edexcel

INTERNATIONAL ADVANCED LEVEL

Biology

SAMPLE ASSESSMENT MATERIALS

Pearson Edexcel International Advanced Subsidiary in Biology (XBI01)

Pearson Edexcel International Advanced Level in Biology (YBI01)

For first teaching in September 2013
First examination January 2014

ALWAYS LEARNING

PEARSON

Contents

Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number	Candidate Number

Biology

Advanced Subsidiary

Unit 1: Lifestyle, Transport, Genes and Health

Sample Assessment Material
Time: 1 hour 30 minutes

Paper Reference
WBI01/01

You do not need any other materials.

Total Marks

Instructions

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

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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

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

Turn over ▶

S45354A

S 4 5 3 5 4 A 0 1 2 4

PEARSON

Answer ALL questions.

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) Read through the following passage on the blood clotting process, then write on the dotted lines the most appropriate word or words to complete the passage.

(5)

The blood clotting process starts when cell fragments called .....

release molecules of ..... . These molecules

are ..... which catalyse the conversion of .....

into ..... , in the presence of calcium ions. As a result, fibrinogen

is converted into fibrin and blood cells are trapped to form the clot.

(b) Fibrinogen and fibrin are both proteins.

A protein consists of a chain of amino acids joined together by bonds.

(i) In the space below, draw a diagram to show the structure of an amino acid.

(3)

(ii) Name the covalent bond that joins the amino acids into a chain.

(1)

.....

(iii) Suggest **two** differences between fibrinogen and fibrin.

(2)

1 .....

.....

.....

2 .....

.....

.....

(Total for Question 1 = 11 marks)

2 DNA is a very important molecule in living organisms as it carries the genetic code. Before a cell divides, the DNA molecule replicates so that each resulting daughter cell is genetically identical to the original parent cell.

(a) Explain the nature of the genetic code.

(2)

*(b) Describe the process of DNA replication.

(5)

(Total for Question 2 = 7 marks)

3 Lipoprotein lipase is a biological catalyst and is involved in the hydrolysis of triglycerides.

(a) For each of the statements below, put a cross ☒ in the box that corresponds to the correct statement.

(i) A catalyst

(1)

☒ **A** decreases the rate of reaction by increasing the activation energy

☒ **B** decreases the rate of reaction by reducing the activation energy

☒ **C** increases the rate of reaction by increasing the activation energy

☒ **D** increases the rate of reaction by reducing the activation energy

(ii) Hydrolysis results in bonds between glycerol and a fatty acid

(1)

☒ **A** being broken and water being formed

☒ **B** being broken and water being used

☒ **C** being formed and water being formed

☒ **D** being formed and water being used

(iii) A triglyceride is made from

(1)

☒ **A** one glycerol and one fatty acid

☒ **B** one glycerol and three fatty acids

☒ **C** three glycerols and one fatty acid

☒ **D** three glycerols and three fatty acids

(iv) A type of bond found in a triglyceride is

(1)

☒ **A** an ester bond

☒ **B** a glycosidic bond

☒ **C** a hydrogen bond

☒ **D** a phosphodiester bond

(b) Some people have a mutation in the gene coding for lipoprotein lipase.

The table below shows the mean concentration of some types of lipid in the blood of people without the mutation and in the blood of people with the mutation.

Type of lipid	Mean concentration of lipid in blood / mg dm^{-3}	
	People without the mutation	People with the mutation
Triglyceride	102	93
LDL cholesterol	121	111
HDL cholesterol	48	49
Total cholesterol	186	179

It has been suggested that people with this mutation may be more at risk of developing cardiovascular disease (CVD).

(i) Give **two** reasons why the information in the table does **not** support this suggestion.

(2)

1 .....

.....

.....

2 .....

.....

.....

(ii) Name the type of drug that could be given to people with this mutation, to reduce the risk of developing CVD.

(1)

.....

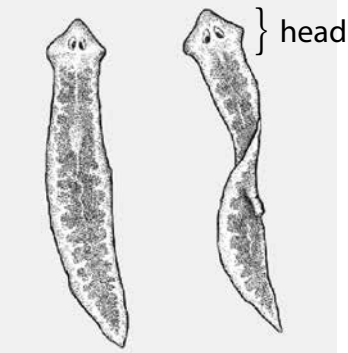
(iii) State **one** health risk associated with using this type of drug.

(1)

.....

(Total for Question 3 = 8 marks)

4 Some species of flatworm are found in freshwater streams.
Flatworms obtain oxygen from the water through the surface of their bodies.
The diagram below shows the structure of flatworms.



Flatworms

Magnification ×10

(a) Using the diagram and your knowledge of gas exchange surfaces, explain how the structure of a flatworm is adapted to obtain oxygen from the water.

(2)

(b) The table below shows the relationship between the temperature of water and the solubility of oxygen in water.

Temperature of water / °C	Solubility of oxygen in water / mg dm^{-3}
0	14.6
5	12.8
10	11.3
15	10.2
20	9.2
25	8.6
30	7.5
35	6.9
40	6.4

(i) Describe the relationship between the temperature of the water and the solubility of oxygen in water.

(2)

(ii) Using the information in the table and your knowledge of gas exchange and enzymes, suggest why flatworms are often found in water at a temperature of about 15 °C .

(3)

(c) Flatworms do not have a heart or a circulatory system.

Explain why many animals need a heart and a circulatory system.

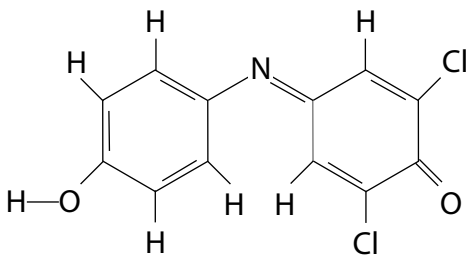
(4)

(Total for Question 4 = 11 marks)

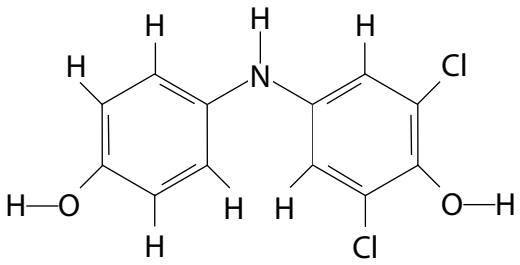
BLANK PAGE

5 The concentration of vitamin C in a solution can be determined using the chemical DCPIP.
DCPIP is blue when it is in its oxidised form and colourless when it is in its reduced form.

(a) The diagrams below show the structure of DCPIP in its oxidised form and in its reduced form.



Oxidised DCPIP



Reduced DCPIP

(i) Using the diagram, describe **two** differences between the structure of oxidised DCPIP and reduced DCPIP.

(2)

1 .....

.....

.....

.....

2 .....

.....

.....

.....

(ii) Suggest why these differences occur when DCPIP is used to determine the concentration of vitamin C.

(1)

.....

.....

.....

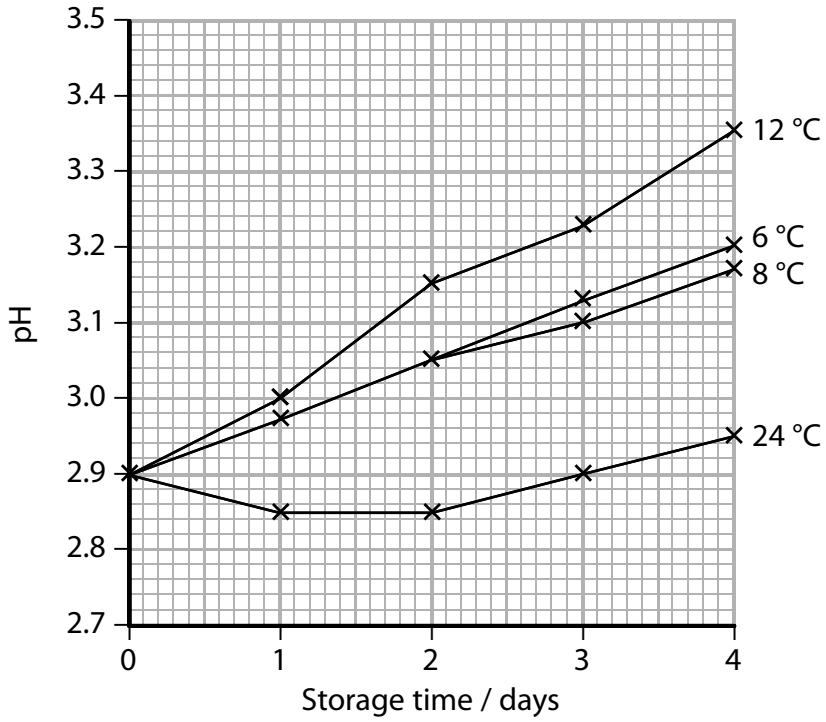
(b) Mangaba fruit is produced by a tropical plant native to Brazil.
As this fruit is a good source of protein and vitamins, it is important to study changes that take place in the fruit after picking.

