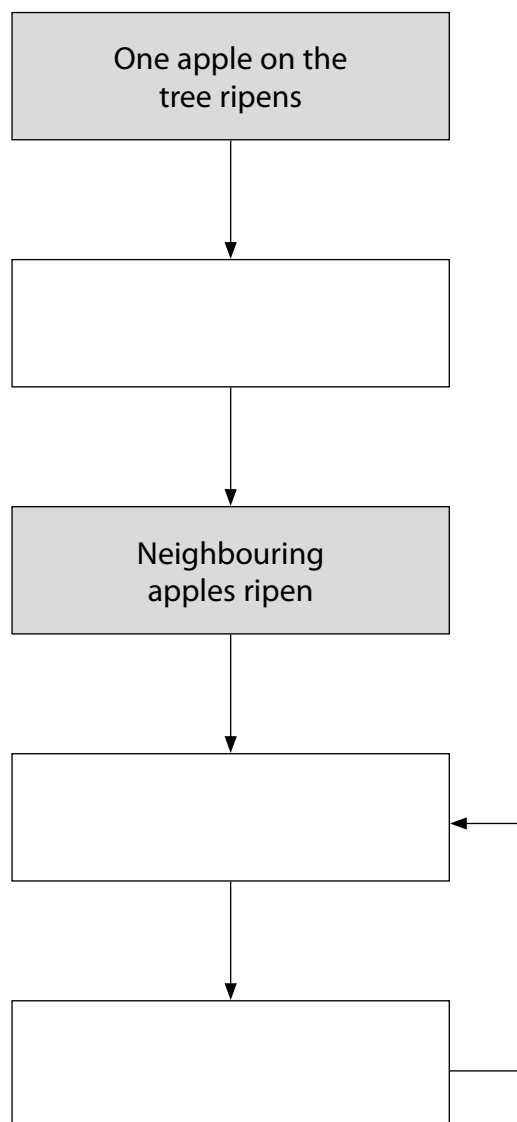
(Total for Question 2 = 8 marks)

3 A number of insects can transmit disease when they bite their hosts.

The photograph shows *Rhodnius prolixus*, a blood-sucking insect that transmits Chagas disease between humans.

This insect feeds on blood by extending its proboscis and pushing it through the skin of a person. It is thought to do this when it detects body warmth.

proboscis
(extended)

© Oxford Scientific/Getty Images

An investigation was carried out to study the effect of a heat stimulus on the proboscis extension response (PER).

Insects were kept in a temperature-controlled container with a heat pad placed in front of them. The heat pad could be touched by the proboscis when fully extended.

The heat pad was initially set at 25 °C. It was then heated up to 35 °C and the number of insects with a fully-extended proboscis were counted. It was then returned to a temperature of 25 °C.

This procedure was repeated a number of times.

The graph shows the results of this investigation.
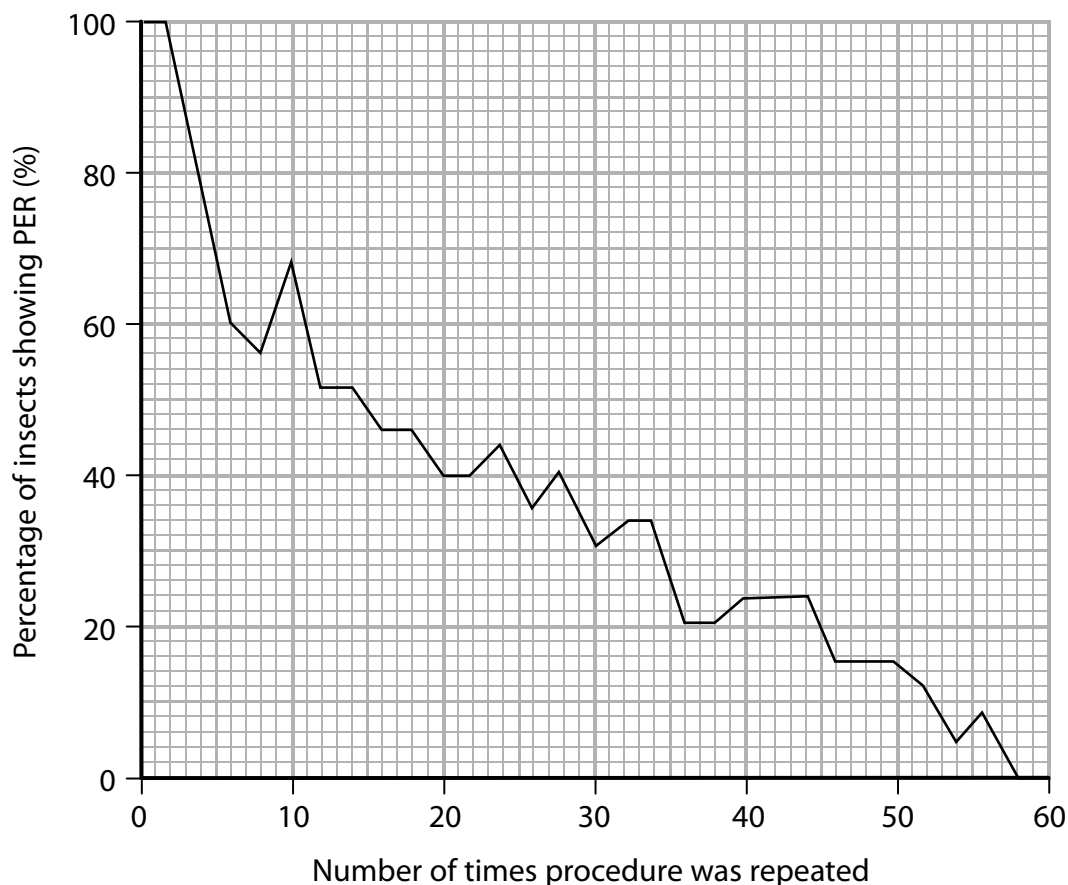
(a) In this investigation, 350 insects were used.

Calculate the mean decrease in the number of insects showing PER each time the procedure was repeated.

(3)

Answer ....

(b) Explain the results of this investigation.

(3)

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(c) Suggest why a drop in PER to a heat stimulus could be an advantage to these insects.

(2)

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(Total for Question 3 = 8 marks)

4 Movement in mammals results from the interaction between muscles, tendons, ligaments and the skeleton.

(a) Which row of the table describes tendons and ligaments?

(1)

	Tendons	Ligaments
☒ **A**	flexible, non-elastic tissue connecting bone to bone	flexible tissue connecting muscle to bone
☒ **B**	flexible, non-elastic tissue connecting muscle to bone	flexible tissue connecting bone to bone
☒ **C**	flexible tissue connecting bone to bone	flexible, non-elastic tissue connecting muscle to bone
☒ **D**	flexible tissue connecting muscle to bone	flexible, non-elastic tissue connecting bone to bone

(b) (i) The diagram shows part of a skeletal muscle fibre.
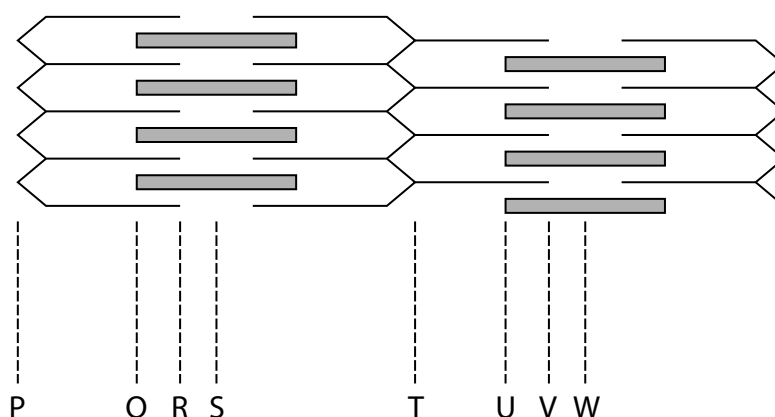
Which pair of letters represents one sarcomere?

(1)

☒ **A** P to T

☒ **B** Q to U

☒ **C** R to V

☒ **D** S to W

(ii) Compare and contrast the structure of fast-twitch and slow-twitch muscle fibres.

(4)

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*(c) The power output of a muscle depends on the speed of contraction and the proportion of fast-twitch and slow-twitch fibres in the muscle.