The photograph below shows mangaba fruit.

Magnification × 0.2

A study was carried out to measure the changes in pH of mangaba fruit at different storage temperatures. Mangaba fruits were picked and stored at four different temperatures for four days. Each day the pH of the fruits was measured.

The graph below shows the results of this study.



(i) Using the information in the graph, describe the effects of storage temperature on the pH of mangaba fruits during this four-day storage period.

(3)

*(ii) Describe an experiment that could be carried out to compare the changes in the vitamin C content of the mangaba fruit stored at 6 °C and 8 °C.

(5)

(Total for Question 5 = 11 marks)

6 The structure and properties of the cell membrane control which molecules can move into or out of the cell.

(a) The phospholipid bilayer plays an important role in this control of movement of molecules.

Explain why the phospholipid molecules form a bilayer.

(3)

(b) The table below describes four methods by which molecules or ions can move through the cell membrane.

Description of method	Method by which molecules or ions can move through the cell membrane			
	A	**B**	**C**	**D**
The direction of movement is from a higher concentration to a lower concentration of the molecule	✓	✗	✓	✓
ATP required	✗	✓	✗	✗
Membrane proteins involved	✓ or ✗	✓	✓	✗
A molecule or ion transported by this method	water	sodium ions	glucose	oxygen

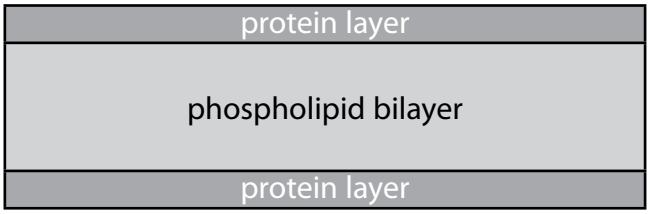
Identify the method of movement by placing a cross ☒ in the correct box in the table below.

(3)

Method of movement	A	B	C	D
Active transport	☒	☒	☒	☒
Facilitated diffusion	☒	☒	☒	☒
Osmosis	☒	☒	☒	☒

(c) The fluid mosaic model explains our current knowledge of the structure and properties of cell membranes. This model was developed from the Davson-Danielli model.

The diagram below shows the Davson-Danielli model of membrane structure.



(i) Use the information in the diagram to compare the Davson-Danielli model with the fluid mosaic model.

(2)

(ii) Explain why the Davson-Danielli model does not support our current knowledge of how molecules can move through the cell membrane.

(2)

(Total for Question 6 = 10 marks)

7 Cystic fibrosis is a genetic disease caused by mutations in the CFTR gene. This disease can be classified according to the effect of the different gene mutations on the CFTR protein.

The table below shows the classification of cystic fibrosis.

Class	Effect on the CFTR protein
I	CFTR protein is not synthesised.
II	CFTR protein is mis-folded and is not found in the correct location.
III	CFTR protein is mis-folded and is found in the correct location, but does not function properly.
IV	CFTR protein has a faulty opening.
V	CFTR protein is synthesised in smaller quantities than normal.
VI	CFTR protein breaks down quickly after it is synthesised.

(a) For class I cystic fibrosis, suggest how a mutation in the CFTR gene could result in no CFTR protein being synthesised.

(2)

(b) Class II cystic fibrosis results from the CFTR protein being located in the wrong place.

Describe the correct location for the CFTR protein.

(2)

(c) The mutation causing class III cystic fibrosis results in a change in the primary structure of the CFTR protein.

Explain why this would result in the CFTR protein being mis-folded.

(2)

(d) For class IV cystic fibrosis, explain why a faulty opening of the CFTR protein would affect the functioning of this protein.

(2)

(e) For a person with class V cystic fibrosis, describe the effect of having smaller quantities of CFTR protein.

(2)

(f) For class VI cystic fibrosis, suggest how the CFTR protein is broken down.

(2)

(Total for Question 7 = 12 marks)

8 Cirrhosis is a disease of the liver that is associated with alcohol abuse.

Two studies, study A and study B, were carried out to determine the relative risk of developing cirrhosis in relation to the mass of alcohol consumed each day by men and women.

The graph below shows the results of these two studies.

(a) The results of these studies indicate that there is a correlation between alcohol consumption and cirrhosis.

Explain how these results indicate that there is a **correlation** between alcohol consumption and cirrhosis.

(1)

(b) (i) Using the information in the graph, compare the results for women in studies A and B.

(2)

(ii) Suggest **two** reasons for the differences between the results for women in these two studies.

(2)

1 .....

2 .....

(c) Describe the evidence shown in the graph that suggests that the risk of developing cirrhosis depends on gender.

(2)

(d) Comment on the reliability of these results.

(2)

(e) It is possible that the men and women in these studies underestimated their alcohol consumption.

Suggest **one** reason for this.

(1)

(Total for Question 8 = 10 marks)

TOTAL FOR PAPER = 80 MARKS

Mark Scheme (SAM)

Pearson Edexcel International Advanced Subsidiary in Biology

Unit 1: Lifestyle, Transport, Genes and Health

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- 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 may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed-out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of Quality of Written Communication, are being assessed. The strands are as follows:
    i. ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
    ii. select and use a form and style of writing appropriate to purpose and to complex subject matter
    iii. organise information clearly and coherently, using specialist vocabulary when appropriate.

Using the Mark Scheme

Examiners should NOT give credit for incorrect or inadequate answers, but allow 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 still be creditworthy.

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.
Bold	Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq	(error carried forward)(transfer error)(consequential) 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. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions that involve the writing of continuous prose require candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where Quality of Written Communication is likely to be particularly important are indicated (Quality of Written Communication) in the mark scheme, but this does not preclude others.

Question Number	Answer	Additional Guidance	Mark
1(a)	1. Platelets 2. Thromboplastin 3. Enzymes 4. Prothrombin 5. Thrombin	1. ACCEPT thrombocytes 2. ACCEPT enzyme if not given in Mp3 3. ACCEPT thromboplastin if not given in Mp2 N.B. allow phonetic spelling.	**(5)**

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	1. Central carbon with {R/H/eq} and H attached by single bonds 2. {NH_2/NH_3^+} attached to a carbon by single bond 3. {COOH/COO^-} attached to a carbon by single bond	Mp1 Must show C, H and R or a plausible R-group. Mp2 and 3 ACCEPT groups attached to a central C that is not shown (chemical notation). ACCEPT groups written wrong way round, e.g. C-H_2N. NOT incorrect bonding within groups, if shown, e.g. C=OH. ACCEPT if correct group attached to wrong molecule, e.g. glucose.	**(3)**

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	Peptide (bond)	ACCEPT peptide link. NOT polypeptide or dipeptide.	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(iii)	1. Idea that fibrinogen is globular and fibrin is fibrous 2. Fibrinogen is soluble and fibrin is insoluble 3. Idea that they are different sizes	1. ACCEPT fibrinogen globular and fibrin (long) strand or chain 3. ACCEPT fibrinogen is {smaller/larger/has more amino acids} than fibrin ACCEPT marks to be pieced together across the response. N.B. answers must be comparative, e.g. fibrin is fibrous, fibrinogen is not.	**(2)**

Total for Question 1 = 11 Marks

Question Number	Answer	Additional Guidance	Mark
2(a)	1. Triplet code/3 bases to each code/eq 2. Reference to adenine, thymine, guanine and cytosine 3. Idea that each triplet of bases codes for one amino acid 4. Idea that the code is not overlapping 5. Idea that the code is universal 6. Idea that the code is degenerate	1. IGNORE codon, triple 2. ACCEPT phonetic spelling	**(2)**

Question Number	Answer	Additional Guidance	Mark
***2(b) Quality of Written Communication**	(Quality of Written Communication – Spelling of technical terms must be correct and the answer must be organised in a logical sequence.) 1. Reference to *semi-conservative replication* 2. DNA (*molecule*/strands) {unwinds/separate/eq} 3. *(Mono)nucleotides* line up along (both) strands/eq 4. Reference to *complementary* pairing between bases 5. Reference to *hydrogen bonds* formed (between bases) 6. Reference to formation of *phospho(di)ester* bonds (between adjacent *mononucleotides*) 7. Reference to condensation reaction 8. Name of an enzyme involved in DNA replication	Quality of written communication – Spelling of technical terms must be correct – penalise first error only – can still reach maximum of 5 marks if 6 points given. **If context is transcription, maximum 2 marks from Mp2, 5, 6, 7 and 8.** 1. ACCEPT clear description 2. ACCEPT unzipped/hydrogen bonds broken/eq 3. NOT RNA OR one strand only described IGNORE bases line up 4. ACCEPT description, NOT uracil/U 5. NOT between nucleotides in the same strand ACCEPT between (DNA) strands 8. For example, (DNA) *polymerase*, (DNA) *helicase, ligase*	**(5)**