The graph shows the relationship between the power output and the speed of contraction of two different types of muscle.
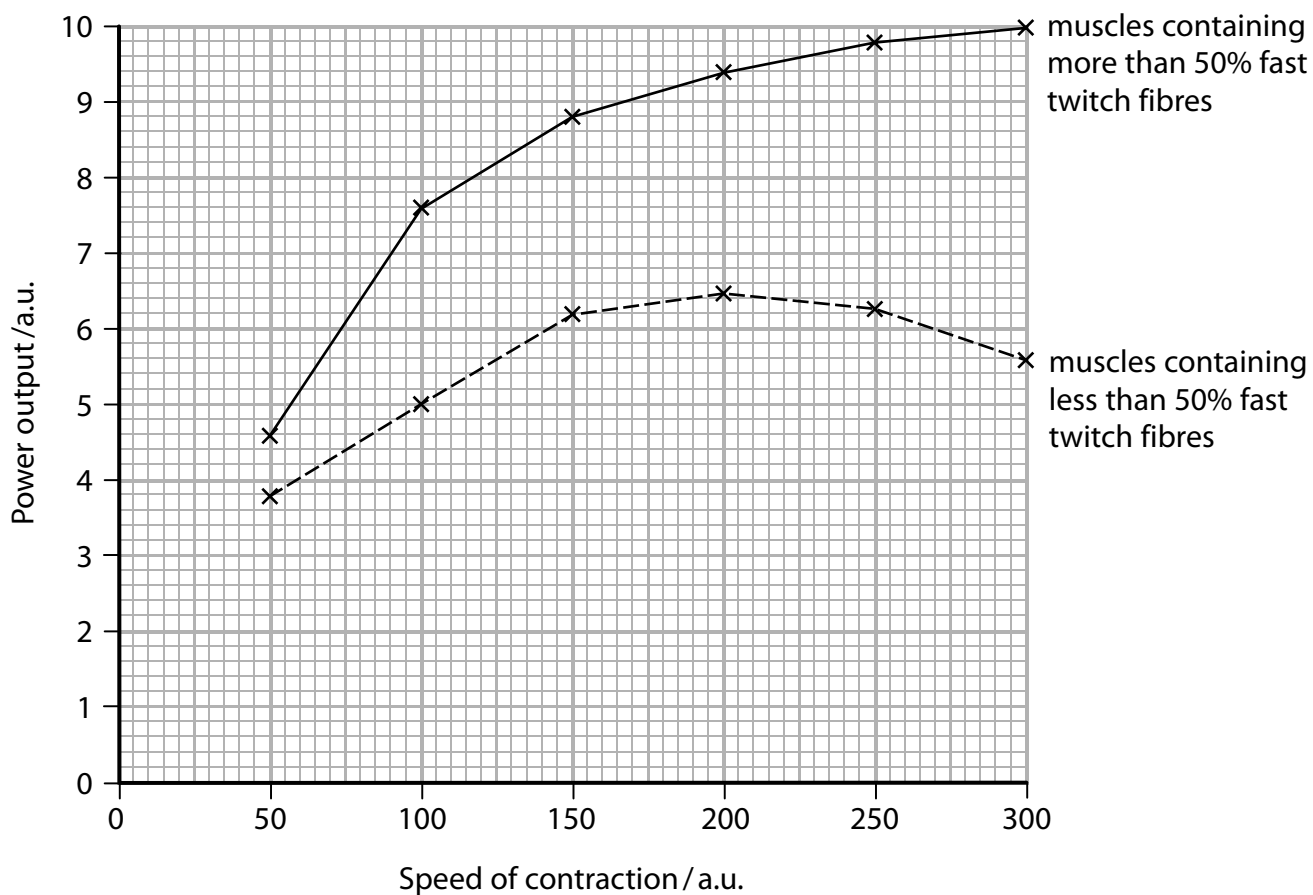
Explain the relationship between power output and the speed of contraction of these two types of muscle. Use the information in the graph and your own knowledge to support your answer.

(6)

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(Total for Question 4 = 12 marks)

5 Multiple sclerosis (MS) is a disease that causes the destruction of the myelin sheaths around neurones.

This destruction is caused by the person's own immune system.

Lesions form in the brain where myelin is destroyed.

(a) The photograph shows lesions in the brain of a person with MS, as seen using magnetic resonance imaging (MRI).

lesion

X

Y
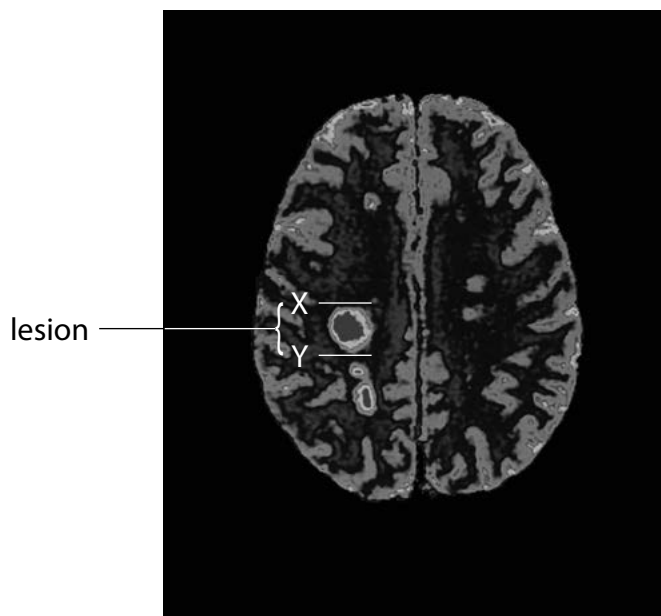
© M210/0087 SGI/Science Photo Library

The actual length of this brain is 15 cm.

Calculate the actual diameter, in mm, of the lesion between X and Y.

(2)

Answer .... mm

(b) The table shows the speed of conduction of an impulse along non-myelinated and myelinated neurones with axons of different diameters.

Type of neurone	Diameter of axon / μm	Speed of conduction of impulse / m s⁻¹
non-myelinated	1	2.3
non-myelinated	2	3.1
non-myelinated	4	4.2
myelinated	1	2.6
myelinated	2	8.5

(i) Show that the effect of diameter on the speed of conduction of an impulse is six times greater in a myelinated neurone than in a non-myelinated neurone.

(2)

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(ii) Explain the effect of the myelin sheath and the diameter of the axon on the speed of conduction of an impulse.

(4)

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(iii) Symptoms of MS can include blindness in one eye and lack of coordination.

Suggest why a person with MS could have these symptoms.

(3)

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(Total for Question 5 = 11 marks)

6 The kidney is involved in osmoregulation and the production of urine.

(a) (i) Which substances are filtered from the blood in the renal capsule?

(1)

☒ **A** glucose and fibrinogen

☒ **B** glucose, fibrinogen and urea

☒ **C** glucose and urea

☒ **D** urea and prothrombin

(ii) Which structure is acting as the filter in the renal capsule?

(1)

☒ **A** basement membrane

☒ **B** cells lining the renal capsule

☒ **C** endothelial cells in the walls of the capillaries

☒ **D** podocytes

(iii) Which transport mechanism is responsible for the uptake of glucose into the cells of the wall of the proximal tubule?

(1)

☒ **A** diffusion

☒ **B** endocytosis

☒ **C** sodium co-transport

☒ **D** osmosis

(iv) Explain why some urea is reabsorbed in the proximal tubule.

(2)

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(b) In an investigation, salt solution was injected into the carotid artery of a mammal. The carotid artery carries blood to the head.

The rate of urine production was measured after the injection.

The table shows the results.

Time after injection of salt solution / min	Rate of urine production / cm³ min⁻¹
0	7.0
5	1.1
10	0.6
15	1.0
20	1.5
25	2.2
30	2.4

(i) Calculate the percentage decrease in the rate of urine production 10 minutes after the injection.

Give your answer to 2 decimal places.

(2)

Answer ....%

(ii) At what times should more measurements be taken to find the lowest rate of urine production?

(1)

☒ **A** at 1-minute intervals between 5 minutes and 10 minutes

☒ **B** at 1-minute intervals between 5 minutes and 15 minutes

☒ **C** at 1-minute intervals between 10 minutes and 15 minutes

☒ **D** at 5 minutes, 10 minutes and 15 minutes, two more times

(iii) Explain the results of this investigation. Use the information in the table to support your answer.

(4)

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(Total for Question 6 = 12 marks)

7 Some groups of living organisms produce neurotoxins.

Neurotoxins act at synapses, preventing the generation of nerve impulses.

Some scientists have been studying neurotoxins using a combination of computer science, statistics and mathematics.

(a) What is the name of a study that combines computer science, statistics and mathematics?

(1)

☒ **A** bioinformatics

☒ **B** computed tomography

☒ **C** epigenetics

☒ **D** forensic entomology

(b) Some neurotoxins act in these ways:
- inhibiting the release of acetylcholine
- blocking of ion channels
- blocking of acetylcholine receptors.

Explain how these neurotoxins prevent the generation of nerve impulses.

(3)

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(c) The table shows the mean composition of three amino acids, in neurotoxins and non-toxins.

Type of amino acid	Mean composition of amino acid in neurotoxins	Mean composition of amino acid in non-toxins
Cysteine	13.69	1.95
Glutamine	2.35	4.16
Leucine	5.53	10.17

The graphs show the mean composition of these amino acids in neurotoxins produced by three groups of organisms: bacteria, cnidarians and molluscs.

cysteine

glutamine

leucine
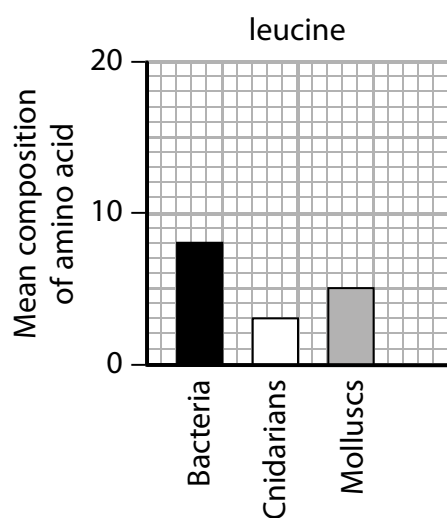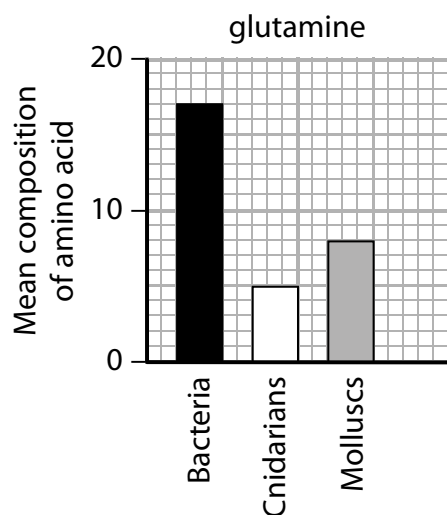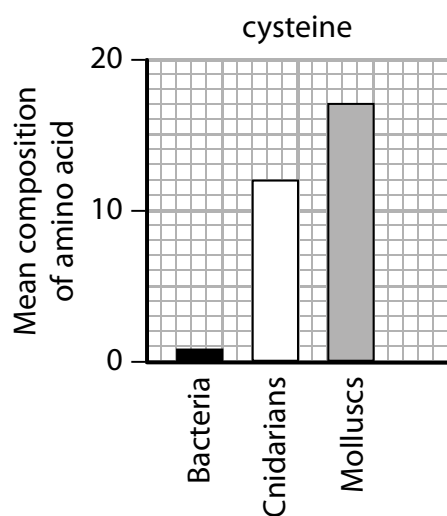
*(i) Comment on the amino acid composition of these neurotoxins. Use the information in the table and in the graphs to support your answer.

(6)

(ii) Explain why the replacement of one amino acid in a neurotoxin could decrease its toxicity.

(2)

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(Total for Question 7 = 12 marks)

8 The scientific document you have studied is adapted from an article in nature.com: *Microgravity elicits reproducible alterations in cytoskeletal and metabolic gene and protein expression in space-flown Caenorhabditis elegans*.

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

(a) Suggest why the authors of this article have named the species of nematode used in this study (paragraph 2).

(1)

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(b) State **one** ethical issue of using nematodes in this study.

(1)

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(c) Describe how microgravity can cause changes in gene expression in these nematodes (paragraph 4).

(3)

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(d) Suggest why there was a lower fat accumulation and shorter body length in nematodes grown in microgravity (paragraph 4).

(3)

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(e) Explain why there were reduced levels of a number of metabolic proteins in nematodes grown in microgravity (paragraph 6).

(4)

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(f) Explain why microarrays could be used to show that mitochondrial electron transport genes are downregulated, whereas the sirtuin gene was upregulated (paragraph 7).

(3)

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(g) Explain why Sudan Black was used in this study (paragraph 8).

(2)

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(h) Comment on the reliability of the data presented in Table 1 (paragraph 9).

(3)

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(Total for Question 8 = 20 marks)

TOTAL FOR PAPER = 90 MARKS

Pearson Edexcel International Advanced Level

Biology

Unit 5: Respiration, Internal Environment, Coordination and Gene Technology

Do not return the Insert with the question paper.

Turn over ▶

S 5 8 6 9 1 A

Microgravity elicits reproducible alterations in cytoskeletal and metabolic gene and protein expression in space-flown *Caenorhabditis elegans*

Introduction

1. Spaceflight-induced muscle atrophy poses a significant risk for astronaut health and mission performance. Accordingly, it is a major obstacle for manned deep-space exploration. In contrast to observations on the Earth, exercise countermeasures employed during spaceflight have proven ineffective for maintaining skeletal muscle mass. Although the optimal exercise and nutritional strategies might simply have not yet been developed, there is growing evidence that muscle may be intrinsically sensitive to the effects of spaceflight *per se*. For example, vascular and cardiac muscles undergo atrophy, without reported muscle unloading, and cultured embryonic muscle synthesizes less protein as a direct consequence of spaceflight. However, the molecular events regulating these changes remain unclear.

2. Here we aimed to identify the mechanisms that are triggered in response to microgravity using the nematode *Caenorhabditis elegans*. In this space experiment (CERISE; *C. elegans* RNA Interference in Space Experiment), we synchronously cultured L1 larvae-stage animals to adulthood in liquid media for 4 days either in microgravity or 1-G (gravitational acceleration unit) centrifuge conditions onboard the Japanese Experiment Module of the International Space Station (ISS). The nematode larvae were launched to the ISS onboard the Space Shuttle Atlantis STS-129 on 16 November 2009, cultures were initiated on 20 November 2009, and the post-cultivation frozen samples were returned by the Space Shuttle Endeavour STS-130 on 21 February 2010.

3. *C. elegans* is an ideal model organism for studies of the physiological effects of space environments because of its small size, short life cycle, and because of its common use on Earth as a model organism for human medical pathologies. The first examinations of the effects of the space environment, including cosmic radiation, on *C. elegans* were performed using essentially standard laboratory culturing techniques with agar plates. *C. elegans* can mate, reproduce, and undergo embryonic development during spaceflight, and radiation-induced mutations can be monitored during spaceflight experiments. During the Dutch Soyuz mission DELTA to the ISS in April 2004, an international collaboration of laboratories carried out the "the first International *C. elegans* Experiment in Space" (ICE-First). In the ICE-First experiment, we found that muscle-, metabolic-, and aging-related genes showed 10–20% lower expression levels in response to spaceflight. These studies were carried out in a chemically defined medium, which allowed study of the effects of surface tension in flight but which significantly alters *C. elegans* life history in a manor akin to dietary restriction.

4. In this study, we wished to confirm that gene and protein expression changes observed in ICE-FIRST were not unique to the operational issues associated with that spaceflight, were not owing to the use of a non-standard laboratory diet, and were owing to exposure to microgravity. To achieve these goals we flew worms on a different launch system, cultured them in a different segment of the ISS, froze them on orbit, used the standard nutritionally rich bacterial diet, and cultured them both in microgravity and on a 1-G centrifuge onboard the ISS. In our previous study ICE-First, worms exposed to microgravity showed ~20% lower expression of thick filament components such as myosin heavy chain and paramyosin upon return to Earth. In the current study CERISE, changes in the expression of these same genes were found in the worms grown in microgravity versus in those grown at 1 G (changes were 53–71%). These results confirm that the past reported gene and protein expression changes for *C. elegans* during spaceflight are not unique to specific operational constrains or diet, and are owing to microgravity. In addition to alterations in cytoskeletal genes we have observed reproducible changes in metabolic genes including sirtuin, which is also known to influence ageing. Consistent with the gene and protein expression changes we also found lower fat accumulation and shorter body length in the microgravity-exposed worms. Last, alterations in the movement of the microgravity worms were observed. These results demonstrate a reproducible set of *C. elegans* gene and protein expression changes in response to microgravity and provide the basis for future mechanistic studies of how microgravity impacts muscle alteration and metabolism in *C. elegans* and possibly astronauts.