Total for Question 2 = 7 Marks

Question Number	Answer	Mark
3(a)(i)	D	(1)

Question Number	Answer	Mark
3(a)(ii)	B	(1)

Question Number	Answer	Mark
3(a)(iii)	B	(1)

Question Number	Answer	Mark
3(a)(iv)	A	(1)

Question Number	Answer	Additional Guidance	Mark
3(b)(i)	1. (Total) cholesterol levels in people with mutation are not higher than people without mutation/eq 2. LDL (cholesterol) levels in people with mutation are not higher than people without mutation/eq 3. HDL (cholesterol) levels in people with mutation are not lower than people without mutation/eq 4. Credit correct use of manipulated figures	1, 2, 3: ACCEPT converse, similar/little difference. Decreased/reduced is **not** equivalent to lower. 1. IGNORE same 2. IGNORE same 3. ACCEPT ref to HDL to LDL ratio higher in people with the mutation 4. Must be manipulated, e.g. difference calculated and not just quoted (difference in LDL=10, total cholesterol=7) ACCEPT without units	(2)

Question Number	Answer	Additional Guidance	Mark
3(b)(ii)	(Plant) statin	IGNORE named drug, sterol, stanin.	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(b)(iii)		NOT cancer or reduced vitamin absorption IGNORE affect	
	1. Muscle {inflammation/pain/eq}	ACCEPT problems as equivalent to damage etc.	
	2. Liver {damage/failure/eq}	2. ACCEPT disease	
	3. Joint {aches/pains/eq}		
	4. Nausea/constipation/diarrhoea/indigestion/flatulence/loss of appetite/eq	4. ACCEPT vomiting	
	5. Kidney {damage/failure/eq}	5. ACCEPT kidney disease	**(1)**
	6. Cataracts/blurred vision		
	7. Diabetes		
	8. Allergies/skin inflammation/skin rash/eq		
	9. Respiratory problems/persistent cough/nosebleeds/eq		
	10. Headaches/dizziness/depression/insomnia/ringing in ears/fatigue/eq	10. ACCEPT mood swings	

Total for Question 3 = 8 Marks

Question Number	Answer	Additional Guidance	Mark
4(a)	1. Idea of large surface area to volume ratio or that it is thin (body) 2. Idea that this helps diffusion, e.g. short diffusion distance, faster diffusion	1. IGNORE flat, small unqualified, thin membrane, thin skin etc. NOT cell wall 2. IGNORE gas exchange NOT osmosis	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	1. Solubility of oxygen decreases as temperature increases/eq 2. Credit correct manipulation of figures	1. ACCEPT converse, negative correlation. 2. Units not required but if given then they must be correct, e.g. 8.2 mg dm^{-3} difference in solubility between 0 and 40°C, solubility halved between 5°C and 40°C.	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	1. Idea that there is quite a lot of dissolved oxygen in the water at this temperature 2. Idea of oxygen concentration gradient (between water and flatworm's cells) 3. Idea of enzyme activity being temperature dependent 4. Idea that water below 15^{o}C would be too cold for {enzymes/metabolism/eq} to work effectively 5. Idea that it is a balance between oxygen availability and {enzyme activity/kinetic effects/eq}	IGNORE there is most oxygen available. 1. ACCEPT sufficient O_2, not enough O_2 at higher temperature. 2. Reference to diffusion or gas exchange alone, not sufficient for the mark. 3. ACCEPT, e.g., 15^{o}C is optimum for their enzymes NB: This is for linking enzymes and temperature, Mp4 is a development of Mp3 stating something specific. 4. IGNORE reference to effects above 15^{o}C	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(c)	1. Heart needed to {pump/move/eq} blood (around the body) 2. Reference to mass flow 3. Idea that many animals have a small surface area to volume ratio 4. Idea that a circulatory system is needed to overcome limitations of diffusion/eq 5. Credit correctly named molecule transported (in blood) 6. Idea that many animals have a high metabolic rate	4. ACCEPT idea that diffusion is not sufficient 5. Oxygenated blood not enough by itself ACCEPT any appropriate molecule in the blood. ACCEPT idea of thermoregulation, e.g. heat.	**(4)**

Total for Question 4 = 11 Marks

Question Number	Answer	Additional Guidance	Mark
5(a)(i)	1. Reference to {H on the N/NH} in the reduced DCPIP 2. Reference to more {H on the O/OH/hydroxyl} in the reduced DCPIP 3. More Hs in the reduced DCPIP/eq 4. Idea of double bonds different in {number/location/eq},e.g. fewer in reduced DCPIP 5. Idea of CN double bond not present in reduced 6. Idea of CO double bond not present in reduced	IGNORE hydrogen bonds. ACCEPT converse for oxidised DCPIP. ACCEPT a clear statement about one implies a difference. 2. For example, two OH groups in reduced form ACCEPT alcohol groups 3. NOT more than two more Hs 4. IGNORE reduced more saturated 6. ACCEPT ref to ketone group	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(a)(ii)	Idea that the Hs come from the vitamin C/idea that vitamin C acts as a reducing agent	ACCEPT Description in terms of electrons (vitamin C loses electrons/DCPIP gains electrons). ACCEPT vitamin C is oxidised. ACCEPT vitamin C reduces DCPIP. DCPIP is reduced alone is not enough.	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	1. pH increases during storage (over 4 days)/eq 2. Greatest increase in pH at 12°C/smallest increase in pH at 24°C/eq 3. Idea that pH changes are similar at 6°C and 8°C 4. Reference to slight decrease in pH during first {one/two} days at 24°C 5. Credit correct manipulation of figures for a time period	ACCEPT reduction in acidity for increase in pH. 1. ACCEPT for all or for any one temperature 2. ACCEPT 12°C highest pH 3. ACCEPT the same up to day 2 4. ACCEPT after 2 days 5. Assume value is for four days unless otherwise stated, as four days specified in question stem. For example, 12°C increased 0.45/12°C 0.4 higher than 24°C/only 0.03 between 6°C and 8°C (after 4 days)	**(3)**

Question Number	Answer	Additional Guidance	Mark
***5(b)(ii) Quality of Written Communication**	(Quality of Written Communication – Spelling of technical terms must be correct and the answer must be organised in a logical sequence.) 1. Idea of using juice (from stored fruits) 2. Reference to {titration/eq} (of juice) 3. Correct colour change described 4. Compare volumes of {juice/DCPIP} used 5. Use of {repeats/replicates/eq} 6. Reference to extended storage 7. Reference to named controlled variable, e.g. same volume DCPIP 8. Reference to testing at regular intervals	Quality of Written Communication points must be clear and unambiguous for awarding. 1. NOT storing the juice 2. Can be described or named 3. Must be checked for context, e.g. blue to colourless/clear/pink when titrating juice into the DCPIP, colourless to blue if DCPIP to juice ACCEPT suitable description of use of colourimeter 4. ACCEPT in context of calibration of DCPIP 6. Beyond the 4 days of the original experiment	**(5)**

Total for Question 5 = 11 Marks

Question Number	Answer	Additional Guidance	Mark
6(a)	1. {Phosphate group/heads} are hydrophilic 2. Idea that heads can be attracted to water 3. {Fatty acids/tails} are hydrophobic 4. Idea that tails orientate themselves away from water/eq 5. Idea of aqueous environment on both sides of the membrane	ACCEPT marks for annotated diagram, phonetic spelling OK. IGNORE 'water loving/hating'. 1. ACCEPT polar 2. NOT just facing water 4. ACCEPT repel water, face away from water, away from polar environment 5. ACCEPT polar environment	**(3)**

Question Number	Answer	Mark
6(b)	B C A	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(c)(i)	1. Both have a phospholipid bilayer and protein/eq 2. Idea that the fluid mosaic model has {proteins within the phospholipid layer/protein channels } while the Davison-Danielli model has protein layer on the outside of the membrane only 3. Reference to other components present in fluid mosaic model, e.g. glycolipid, glycoprotein, cholesterol	1. ACCEPT point pieced together in response 2. Needs clear comparative statement re the position of the proteins in the two models, but can be expressed in a number of ways	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(c)(ii)	1. Idea that molecules would not be able to diffuse through the (two) protein layers/eq 2. Idea of no {channels/carriers/protein} for {facilitated diffusion/active transport /osmosis} 3. Comment on fluidity of membrane/limits fusion of vesicles/eq	1. ACCEPT osmosis in context of water passing through protein layer 2. ACCEPT pumps for active transport 3. ACCEPT endo/exocytosis	**(2)**

Total for Question 6 = 10 Marks

Question Number	Answer	Additional Guidance	Mark
7(a)	1. Mutation change the sequence of bases/eq 2. Reference to stop code/idea of {insertion/deletion/eq} changes all triplets/frame shift/eq 3. {Transcription/translation} does not occur/mRNA too short/protein too short/a different protein is made/eq	1. ACCEPT correct sequence of bases not there 2. IGNORE changes one triplet/codon ACCEPT no start codon, no ribosome binding site 3. IGNORE change of an amino acid ACCEPT wrong protein made, different sequence of amino acids	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(b)	1. In the (cell surface) membrane 2. Of mucus-producing cells/eq	1. ACCEPT in phospholipid bilayer, apical membrane NOT on, attached, basal membrane 2. ACCEPT {epithelial/endothelial/lining} cells of appropriate named organ or system, e.g. cells lining respiratory, digestive, reproductive	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(c)	1. (Change in) {number/type/sequence/eq} of {amino acids/R groups} 2. So the {bonding/named bond} will be different/eq	2. ACCEPT hydrogen, disulfide bridges, van der Waal forces, ionic NOT peptide, glycosidic, ester bond, etc IGNORE references to shape, including active sites	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(d)	1. FTR is a channel protein/eq 2. Idea that {fewer/no} chloride ions will be able to {enter/bind to/pass through/eq} the CFTR protein 3. Idea that fewer chloride ions will leave the cel	NOT chlorine, penalise once. 1. NOT carrier 2. ACCEPT CFTR has a specific shape for chloride ions ACCEPT other ions can pass through	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(e)	1. Less {chloride ions/water} in mucus/eq 2. Idea that mucus is different, e.g. thicker, stickier 3. In the {respiratory system/lungs/digestive system/pancreas/reproductive system/oviducts /fallopian tubes/cervix/sperm duct/vas deferens/eq} 4. Credit correct reference to a consequence of thicker mucus	For example, less ventilation, enzyme release, absorption of nutrients, more chest infections, reduced fertility, etc.	**(2)**

Question Number	Answer	Mark
7(f)	1. By {enzymes/proteases} 2. By hydrolysis/eq 3. Of peptide bonds	(2)

Total for Question 7 = 12 Marks

Question Number	Answer	Additional Guidance	Mark
8(a)	Idea that the {increase/change} in relative risk of developing cirrhosis is {reflected/accompanied/eq} by the {increase/change} in alcohol consumption.	ACCEPT 'the higher the consumption, the higher the risk' and similar. IGNORE causation comments, it is positive.	(1)

Question Number	Answer	Additional Guidance	Mark
8(b)(i)	1. Both show an increase in risk with an increase in alcohol consumption/eq 2. Idea that the risk increases markedly at 30 g day^{-1} in study A but at 40 g day^{-1} in study B 3. Study A found the risk was higher than study B /eq 4. Credit use of comparative manipulated figures	ACCEPT Mps to be pieced together. 2. IGNORE faster ACCEPT steeper 3. ACCEPT for specified value of alcohol consumption or risk 4. For example, for 30 g alcohol per day study A women have a relative risk 2 higher than study B women If units given they must be correct.	(2)

Question Number	Answer	Additional Guidance	Mark
8(b)(ii)	Any **two** from differences in: age/diet/medication/other drug abuse/nationality/ethnicity/genetics/body mass/activity levels/other medical conditions/study method/sample size/{over/under/eq} estimation of consumption of alcohol/pattern of drinking (e.g. binge compared to regular/type of drink)	ACCEPT two correct answers in first section. IGNORE environmental factors, lifestyle, occupation, pregnancy. ACCEPT smoking, weight, BMI, countries, regions, areas, metabolism, liver size.	**(2)**

Question Number	Answer	Mark
8(c)	1. Each study found women to have a greater risk than men/eq 2. Idea that the risk increases markedly at 50 g day^{-1} for men but at {30/40/ both} g day^{-1} for women 3. Idea that gradient of increased risk smaller for men than women (in both studies) 4. Credit correct use of figures, e.g. above 42-44 g day^{-1} men are at a lower risk/eq	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(d)	1. Results of both studies are (fairly) similar suggesting that the results are reliable/eq 2. Comments on the numbers of people in the studies/eq 3. Comment on lack of error bars/eq 4. Idea that the results do not reliably show at what level risk increases significantly	1. ACCEPT results show same pattern, e.g. men lower than women in both studies 2. For example, we don't know the sample size IGNORE number of studies 3. ACCEPT no information about the range of results in each study	**(2)**

Question Number	Answer	Mark
8(e)	Misreporting the amount of alcohol they had consumed/{did not know/guessed} the alcohol content of their drinks/used average values for alcohol content of drinks/{lost track of/could not remember} how much they drank/eq	**(1)**

Total for Question 8 = 10 Marks

Total for Paper = 80 Marks

Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number	Candidate Number

Biology

Advanced Subsidiary

Unit 2: Development, Plants and the Environment

Sample Assessment Material
Time: 1 hour 30 minutes

Paper Reference
WBI02/01

You do not need any other materials.

Total Marks

Instructions

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

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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

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

Turn over ▶

S45355A

S 4 5 3 5 5 A 0 1 2 4

PEARSON

Answer ALL questions.

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 student studied three different cells: an animal cell, a bacterial cell and a plant cell.

For each of the statements below, put a cross ☒ in the box that corresponds to the correct statement.

(a) DNA is located in the nucleus in

(1)

☒ **A** the animal cell only

☒ **B** the bacterial cell only

☒ **C** two of the cells only

☒ **D** all three cells

(b) A cell wall is present in

(1)

☒ **A** the animal cell only

☒ **B** the bacterial cell only

☒ **C** the plant cell only

☒ **D** two of the cells only

(c) Centrioles are present in

(1)

☒ **A** the animal cell only

☒ **B** the plant cell only

☒ **C** two of the cells only

☒ **D** all three cells

(d) A cell surface membrane is found in

(1)

☒ **A** the bacterial cell only

☒ **B** the plant cell only

☒ **C** two of the cells only

☒ **D** all three cells

(e) Mitochondria are found in

(1)

☒ **A** the bacterial cell only

☒ **B** the plant cell only

☒ **C** two of the cells only

☒ **D** all three cells

(f) Ribosomes are found in

(1)

☒ **A** the animal cell only

☒ **B** the bacterial cell only

☒ **C** two of the cells only

☒ **D** all three cells

(g) Smooth endoplasmic reticulum (SER) is present in

(1)

☒ **A** the animal cell only

☒ **B** the bacterial cell only

☒ **C** the plant cell only

☒ **D** two of the cells only

(h) Amyloplasts may be present in

(1)

☒ **A** the animal cell only

☒ **B** the bacterial cell only

☒ **C** the plant cell only

☒ **D** all three cells

(Total for Question 1 = 8 marks)

2 Several processes lead up to fertilisation in animals and plants.

*(a) Describe and explain how, in mammals, events following the acrosome reaction prevent more than one sperm fertilising an egg.

(4)

(b) Animals produce haploid gametes by meiosis.

Explain how meiosis gives rise to genetic variation in gametes.

(2)

(c) In flowering plants, the growth of pollen tubes is affected by many factors. An investigation was carried out to study the effect of the concentration of a chemical called methylpurine on pollen tube growth.

Pollen grains from lily flowers were exposed to 0.01 mol dm^{-3} methylpurine at pollination.

Lily flowers
Magnification × 0.2

After 48 hours, the lengths of the pollen tubes formed were measured and the mean length calculated.

This was repeated with two other concentrations of methylpurine and a control with no methylpurine.

The results are shown in the table below.

Concentration of methylpurine / mol dm^{-3}	**Mean length of pollen tube after 48 hours / mm**
0.0000	94
0.0001	95
0.0010	90
0.0100	28

(i) The investigation was carried out at a constant temperature of 22.5 °C.

Suggest why the temperature was kept constant.

(2)

.....

.....

.....

.....

(ii) Using the information in the table, describe the effect of methylpurine concentration on the mean length of pollen tubes from lily flowers.

(3)

(iii) Methylpurine can inhibit messenger RNA (mRNA) synthesis.

Suggest how this can cause the change in mean pollen tube length.

(2)

(Total for Question 2 = 13 marks)

3 (a) William Withering tested the use of digitalis to treat a heart condition.
The table below describes some of the stages he could have used.