Results

Proteomic and transcriptomic analysis of space-flown *C. elegans*

5. To identify proteins that were differentially expressed in the nematodes during spaceflight, we quantitatively analyzed the expression levels of 475 proteins by matrix-assisted laser desorption/ ionization time-of-flight tandem mass spectrometry. This analysis revealed significantly increased expression of 16 proteins and significantly decreased expression of 43 proteins in microgravity ($P \leqslant 0.05$). Of the 16 proteins with increased expression, the expression of ASP-1 (aspartic protease) was increased 1.89-fold ($\log_2[\mu G/1\ G] = 0.92$) with the remaining proteins only slightly increased; these include proteins involved in protein synthesis such as ribosomal proteins and translation elongation factors (Figure 1). Gene expression analysis confirmed the downregulation of muscle-related proteins such as the myosin heavy chains, troponins, and intermediate filaments in the microgravity-cultured worms (Figure 1). Importantly, the pattern of downregulation of expression of muscle genes such as myosin heavy-chain genes *myo-3* ($\log_2[\mu G/1\ G] = -0.89$) and *unc-54* ($\log_2[\mu G/1\ G] = -0.49$) as well as the paramyosin gene *unc-15* ($\log_2[\mu G/1\ G] = -0.62$) were reproducibly observed in both the current experiment and the previous flight experiment.

Figure 1
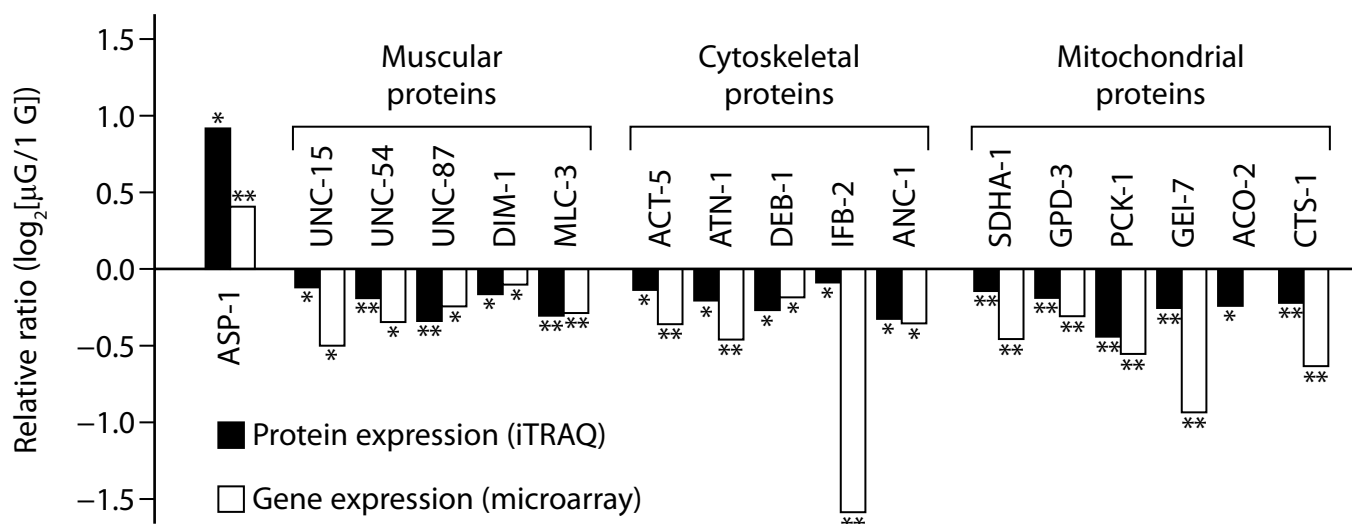
Quantitative analysis of protein (iTRAQ) and gene expression (microarray) levels in space-flown worms. The levels of certain muscular, cytoskeletal, and mitochondrial proteins and an aspartic protease (ASP-1) were significantly altered in worms cultured under microgravity conditions. *$P \leqslant 0.05$, **$P \leqslant 0.01$, Student's t-test for analyses.

6. Other cytoskeletal components also displayed decreased expression during culture in microgravity, for example ACT-5 (actin), ATN-1 (α-actinin), DEB-1 (vinculin), IFB-2 (intermediate filament), and ANC-1 (nuclear and mitochondrial anchorage protein. In addition, significantly reduced levels of metabolic proteins were observed during culture in microgravity, for example, components involved in glycolysis (GPD-3), gluconeogenesis (PCK-1: phosphoenolpyruvate carboxykinase), and the glyoxylate cycle, a variation of the tricarboxylic acid (TCA) cycle (GEI-7). Moreover, the levels of components of the electron transport chain (SDHA-1) and the TCA cycle (ACO-2 and CTS-1) also significantly decreased during spaceflight. DNA microarray analysis confirmed these decreased protein expression levels in response to microgravity and suggested other energy metabolism gene expression level changes in microgravity. For example, genes encoding NADH dehydrogenase (complex I) and succinate dehydrogenase (complex II) displayed lower gene expression levels in the worms cultured in microgravity versus those cultured on the 1-G centrifuge (complex I: $\log_2[\mu G/1\ G] = -0.18$ to -1.03, complex II: $\log_2[\mu G/1\ G] = -0.56$ to -0.76). Similarly, ATP synthase expression was down ($\log_2[\mu G/1\ G] = -0.38$ to -0.76).

7. Whereas DNA microarray analysis suggests that major muscle components, cytoskeletal elements, metabolic genes, and mitochondrial electron transport genes largely are downregulated in microgravity, some genes in these broad classes appear to be upregulated. Notably, a sirtuin gene, *sir-2.1* encoding SIRT-1 protein, was upregulated. Sirtuin proteins deacetylate histones and several transcriptional factors, resulting in the activation or repression of target genes, and the sirtuin family may act as a global regulator of tissue health in response to diet and other stimuli. It was reported that *sir-2.1* is involved in longevity and anti-aging of *C. elegans*, and that *abu-6*, *abu-7*, and *pqn-5* are downstream targets that are negatively regulated by *sir-2.1*. Our microarray data indicate not only that the expression level of *sir-2.1* significantly increases in microgravity but also that the downstream target gene expression levels significantly decrease under microgravity condition; notably, significant changes in the same directions of expression alteration were also noted on our previous flight. Real-time quantitative PCR (qPCR) analysis confirmed the increased expression of *sir-2.1* and the decreased expression of downstream genes, which are negatively regulated by *sir-2.1*, including *abu-6*, *abu-7*, and *pqn-5*.

Body length and fat accumulation of nematodes cultured in microgravity

8. As proteomic and microarray analyses demonstrated decreased muscle and metabolic gene expression in microgravity, body lengths of a small subset of worms not used for omic analyses were microscopically measured. The body length of worms cultured in microgravity were slightly but significantly decreased by ~5.5% versus worms cultured on the centrifuge (μG: 1.37 ± 0.053 mm, 1 G: 1.45 ± 0.094 mm, n = 15 worms per group, $P \leqslant 0.05$; Figure 2). The data from the omics analyses suggest that the space-flown worms had lower energy metabolism capacity. Several molecules involved in fat metabolism are downstream targets of sirtuin signaling. Our DNA microarray analyses indicated that microgravity induced the decreased expression of *fat* genes encoding fatty acid desaturases and *lbp* genes that are involved in lipid binding activity (Figure 3c). The *sir-2.1* downstream target genes *fat-7* and *lbp-6* were among the downregulated transcripts ($\log_2[\mu G / 1\, G]$ = –0.38 (P = 0.01) and –0.47 (P = 0.00), respectively). Therefore, we assessed lipid stores in a small subset of worms not used for omic analysis. Sudan Black staining indicated that the accumulation of fat in microgravity-cultured nematodes was significantly reduced compared with 1-G cultured worms (Figure 3a,b).