Place a tick (✓) in the box if he used this stage in his test and place a cross (✗) in the box if he did not.

(3)

Description of stage	Tick / cross
He tried to isolate digitalis from foxglove plants.	
He tested digitalis on healthy humans.	
He used a placebo to make sure digitalis worked.	

(b) (i) Explain why placebos are used to test the efficiency of new drug treatments.

(2)

(ii) Explain what is meant by a **double blind trial**.

(2)

(Total for Question 3 = 7 marks)

4 Recently, scientists have shown an interest in using plant tissue culture techniques to produce large numbers of genetically identical cotton plants. Cotton plants provide fibres used for clothing.

Plant tissue culture techniques depend on the totipotent properties of the cells used.

(a) Describe how you could use a plant tissue culture technique to show totipotency in cotton plant seedlings.

(4)

(b) Scientists used similar plant tissue culture techniques to investigate the effect of the age of the seedlings on totipotency.
Seedlings were divided into four groups, each consisting of 25 seedlings. One group was grown for 7 days before the plant tissue culture technique was carried out.
The number of seedlings that showed totipotency was recorded as a percentage.

This procedure was repeated for the other three groups of seedlings, which were grown for 14, 21 and 28 days respectively before the plant tissue culture technique was carried out.

The results are shown in the table below.

Age of seedlings before plant tissue culture technique carried out / days	Percentage of seedlings showing totipotency (%)
7	76
14	56
21	40
28	60

(i) Describe the effect of age on the percentage of seedlings showing totipotency.

(2)

(ii) The scientists were concerned about the reliability of the data.

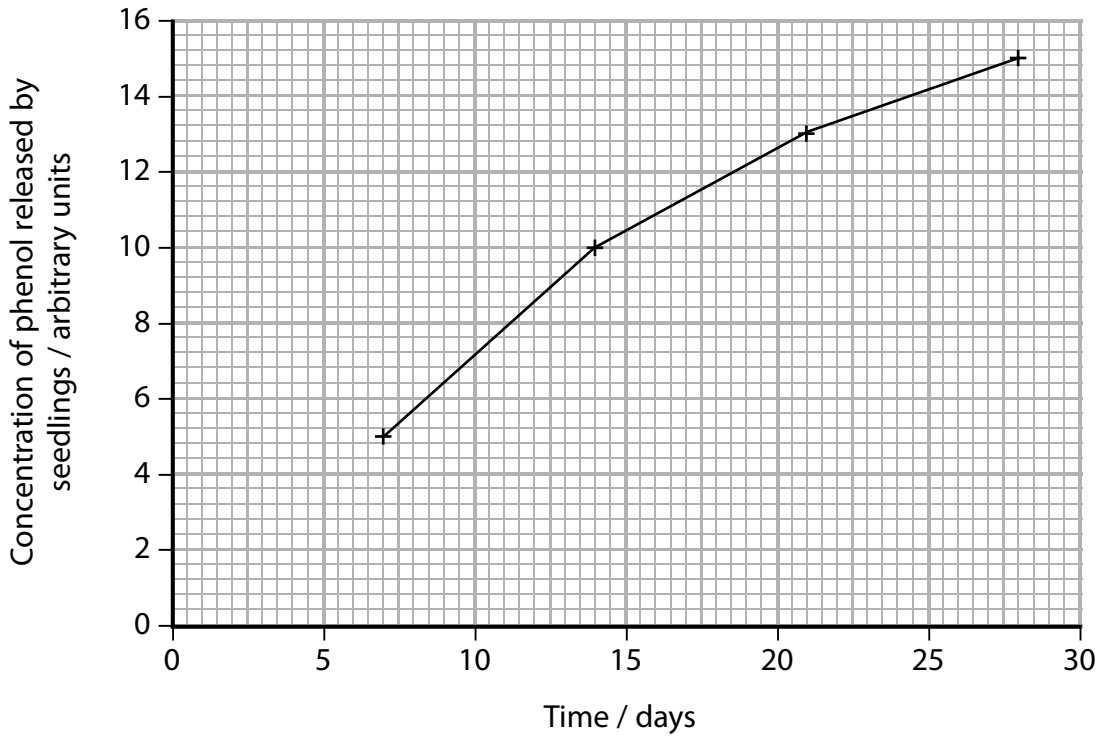
Suggest how the data could have been made more reliable.

(2)

(c) As cotton plants grow, they release a substance called phenol.

In another investigation, the scientists measured the concentration of phenol released by seedlings.

The results are shown in the graph below.



(i) Using the information in the table in part (b) and the graph, give evidence to support the hypothesis that phenol reduces totipotency.

(1)

(ii) Using the information in the table in part (b) and the graph, give evidence that does **not** support the hypothesis that phenol reduces totipotency.

(1)

.....

.....

.....

.....

(d) Human stem cell research involves the use of both totipotent and pluripotent stem cells.

Describe the differences between a totipotent stem cell and a pluripotent stem cell.

(2)

.....

.....

.....

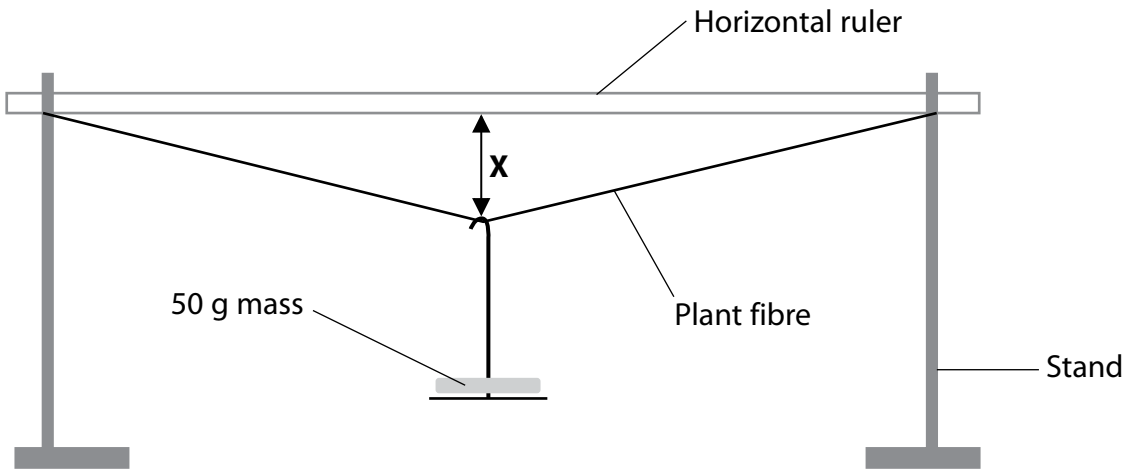
.....

.....

.....

(Total for Question 4 = 12 marks)

5 (a) A student used the apparatus shown in the diagram below to investigate the tensile strength of plant fibres.



She added a 50 g mass to the middle of the fibre and measured distance **X**.
She repeated this by adding additional 50 g masses.

The results are shown in the table below.

Mass / g	Distance X / cm
0	0
50	2
100	4
150	5
200	5
250	Fibre broke

(i) Describe the effect on distance **X** of increasing the mass.

(2)

(ii) Another student thought that the data did not show the mass needed to break the fibre. He suggested that it could be anywhere between 200 g and 250 g.

Suggest how a more accurate result could be determined.

(2)

(b) Suggest how you would use this apparatus to enable a valid comparison of the tensile strength of fibres from two different plants.

(5)

(Total for Question 5 = 9 marks)

6 Carl Woese suggested that living organisms could be grouped into three domains.

(a) The Eukarya domain includes the plant kingdom.
Plants are different from other groups of organisms in the Eukarya domain as they have cellulose cell walls. The cellulose molecules in the cell wall are arranged in microfibrils.

The table below gives four features of a cellulose molecule and a cellulose microfibril.

If the feature is present place a tick (✓) in the box and if it is absent, place a cross (✗) in the box.

(4)

Feature	Cellulose molecule	Cellulose microfibril
Alpha (α) glucose		
1,4-glycosidic bonds		
1,6-glycosidic bonds		
Hydrogen bonds		

(b) Eukarya is one of the three domains.

Name the other **two** domains.

(2)

1. .....

2. .....

(c) Scientists classify organisms into taxonomic groups, such as the three domains.

Explain how organisms can be classified into taxonomic groups.

(2)

.....

.....

.....

.....

.....

.....

(d) When Carl Woese first suggested that all organisms could be classified into one of the three domains, his ideas were not accepted.

Suggest how Woese's idea was critically evaluated.

(3)

.....

.....

.....

.....

.....

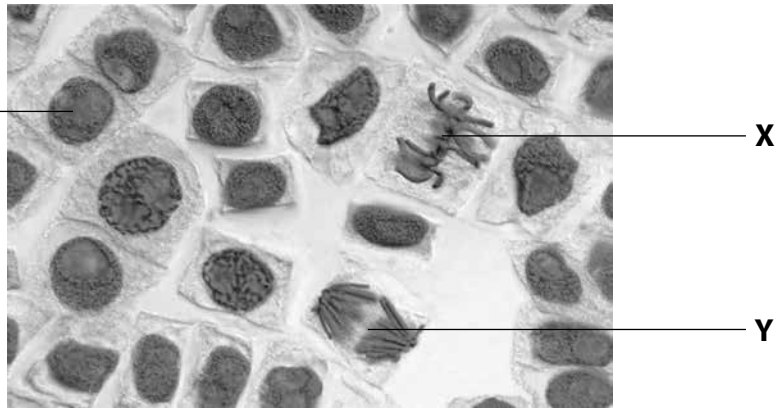
.....

.....

.....

(Total for Question 6 = 11 marks)

7 The photograph below shows plant cells at different stages in the cell cycle.



Magnification × 600
Herve Conge,ISM / Science Photo library

(a) Name the stage of mitosis shown by each of the cells labelled **X** and **Y**.

(2)

X .....

Y .....

(b) Describe what occurs during prophase.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Cell **Z** is not undergoing mitosis.

Suggest which stage of the cell cycle it is undergoing.
Give a reason for your answer.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 7 = 8 marks)

8 The black-footed ferret, shown in the photograph below, is one of North America's most endangered species. In 1986, only 18 individuals were living in the wild. These were used to start a captive breeding programme. Six zoos are now involved in this programme.

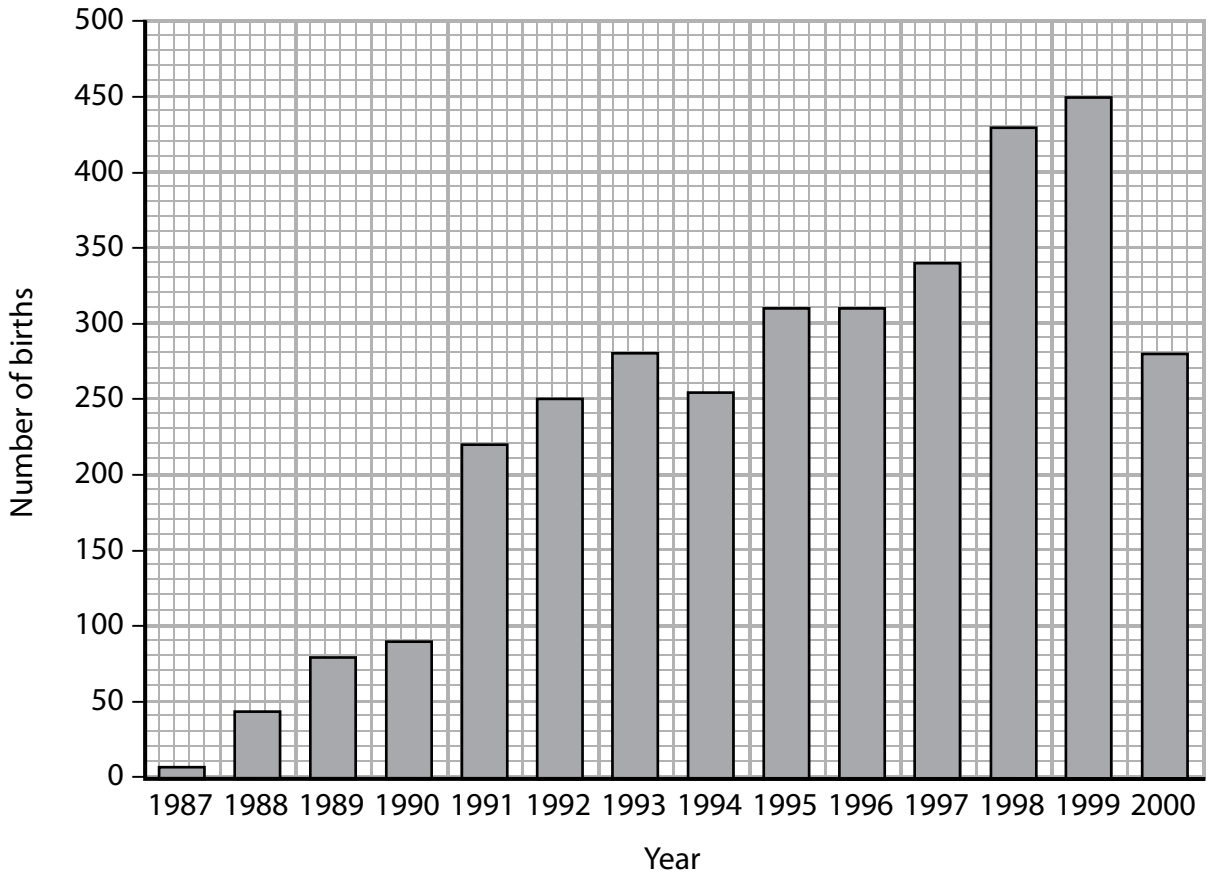
Black-footed ferret

Magnification × 0.1

*(a) Suggest how this captive breeding programme in the six zoos ensures that genetic diversity is maintained in this species.

(5)

(b) The graph below shows the number of black-footed ferrets in captivity born each year from 1987 to 2000.



(i) Each year since 1991, 200 black-footed ferrets have been released into the wild.

Suggest why no black-footed ferrets were released into the wild before 1991.

(2)

.....

.....

.....

.....

(ii) Using the information in the graph, suggest how effective the captive breeding programme was between 1991 and 2000.

(2)

.....

.....

.....

.....

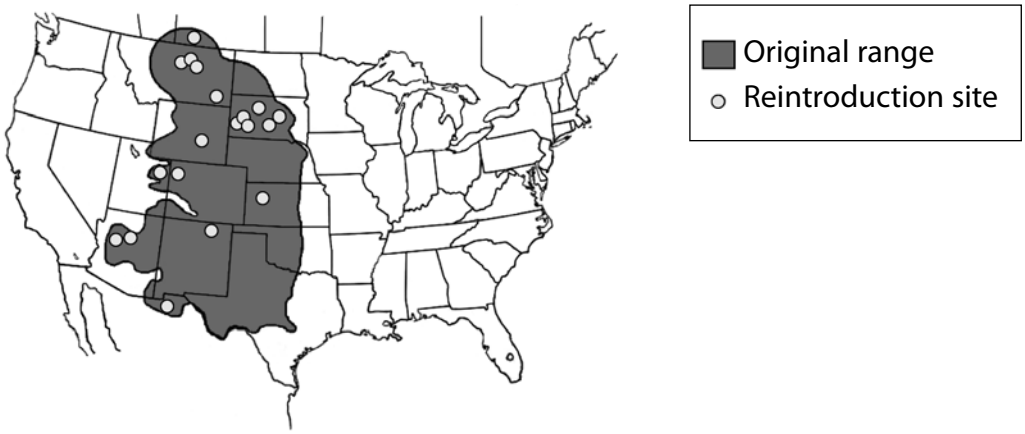
.....

.....

(c) The map of the USA below shows the original range of the black-footed ferrets and the sites where they have been reintroduced. Their natural habitat is prairie, which is a type of grassland.

Only 1% of the prairie remains undisturbed by human activity.

Black-footed ferrets mainly prey on prairie dogs. Prairie dogs are treated as pests by farmers who may use poison to kill them.



Suggest **three** factors that could affect the survival chances of black-footed ferrets when they are reintroduced to the sites shown on the map.

(3)

1 .....

.....

.....

2 .....

.....

.....

3 .....

.....

.....

(Total for Question 8 = 12 marks)

TOTAL FOR PAPER = 80 MARKS

BLANK PAGE

Mark Scheme (SAM)

Pearson Edexcel International Advanced Subsidiary in Biology

Unit 2: Development, Plants and the Environment

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- 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 may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed-out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of Quality of Written Communication, are being assessed. The strands are as follows:
    i. ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
    ii. select and use a form and style of writing appropriate to purpose and to complex subject matter
    iii. organise information clearly and coherently, using specialist vocabulary when appropriate.

Using the Mark Scheme

Examiners should NOT give credit for incorrect or inadequate answers, but allow 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 still be creditworthy.

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.
Bold	Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq	(error carried forward)(transfer error)(consequential) 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. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions that involve the writing of continuous prose require candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where Quality of Written Communication is likely to be particularly important are indicated (Quality of Written Communication) in the mark scheme, but this does not preclude others.