Figure 2
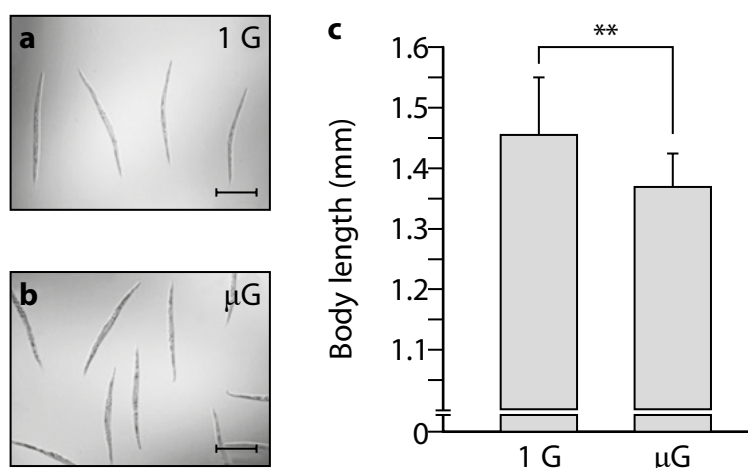
Alteration of body length of space-flown *C. elegans*. (a) Microscopic image of worms grown on the 1 G centrifuge for 4 days. (b) Microscopic image of worms grown in microgravity for 4 days. The worms in both conditions had normal levels of eggs in their bodies. (c) The mean of body length of the worms grown at 1 G was 1.45 ± 0.09 mm, and for microgravity was 1.37 ± 0.05 mm, respectively (n = 15, means ± s.d.). **$P \leqslant 0.01$, Welch's *t*-test. Scale bars indicate 0.5 mm.

Figure 3

a

1 G

μG

Scale bars indicate 100 μm.

b

c

gene name	log$_2$[μG/1 G]	*p*-value
fat-1	−0.82	0.00
fat-3	−0.72	0.00
fat-4	−0.12	0.02
fat-5	0.57	0.00
fat-6	0.19	0.01
fat-7	−0.38	0.01
lbp-1	0.49	0.01
lbp-2	0.39	0.01
lbp-3	−0.49	0.01
lbp-5	−1.23	0.00
lbp-6	−0.47	0.00
lbp-7	−1.47	0.00
lbp-8	0.75	0.01
lbp-5	0.21	0.01
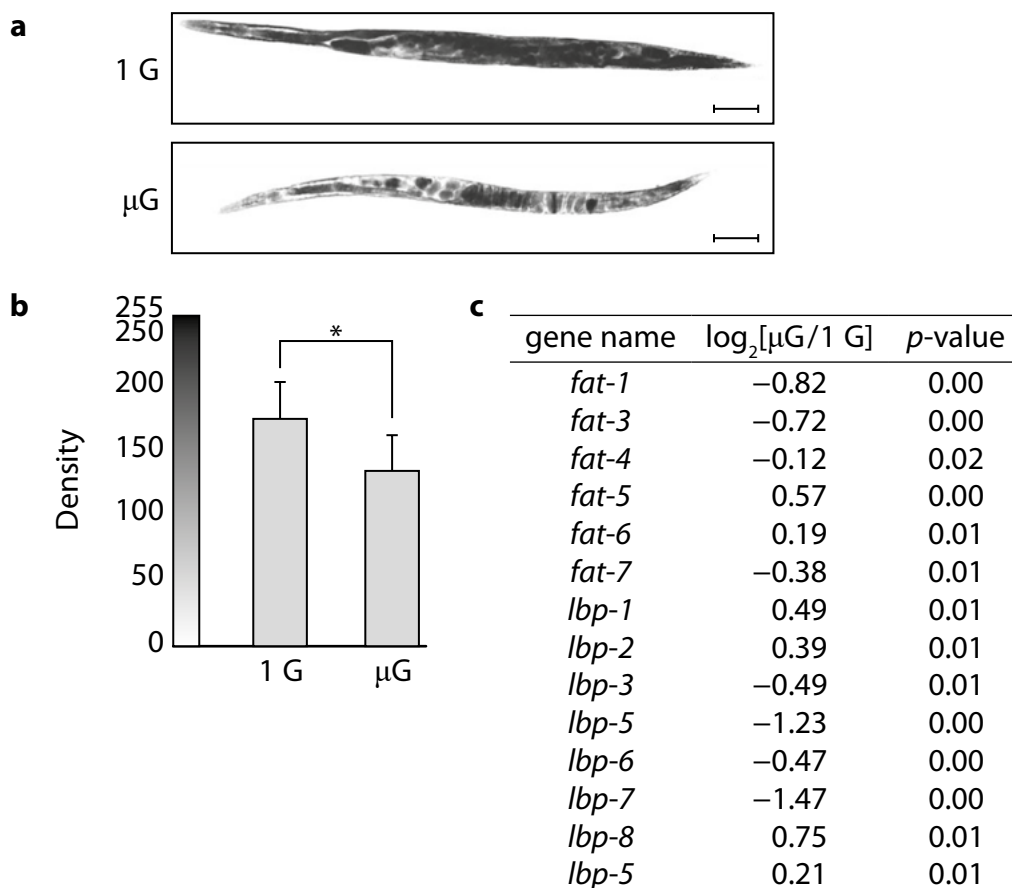
Altered fat storage in microgravity-cultured *C. elegans*. (a) Images of Sudan Black staining of accumulated fat in *C. elegans*. Worms grown onboard the 1 G centrifuge (upper image) and in microgravity (lower image) are displayed. Scale bars indicate 100 μm. There was less fat accumulation in microgravity-cultured worms compared with 1 G controls. (b) Density measurements of Sudan Black stained worms (as described in Methods). The mean densities were 135.36 ± 28.12 in microgravity-cultured worms and 176.55 ± 27.61 in 1-G cultured worms (means ± s.d.). *$P \leqslant 0.05$, Student's *t*-test. (c) Alteration of fat-related gene expression determined by microarray analysis. *P*-values as indicated in the panel, Student's *t*-test.

Effect of microgravity on swimming behavior of *C. elegans*

9. To examine the swimming behavior changes of *C. elegans* during spaceflight, we analyzed the swimming motion of worms grown under microgravity or 1 G on the ISS for 4 days. As shown in Table 1, wavelength showed no difference between microgravity and 1-G cultured worms. However, frequency of swimming was significantly different, and this likely caused a significant difference in wave velocity. Amplitude was measured at the point of 0.1 L, and no significant difference was observed. These results suggest that microgravity induced lower beating frequency and slower wave velocity without changing the shape feature of movement, i.e., the movement of the worm became slower under microgravity.

Table 1: Characteristics of moving behaviors of space-flown nematodes

Culture condition	μG ($n = 6$)	1 G ($n = 3$)	*P*-value
Wavelength (L)	2.29 ± 0.71	2.07 ± 0.30	>0.1
Frequency (Hz)	1.53 ± 0.64	2.61 ± 0.12	<0.01
Wave velocity (L/s)	3.19 ± 0.76	5.39 ± 0.64	<0.01
Amplitude (rad/L)	4.09 ± 0.76	4.75 ± 0.40	>0.1

Discussion

10. It is well known that microgravity exerts considerable effects on physiological processes. Muscle atrophy is one of the main concerns for astronauts during spaceflight. To counter atrophy, astronauts are forced to perform several exercises such as using an ergometer. In 2004, we had the opportunity to conduct an experiment using the nematode *C. elegans* on the ISS. Nematodes flown in microgravity for ten days exhibited reduced gene expression of muscle-related molecules. Both gene and protein expression levels of myosin heavy chain and paramyosin, main components of thick filaments in invertebrates, significantly decreased in space-flown worms. In the present study, we also observed lower expression levels of both the major components for myofilament assembly such as myosin heavy chain and paramyosin. This repeated observation suggests that these changes are caused by spaceflight and not operational, technical, or dietary differences between these two spaceflight experiments.