Question Number	Answer	Mark
1(a)	C	(1)

Question Number	Answer	Mark
1(b)	D	(1)

Question Number	Answer	Mark
1(c)	A	(1)

Question Number	Answer	Mark
1(d)	D	(1)

Question Number	Answer	Mark
1(e)	C	(1)

Question Number	Answer	Mark
1(f)	D	(1)

Question Number	Answer	Mark
1(g)	D	(1)

Question Number	Answer	Mark
1(h)	C	(1)

Total for Question 1 = 8 Marks

Question Number	Answer	Additional Guidance	Mark
***2(a) Quality of Written Communication**	(Quality of Written Communication – spelling of technical terms must be correct and the answer must be organised in a logical sequence.) 1. Sperm cell {fuses/eq} with egg cell (*membrane*) 2. Reference to {*corticalgranules/vesicles/lysosomes}* 3. Idea of (cortical granules) {moving towards/fusing with} egg cell (surface) *membrane* 4. Reference to *exocytosis* (of *cortical granules/vesicles/lysosomes)* 5. Idea of contents (of *cortical granules*) {secreted /released into jelly layer/eq} OR reference to *cortical reaction* 6. Idea of {hardening/thickening/eq } of {*zona pellucida*/jelly layer} OR formation of *fertilisation membrane* 7. Reference to change in charge across egg cell membrane	Quality of Written Communication emphasis is on spelling of technical terms. 1. NOT the fusion of the nuclei 4. NOT for acrosome reaction 5. ACCEPT enzymes/chemicals NOT released into ovum 6. ACCEPT fertilisation	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(b)	1. Reference to both {independent/random} assortment and {crossing-over/chiasma(ta)} 2. Independent assortment gives rise to {new/ different/eq} combinations of (paternal and maternal) chromosomes 3. Crossing over involves swapping of {sections/eq} of {chromatids/chromosomes}	3. NOT swapping genes ACCEPT new combinations of alleles (on a chromosome)/recombinants	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(c)(i)	1. Idea that temperature is a controlled variable, e.g. constant temperature removes this variable, so temperature does not affect {results/length of pollen tube} 2. Idea that (pollen tube) {growth/enzymes/proteins/eq} affected by temperature 3. Idea that at this temperature {enzymes/proteins} will not be denatured/pollen not destroyed at this temperature/22.5°C optimum temperature 4. Idea that the investigation is valid	1. ACCEPT the idea of only changing one variable and keeping all the others constant – or so that only methylpurine affecting pollen tubes NOT control variable 4. NOT reliable IGNORE fair test, accurate, precise	**(2)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>2(c)(ii)</td><td>1. Idea of {no significant/small/1mm/eq} increase in {mean length/growth} up to 0.0001 mol dm^{-3}

2. Idea of negative correlation described, e.g. {decrease in length of/shorter/reduced growth of} pollen tubes as concentration increased OR over stated range from 0.0001 to 0.01

3. Idea of greatest {change/drop/eq} between 0.0010 and 0.0100 mol dm^{-3}/eq

4. Credit correct manipulation of the data to illustrate decrease</td><td>IGNORE units.

2. ACCEPT reference to decreases at specific concentrations of methylpurine
IGNORE negative correlation unqualified

3. NOT references to rapid decrease

4. Some examples given below

<table>
<tr><th>Conc. change</th><th>Difference (mm)</th><th>% all decreases</th></tr>
<tr><td>0.0000 – 0.0100 – mp2</td><td>(94-28) 66</td><td>70/70.2 %</td></tr>
<tr><td>0.0001 – 0.0100</td><td>(95-28) 67</td><td>71/70.5 %</td></tr>
<tr><td>0.0001 – 0.0010</td><td>(95-90) 5</td><td>5/5.3 %</td></tr>
<tr><td>0.0010 – 0.0100 – mp3</td><td>(90-28) 62</td><td>69/68.9 %</td></tr>
</table>
</td><td>(3)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
2(c)(iii)	1. {Less/no} transcription/idea of inhibition of RNA polymerase 2. {Less/no} {translation/protein synthesis/protein made/eq} 3. Idea that protein needed for (pollen tube) growth, e.g. less protein leads to reduced growth (of pollen tubes)	2 and 3 ACCEPT reference to enzyme instead of protein. IGNORE repair.	**(2)**

Total for Question 2 = 13 Marks

Question Number	Answer	Additional Guidance	Mark
3(a)	<table><tr><th>Description of stage</th><th>Tick/ cross</th></tr><tr><td>He tried to isolate digitalis from foxglove plants.</td><td>✓</td></tr><tr><td>He tested digitalis on healthy humans.</td><td>×</td></tr><tr><td>He used a placebo to make sure digitalis worked.</td><td>×</td></tr></table>	No marks for blank spaces. No mark for hybrid x/✓.	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(b)(i)	1. Inactive substance/no drug/eq 2. Idea that it is used as a control, e.g. comparison with the actual drug 3. Idea of psychological effect of taking either a drug or a placebo	1. ACCEPT dummy pill, sugar pill, fake pill 3. For example patient believes they will improve and ALLOW reference to placebo effect	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(b)(ii)	1. Idea of one set of patients being given the (new) drug and one set given a placebo 2. Neither patient nor {doctor/scientist/eq} knows if the treatment contains the (new) drug or not 3. Removal of bias from results/eq	1. ACCEPT for placebo pre-existing/old drug	**(2)**

Total for Question 3 = 7 Marks

Question Number	Answer	Additional Guidance	Mark
4(a)	1. Idea of using part of the seedling 2. Idea of using agar 3. (Agar contains) growth substances/hormones/eq 4. Idea of using aseptic technique 5. Idea of covering the top of the container to prevent contamination OR loss of water 6. Idea of supplying light 7. Allow a suitable length of time for growth, e.g. 1 to 6 weeks 8. Look for {roots/leaves/(complete) plant} forming	1. ACCEPT cuttings, explants IGNORE cells unqualified 3. ACCEPT named plant growth substance	**(4)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>4(b)(i)</td><td>1. Percentage of seedlings (showing totipotency) decreases as age increases up to 21 days/negative correlation up to 21 days/eq

2. As age increases {after 21/from 21-28/at 28} days percentage of seedlings showing totipotency increases/eq

3. 28 days is an anomalous result

4. Credit correct manipulation of the data</td><td>4. Some examples are shown below

<table><tr><td>Days</td><td>Difference (%)</td></tr><tr><td>7-28</td><td>(76-60) 16</td></tr><tr><td>7-14</td><td>(76-56) 20</td></tr><tr><td>7-21 – Mp1</td><td>(76-40) 36</td></tr><tr><td>14-21</td><td>(56-40) 16</td></tr><tr><td>21-28 – Mp2</td><td>(40-60) (+) 20</td></tr></table>
IGNORE calculated percentage of percentage.</td><td>(2)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	1. {Repeats/larger number of seedlings} {at each age/in each group}/eq 2. More ages of seedlings used/use seedlings older than 28 days/test 35-day-old seedlings/eq 3. Repeat 28-day group/repeat any anomalous results/eq	1. ACCEPT repeated the whole experiment	**(2)**

Question Number	Answer	Mark
4(c)(i)	As phenol concentration increases from {7 to 21/7 to 14/14 to 21} days, percentage of seedlings showing totipotency decreases/negative correlation up to 21 days/eq	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(c)(ii)	(As phenol concentration increases) at 28 days percentage of seedlings showing totipotency increases /eq	ACCEPT reference to after 21 days.	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(d)	1. Totipotent cells can {give rise to/differentiate to become} {any cell/extra embryonic tissues/eq} 2. Pluripotent cannot {give rise to/differentiate to become} {all cells in the body/extra embryonic tissues/eq} 3. Idea that only totipotent cells can give rise to other totipotent cells 4. Idea that totipotent cells can give rise to an entire human being, pluripotent cells cannot	NOT turns into, become, develop into but penalise once only. 1. ACCEPT specialised for differentiated 1 and 2 IGNORE reference to embryonic cells/tissues, ACCEPT placental cells/tissues. 2. ACCEPT can give rise to most cells	**(2)**