References and Acknowledgements

http://www.nature.com/articles/npjmgrav201522

Microgravity elicits reproducible alterations in cytoskeletal and metabolic gene and protein expression in space-flown *Caenorhabditis elegans*

Akira Higashibata, Toko Hashizume, Kanako Nemoto, Nahoko Higashitani, Timothy Etheridge, Chihiro Mori, Shunsuke Harada, Tomoko Sugimoto, Nathaniel J Szewczyk, Shoji A Baba, Yoshihiro Mogami, Keiji Fukui & Atsushi Higashitani

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Unit 5 - Mark scheme

Question number	Answer	Mark
1(a)	B inner mitochondrial membrane	(1)

Question number	Answer	Mark
1(b)(i)	An explanation that includes any two of the following points: • no ATP will be produced by the electron transport chain (1) • because electrons will not be passed onto the oxygen (1) • therefore {reduced NAD will not be reoxidised / the electron transport chain will stop} (1)	(2)

Question number	Answer	Mark
1(b)(ii)	An explanation that includes the following points: • there will be no ATP production from reduced NAD (1) • there will be some ATP produced from reduced FAD because electrons from reduced FAD enter the electron transport chain after the site of inhibition of rotenone (1)	(2)

Question number	Answer	Mark
1(b)(iii)	An explanation that includes the following points: • because the inhibitors affect the ETC, which is not used in anaerobic respiration (1) • therefore the same quantity of ATP will be produced from substrate level phosphorylation in glycolysis (1)	(2)

Question number	Answer	Mark
2(a)(i)	D chemoreceptor, medulla oblongata	(1)

Question number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation that includes any four of the following points: • an increase in blood carbon dioxide decreases the pH of the blood (1) • the pH of the blood needs to be kept within narrow limits (1) • therefore the ventilation rate has to increase (1) • nerve impulse sent from {respiratory centre / medulla} to intercostal muscles (1) • when inspiratory centre is stimulated, the expiratory centre is inhibited (1)	Accept cells have to be supplied with sufficient oxygen / carbon dioxide has to be removed Accept converse	**(4)**

Question number	Answer	Mark
2(b)	An answer that includes the following points: 	**(3)**

Question number	Answer	Mark
3(a)	• x values read from the graph and subtracted (1) • mean percentage drop calculated (1) • mean percentage of insects calculated (1) Example of calculation: 58 − 1 = 57 100 ÷ 57 = 1.75 350 × 1.75 ÷ 100 = 6	(3)

Question number	Answer	Mark
3(b)	An explanation that includes the following points: • investigation demonstrates habituation (1) • because the {response / number of insects showing PER} decreased each time the stimulus was repeated (1) • because they learned that the heat pad was not a source of blood (1)	(3)

Question number	Answer	Mark
3(c)	An answer that includes the following points: • energy saved by not extending proboscis (1) • less likely to damage the proboscis (1)	(2)

Question number	Answer	Mark
4(a)	B flexible, non-elastic tissue connecting muscle to bone flexible tissue connecting bone to bone	(1)

Question number	Answer	Mark
4(b)(i)	A P to T	(1)

Question number	Answer	Additional guidance	Mark
4(b)(ii)	An answer that includes three of the following points: similarities: • contain {actin / myosin / tropomyosin / troponin} (1) • consist of {sarcoplasm / sarcolemma / sarcomeres} (1) differences: • slow-twitch muscle fibres have more mitochondria (1) • slow-twitch muscle fibres have more myoglobin (1) • slow-twitch muscle fibres have less glycogen (1) • slow-twitch muscle fibres have less creatine phosphate (1)	To gain maximum marks, at least one similarity must be included in the answer Accept the converse points for fast-twitch fibres	**(4)**

Question number	Answer	Mark
4(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 indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • power output is (always) greater in muscles containing more than 50% fast-twitch muscle fibres • power output in muscles containing more than 50% fast-twitch muscle fibres increases with speed of contraction. • power output in muscles containing less than 50% fast-twitch muscle fibres decreases with higher speeds of contraction. • fast-twitch muscles are designed for rapid short bursts of energy. • therefore power output will increase with speed of contraction. • because they are adapted for anaerobic respiration. • example of adaptation described • muscles with low content of fast-twitch muscles cannot sustain aerobic respiration for long periods of time	(6)

Level	Marks	Descriptor
	0	No awardable content.
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and 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.
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.
3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.

Question number	Answer	Mark
5(a)	• diameter of lesion and length of brain measured (1) • diameter of lesion multiplied by the magnification (1) Example of calculation: 6 mm and 63 mm 6 × (150 ÷ 63) = 14 / 14.3 / 14.29	**(2)**

Question number	Answer	Mark
5(b)(i)	• mean increase in conduction per 1 µm increase in diameter for each type of neurone calculated (1) • value for myelinated neurone divided by value for non-myelinated to give an answer that is at least 1 SF more (1) Example of calculation: myelinated = (8.5 − 2.6) ÷ 2 = 2.95 non-myelinated = (4.2 − 2.3) ÷ 4 = 0.475 2.95 ÷ 0.475 = 6.2 / 6.21	**(2)**

Question number	Answer	Mark
5(b)(ii)	An explanation that includes the following points: • both an increase in diameter and the presence of a myelin sheath increase speed of transmission (1) • myelin insulates the axon because it is hydrophobic (1) • therefore {nerve impulses jump from node to node / action potentials only occur at the nodes of Ranvier / saltatory conduction occurs} (1) • as diameter increases the resistance to flow decreases (1)	**(4)**

Question number	Answer	Additional guidance	Mark
5(b)(iii)	An answer that includes any three of the following points: • demyelination in a person with MS will result in impulses travelling slower (1) • blindness in one eye will result from demyelination of {nerve from eye to brain / one side of the brain} (1) • lack of coordination will result from sensory neurones and motor neurones transmitting nerve impulses at different speeds (1) • {blindness in one eye / lack of coordination} will result if demyelination occurs in the part of the brain associated with {vision / coordination} (1)	Accept occipital lobe	(3)

Question number	Answer	Mark
6(a)(i)	C glucose and urea	(1)

Question number	Answer	Mark
6(a)(ii)	A basement membrane	(1)

Question number	Answer	Mark
6(a)(iii)	C sodium co-transport	(1)

Question number	Answer	Mark
6(a)(iv)	An explanation that includes any two of the following points: • because the concentration of urea is greater in the filtrate than in the blood (1) • so urea will diffuse down its concentration gradient (1) • because the walls of the proximal tubule and capillaries are permeable to urea (1)	(2)

Question number	Answer	Mark
6(b)(i)	• correct figures selected from the table and subtracted (1) • percentage decrease calculated (1) Example of calculation: 7.0 – 0.6 = 6.4 (6.4 ÷ 7) × 100 = 91.43	**(2)**

Question number	Answer	Mark
6(b)(ii)	B at 1-minute intervals between 5 minutes and 15 minutes	**(1)**

Question number	Answer	Mark
6(b)(iii)	An explanation that includes any four of the following points: • because the carotid artery will carry the blood straight up to the hypothalamus (1) • which will detect the lower solute potential of the blood (1) • as a result, the (posterior) pituitary gland will release ADH (1) • ADH will result in more reabsorption of water from the {distal tubules / collecting ducts} so less urine produced (1) • because when solute potential returns to normal, ADH will no longer be released and urine production will increase again (1)	**(4)**

Question number	Answer	Mark
7(a)	A bioinformatics	**(1)**

Question number	Answer	Mark
7(b)	An explanation that includes the following points: • inhibition of the release of acetylcholine will prevent the generation of a nerve impulse because a chemical is needed to transmit the nerve impulse across the {synapse / gap} (1) • blocking the ion channels will prevent the generation of a nerve impulse because calcium ions will not be able to enter the pre-synaptic bulb and trigger the release of {neurotransmitter / acetylcholine} (1) • blocking the acetylcholine receptors will prevent the generation of a nerve impulse because acetylcholine will not be able to bind to its receptors on the post-synaptic neurone, so {depolarisation of the membrane / initiation of an action potential} will not occur (1)	**(3)**

Question number	Answer	Mark
7(c)(i)	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 indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • neurotoxins have a greater composition of cysteine • non-toxins have a greater composition of glutamine and leucine • the different groups of organisms that produce neurotoxins have similar compositions of leucine • the different groups of organisms that produce neurotoxins have variations in the compositions of cysteine and glutamine • mollusc neurotoxin has the greatest composition of cysteine but bacteria neurotoxin has the least • bacteria neurotoxin has the greatest composition of glutamine and cnidarians the least	**(6)**

Level	Marks	Descriptor
	0	No awardable content.
1	1-2	Limited number of the most important or relevant scientific factors from the data/information provided are synthesised.
		No judgement is made.
2	3-4	Some of the most important or relevant scientific factors from the data/information provided are synthesised.
		A straightforward but accurate judgement is made.
3	5-6	Most of the important or relevant scientific factors from the data/information provided are synthesised.
		A detailed and accurate judgement is made.

Question number	Answer	Mark
7(c)(ii)	An explanation that includes the following points: • because a different amino acid will have a different R group so different bonds will be formed (1) • therefore the tertiary structure will be different and the neurotoxin will not be able to bind to receptors on the {pre-synaptic membrane / neurotransmitter / post-synaptic membrane} (1)	(2)

Question number	Answer	Mark
8(a)	• so other scientists could repeat the study / because different species might respond differently to microgravity	(1)

Question number	Answer	Mark
8(b)	• nematodes may be {harmed / killed}	(1)

Question number	Answer	Mark
8(c)	A description that includes the following points: • epigenetic changes to {prevent / allow} gene expression (1) • transcription factors to switch {on / off} genes (1) • post-transcriptional modification to determine which protein is produced from a particular gene (1)	(3)

Question number	Answer	Mark
8(d)	An answer that includes any three of the following points: • (lower fat accumulation because) the diet that the nematodes were fed did not have an energy content greater than that being used (1) • (lower fat accumulation because) nematodes did not need to store energy as they were not very active (1) • (shorter body length because) diet was low in protein (1) • genes controlling {fat accumulation / body length} had been switched off (1) • microgravity resulted in less protein being synthesised (1)	(3)

Question number	Answer	Mark
8(e)	An explanation that includes any four of the following points: • less muscle {protein / named protein} synthesised because of muscle atrophy (1) • because the microgravity decreases the force that needs to be exerted by the muscles (1) • less muscle activity, therefore less ATP required (1) • therefore fewer {enzymes / named enzyme} needed for respiration (1) • fewer proteins involved in gluconeogenesis because less glucose needed for respiration (1)	(4)

Question number	Answer	Mark
8(f)	An explanation that includes the following points: • microarrays analyse the {active DNA / RNA} of a cell (1) • therefore less {active DNA / RNA} for the electron transport genes and increased {active DNA / RNA} for the sirtuin gene (1) • compared to nematodes, they are not exposed to microgravity (1)	(3)

Question number	Answer	Mark
8(g)	An explanation that includes the following points: • because the scientists wanted to assess the lipid stores of the nematodes (1) • Sudan Black binds specifically to fat (1)	(2)

Question number	Answer	Mark
8(h)	An answer that includes three of the following points: • mean values are given throughout (1) • frequency data reliable as the standard deviations do not overlap (1) • frequency and wavelength data reliable as p values are less than {0.01 / 0.05} (1) • they are not very reliable as the sample sizes are very small (1)	(3)

Write your name here

Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

Biology
International Advanced Level
Unit 6: Practical Skills in Biology II

Sample Assessment Materials for first teaching September 2018
Time: 1 hour 20 minutes

Paper Reference
WBI16/01

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need*.
- **Show all your working in calculations and include units where appropriate**.

Information

- The total mark for this paper is 50.
- 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 ▶

S58692A0120

Pearson

Answer ALL questions.

Write your answers in the spaces provided.

1 The photograph shows a germinating pea seed.

© Bblickwinkel / Alamy Stock Photo

Magnification ×2.0

The embryo in a seed will start to grow when temperature and moisture conditions are favourable.

The seed contains a food supply which is broken down by enzymes. This provides substrates for respiration.

(a) Describe an experiment to investigate the effect of temperature on the rate of respiration of germinating pea seeds.

(5)

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(b) State two variables, other than the independent variable, that could affect this experiment.

(2)

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(c) Name one of the variables you have identified in (b).

Variable ....

(i) State how this variable could be controlled.

(1)

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(ii) Suggest what effect not controlling this variable could have on the results.

(1)

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(d) Explain how a lack of oxygen could affect the growth of seedlings after germination.

(3)

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(Total for Question 1 = 12 marks)

2 The photograph shows *Daphnia*, a freshwater animal.

© Bblickwinkel / Alamy Stock Photo

Magnification ×20

Daphnia is transparent and the heart can be seen beating.

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

The student selected five *Daphnia*: A, B, C, D and E. The student measured the heart rate, in beats per minute (bpm), of each *Daphnia* in water.

This was repeated using five different concentrations of caffeine solution: 0.1%, 0.5%, 1.0%, 2.0% and 5.0%.

The table shows the data from this investigation.

Daphnia	Concentration of caffeine (%)					
	0.0	0.1	0.5	1.0	2.0	5.0
A	176	257	259	268	274	282
B	178	256	260	270	282	274
C	184	262	264	270	278	285
D	172	248	251	260	270	278
E	182	264	258	272	272	286
mean heart rate / bpm	178	261	258	267	275	

(a) Calculate the mean heart rate (bpm) for the 5.0% caffeine concentration.

(1)

Answer...bpm

(b) Plot a suitable graph to show the effect of caffeine concentration on the mean heart rate of *Daphnia*.

(3)
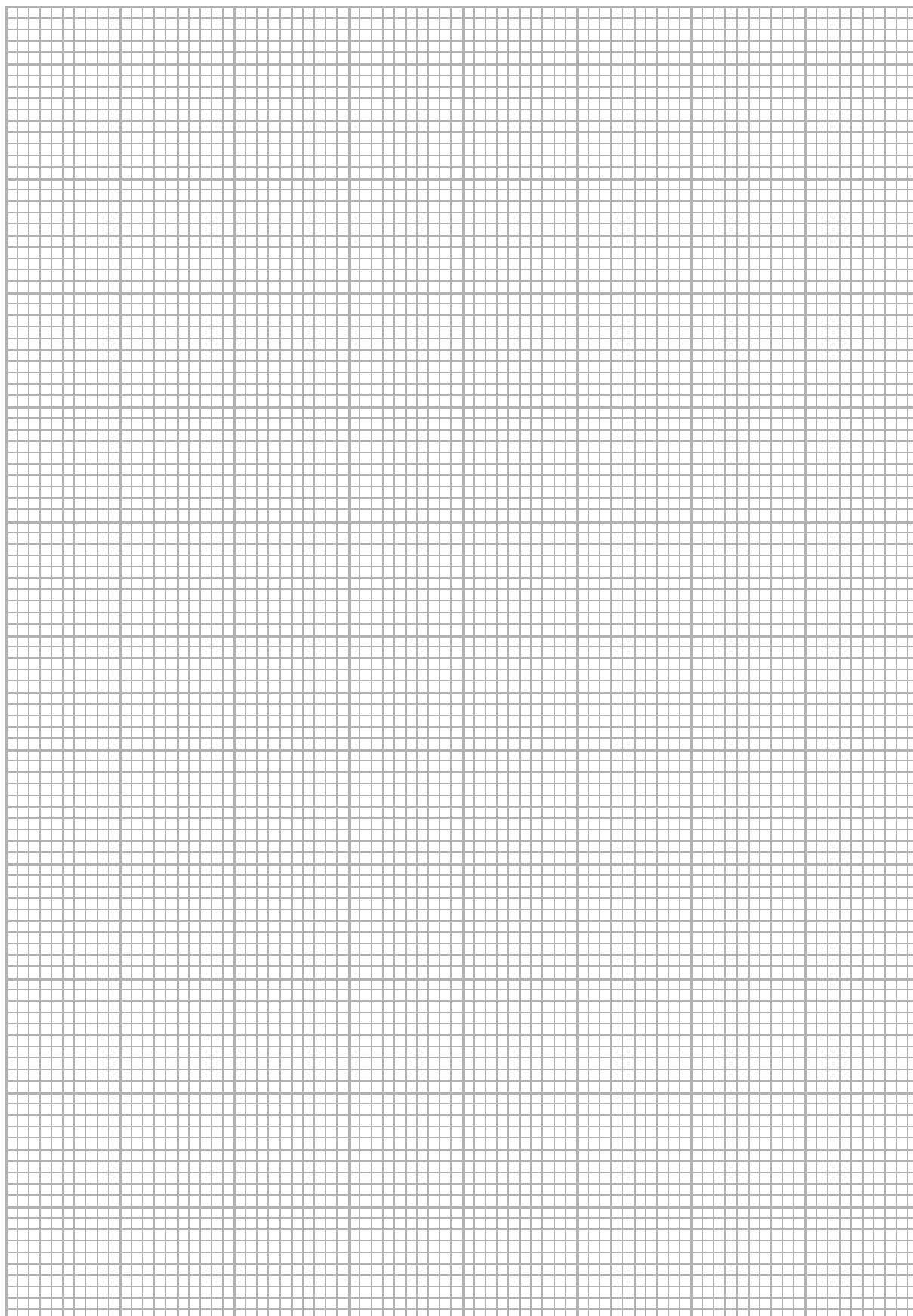
(c) State a suitable null hypothesis for this investigation.

(2)

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(d) Explain one ethical reason why the student chose to use *Daphnia* for this investigation.

(2)

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(e) The student used a statistical test to investigate the significance of the correlation between the mean heart rate and the caffeine concentration.

To calculate the correlation coefficient, the student produced the following table.

Caffeine concentration % (a)	Mean heart rate (b)	Rank a	Rank b	d
0.0	178	1	1	0
0.1	261	2	3	−1
0.5	258	3	2	1
1.0	267	4	4	0
2.0	275	5	5	0
5.0		6	6	0

(i) Calculate the correlation coefficient, r_s, using the formula:

(3)

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

Where:

Σ = the sum of

d = the difference between each pair of ranks

n = the size of the sample (number of pairs of values)

Answer..

(ii) The table shows some critical values for this statistical test.

Number of pairs of values	Level of significance (p)		
	0.10	0.05	0.01
4	1.000	–	–
5	0.900	1.000	–
6	0.829	0.886	1.000
7	0.714	0.786	0.929
8	0.643	0.738	0.881
9	0.600	0.700	0.833
10	0.564	0.648	0.794

Explain how the student could use the graph and the statistical test to draw conclusions from this investigation.

(5)

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(Total for Question 2 = 16 marks)

3 Germinating cereal grains, such as barley, produce the enzyme amylase.

The production of amylase is affected by gibberellin, a plant growth regulator.

A student formed the following hypothesis.

The higher the concentration of gibberellin, the greater the production of amylase by germinating cereal grains.

Plan an investigation to test this hypothesis.

(a) State two safety issues you would need to take into account.

(2)

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(b) Describe preliminary practical work that you might undertake
to ensure your proposed method would provide quantitative results.

(3)

(c) Devise a detailed method, including an explanation of how you would control and monitor important variables.

(10)

(d) Describe how your results should be recorded, presented and analysed in order to draw conclusions from your investigation.

(4)

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(e) Suggest three limitations of your proposed method.

(3)

(Total for Question 3 = 22 marks)

TOTAL FOR PAPER = 50 MARKS

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Unit 6 - Mark scheme

Question number	Answer	Additional guidance	Mark
1(a)	A description that includes five of the following points: • dependent variable identified (1) • range of at least five suitable temperatures (1) • description of how to obtain quantitative results (1) • time measurement to obtain rate (1) • carbon dioxide needs to be absorbed (1) • control of temperature with a thermostatic water bath (1) • {same / stated} time for exposure to each temperature to equilibrate (1) • repeats (at each temperature) and calculate a {mean / standard deviation} (1)	For example, oxygen consumption Accept temperatures within the range of 0 to 40 ºC, e.g. measurement of coloured liquid movement / use of a respirometer / use of hydrogen carbonate indicator Accept reference to use of KOH Accept description of how temperature is controlled, e.g. Bunsen burner and thermometer	(5)
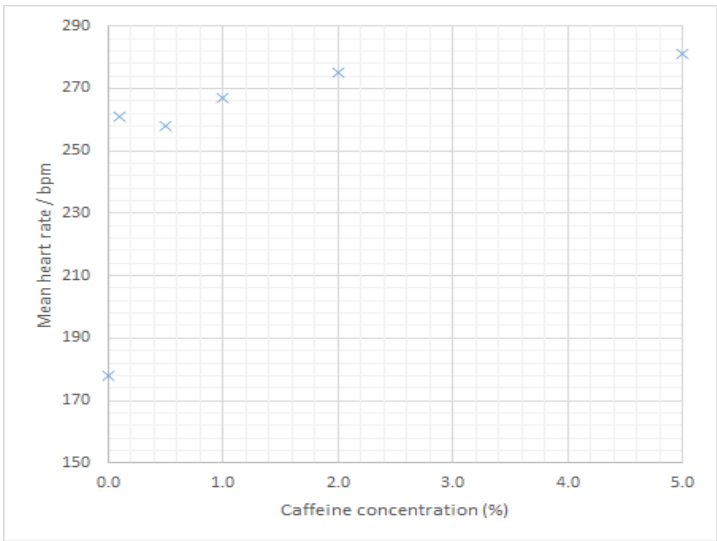
Question number	Answer	Mark
1(b)	An answer that includes any two of the following: • age of seeds (1) • {species / variety} of seeds (1) • {mass / number} of seeds (1) • water available to seeds (1)	(2)

Question number	Answer	Additional guidance	Mark
1(c)(i)	• variable with suitable control method described	For example, (age of seeds) choose seeds from the same plant / pod / packet	(1)

Question number	Answer	Additional guidance	Mark
1(c)(ii)	• results are not valid / description of expected effect on the dependent variable	For example, older seeds may respire more slowly	**(1)**

Question number	Answer	Additional guidance	Mark
1(d)	An explanation that includes the following points: • reduced growth because {increase in anaerobic / decrease in aerobic} respiration (1) • therefore less ATP produced (1) • therefore less energy available for growth (1)	 Accept ethanol produced Accept (ethanol) inhibits growth	**(3)**

Question number	Answer	Mark
2(a)	• total calculated and divided by 5 Example of calculation: 1405 ÷ 5 = 281	**(1)**

Question number	Answer	Mark
2(b)	Graph plotted to show the following: • labelled axes with correct orientation and linear scale (1) • data plotted as {scatter graph / line graph} (1) • all points plotted correctly (1) Allow ecf from 2a Example graph: 	(3)

Question number	Answer	Mark
2(c)	An answer that includes the following points: • there will be no (significant) correlation (1) • between the caffeine concentration and the (*Daphnia*) heart rate (1)	(2)

Question number	Answer	Additional guidance	Mark
2(d)	An explanation that includes the following points: • simple nervous system (1) • so less likely to suffer {pain / stress} (1) or • abundant in nature (1) • so not affecting food chain (1)	Accept invertebrate nervous system	**(2)**

Question number	Answer	Additional guidance	Mark
2(e)(i)	• calculate the value of d^2 (1) • calculate the value of $6\sum d^2$ (1) • calculate the value of r_s (1) Example of calculation: $\sum d^2 = 2$ $6\sum d^2 = 12$ $r_s = 0.943$	Allow ecf from first or second marking point Correct answer with no working shown gains full marks	**(3)**

Question number	Answer	Mark
2(e)(ii)	An explanation that includes any five of the following points: • as caffeine concentration increases, heart rate increases (1) • critical value is 0.886 (1) • calculated value (0.943) is higher than critical value (1) • therefore reject the null hypothesis (1) • there is a significant positive correlation between concentration of caffeine and heart rate (1) • low concentrations have a large effect, higher concentrations give a smaller increase (1)	**(5)**

Question number	Answer	Mark
3(a)	An answer that includes any two of the following points: • risk of growing {bacteria / fungi} (1) • {growth regulators / plant tissue} may cause allergic reaction (1) • sharp instruments / other sensible risk (1)	(2)

Question number	Answer	Mark
3(b)	A description that includes any three of the following points: • find suitable range of concentration of growth regulator (1) • find suitable method for measuring amylase activity (1) • find the time taken for amylase production (1) • identify {other / named} variable that needs to be taken into account (1)	(3)

Question number	Answer	Additional guidance	Mark
3(c)	An answer that includes ten of the following points: • appropriate measurement of dependent variable (1) • measure the dependent variable several times and calculate a mean (1) • at least five concentrations of growth regulator (1) • description of how growth regulator is applied (1) • description of using the endosperm (1) • reference to aseptic conditions (1) • stated time period for incubation (1) • description of using starch as a substrate (1) • description of using iodine solution (1) • repeats at each concentration and mean calculated (1) • control of one variable relating to the cereal grains (1) • control of one other standardised variable (1)	For example, measuring diameter of clear zone Accept description of aseptic methods	(10)

Question number	Answer	Additional guidance	Mark
3(d)	A description that includes the following points: • table with headings (1) • means calculated from repeats (1) • {scatter / line} graph format with labelled axes (1) • use of an appropriate statistical test (1)	For example, (Pearson's) correlation coefficient or Spearman's rank	**(4)**

Question number	Answer	Mark
3(e)	An answer that includes any three of the following points: • difficult to control {all variables / or a named variable} (1) • another factor may be limiting effect of growth regulator (1) • possible contamination with {bacteria / fungi} (1) • more than one growth regulator may be involved (1)	**(3)**

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