Total for Question 4 = 12 Marks

Question Number	Answer	Additional Guidance	Mark
5(a)(i)	1. Increasing mass increased the distance up to 150g 2. 150g to 200g/after 150 (g) the distance did not change 3. Relationship is linear to 100(g) and non-linear above 100 (g) 4. Greatest change in 0 to 100 (g) range	IGNORE UNITS. 1. ACCEPT weights instead of masses	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(a)(ii)	1. Add smaller masses/add 10g or 5g masses 2. From 200g / between 200 and 250g	1. ACCEPT masses of any value less than 50g, e.g. 20g, must state units	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(b)	1. **Two** different fibre variables taken into account, e.g. length, width, age, mass, hydration level, part of plant extracted from 2. Environmental variable controlled, e.g. temperature, humidity 3. Named procedural variable controlled, e.g. size of masses used, retting method used to extract fibres 4. Idea of adding masses until fibre breaks/measure the mass that breaks the fibre/that the fibre can hold before breaking/eq} 5. Repeat and find the {mean/average} 6. Reference to action taken in case of {anomalous result/outlier} 7. Reference to safety procedure	2. IGNORE light intensity 3. ALLOW descriptions of methodology, e.g. the way in which the masses are added to the fibre	**(5)**

Total for Question 5 = 9 Marks

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>6(a)</td><td>Any 2 correct for 1 mark.
<table>
<tr><th>Feature</th><th>Cellulose molecule</th><th>Cellulose microfibril</th></tr>
<tr><td>Alpha (α) glucose</td><td>×</td><td>×</td></tr>
<tr><td>1,4-glycosidic bonds</td><td>✓</td><td>✓</td></tr>
<tr><td>1,6-glycosidic bonds</td><td>×</td><td>×</td></tr>
<tr><td>Hydrogen bonds</td><td>×</td><td>✓</td></tr>
</table></td><td>No marks for blank spaces.
No marks for hybrid x/✓.</td><td>(4)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
6(b)	1. Archaea 2. Bacteria	Either way around. 1. ACCEPT Archaeobacter	**(2)**

Question Number	Answer	Mark
6(c)	1. Idea that organisms with {specific/particular/shared/common/similar/eq} {characteristics/features/traits eg} are placed in a group 2. Detail of how characteristics assessed, e.g. observable characteristics, behavioural similarities, similarities in DNA, molecular phylogeny	(2)

Question Number	Answer	Additional Guidance	Mark
6(d)	1. Scientific findings published, e.g. in a journal 2. Idea of presented at scientific conference/eq 3. Idea of peer review 4. (Other scientists) repeat experiments (to confirm or validate findings/test reliability of data)	IGNORE critically evaluated as it is in the stem of the question. 3. Peer-reviewed journal gains Mp1 as well 4. Must be an indication of further testing being carried out	(3)

Total for Question 6 = 11 Marks

Question Number	Answer	Additional Guidance	Mark
7(a)	X – metaphase Y – anaphase	Accept mettaphase, metaphase. Accept annaphase, annafase.	(2)

Question Number	Answer	Additional Guidance	Mark
7(b)	1. {chromatin/DNA} condenses/eq 2. Chromosomes {condense/become visible/eq} 3. Idea of nuclear {membrane/envelope} breaking down 4. Nucleolus {disappears/eq} 5. Reference to centrioles moving to poles or opposite ends of cell 6. Reference to formation of spindle (fibres)	1. ACCEPT coiling of DNA, not supercoiling 2. ACCEPT shorten or thicken 5. N.B. part (b) does not specify plant cells	**(4)**

Question Number	Answer	Additional Guidance	Mark
7(c)	1. Interphase 2. Chromosomes not visible/nucleus is visible/eq	1. ACCEPT/G1/G2/S 2. Must be a detail seen in the photograph ACCEPT converse, e.g. not mitosis as chromosomes not visible	**(2)**

Total for Question 7 = 8 Marks

Question Number	Answer	Additional Guidance	Mark
***8(a) Quality of Written Communication**	(Quality of Written Communication – Spelling of technical terms must be correct and the answer must be organised in a logical sequence.) 1. Idea that 18 individuals is a small population/small gene pool/low genetic diversity/may have been closely related/eq 2. Captive breeding will increase population 3. Studbooks/records kept of breeding programme /eq 4. (zoos) select mates 5. Inter-zoo exchange of animals for breeding/eq 6. Idea of the need to prevent inbreeding 7. Idea of avoiding genetic drift 8. Use of {IVF/AI/use of surrogates} 9. Process for measuring genetic diversity described, e.g. DNA profiling/eq	Quality of written communication emphasis is clarity of expression. ACCEPT reference to 'species' instead of ferret due to wording of question. 4. Must refer to human intervention – not just the ferrets choosing their mates 6. NOT 'interbreeding' in place of 'inbreeding' ACCEPT 'encourage outbreeding', e.g. ferrets not mated with closely related ferrets	**(5)**

Question Number	Answer	Mark
8(b)(i)	1. (Captive) population not large enough/number of births is low/eq 2. Individuals not mature enough/eq 3. Zoos preparing ferrets for release/eq 4. Idea of maintaining a population in zoos	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(b)(ii)	1. Number of births is rising/eq 2. Increase in population 3. Idea that more are born than are released, e.g. at least 200 births each year 4. Identification of years when number of <u>births</u> fell, i.e. 1994 or 2000 5. Correct manipulation of data	3. Or some understanding that the increases outweigh the decreases, e.g. between 199–1999 it increased by 230, but only fell by 170 to 2000 from 1999 5. Some examples are shown below Year / Difference / % 1991–2000 Mp3 / (220-280) 60 / (+) 27/27.3 1991–1999 / (220-450) 230 / (+) 105/104.5 1999–2000 / (450-280) 170 / (-) 38/37.8	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(c)	1. Idea of habitat as a factor, e.g. loss of habitat/wider range of habitats/eq 2. Availability of {prey/food/prairie dogs/eq} 3. Competition with other ferrets (for resources) 4. Competition with other species (for resources)/eq 5. Effect of eating {poisoned prairie dogs/poison put out for prairie dogs}/eq 6. Presence of {predators/hunters}/ eq 7. Preparation for living in the wild improves chance of survival/if reliant on humans would not survive 8. Idea of too few to be a viable breeding population 9. Idea of presence of disease	Factors may either improve or reduce survival chances. 1. Climate change can be accepted here as a factor affecting availability of suitable habitat ACCEPT description of human activity that could lead to loss or gain of habitat 3. Intraspecific competition 4. Interspecific competition 7. For example, kept in semi-wild conditions initially and hunting behaviour encouraged	**(3)**

Total for Question 8 = 12 Marks

Total for Paper = 80 Marks

Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number	Candidate Number

Biology

Advanced Subsidiary

Unit 3: Practical Biology and Research Skills

Sample Assessment Material
Time: 1 hour 30 minutes

Paper Reference
WBI03/01

You must have:
Ruler, Calculator, HB pencil

Total Marks

Instructions

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

Information

- The total mark for this paper is 40.
- 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.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

S45356A

S 4 5 3 5 6 A 0 1 1 6

PEARSON

BLANK PAGE

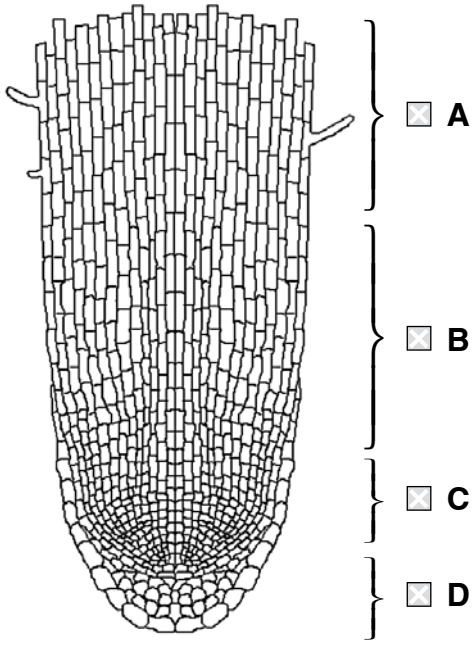
Answer ALL questions.

1 In a class practical, a student had studied cell division (mitosis) in onion roots.

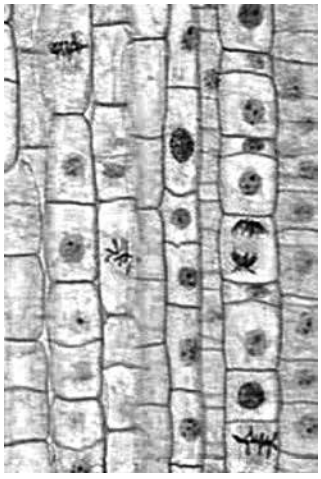
(a) The student was shown the diagram below of a longitudinal section of a root tip.

Place a cross ☒ in the box next to the letter showing the zone where mitosis takes place.

(1)



(b) Her teacher gave her the photograph below and asked her to identify cells undergoing mitosis.



(i) Draw lines to all the cells that are undergoing mitosis and label them **M**.

(2)

(ii) Draw a line to a cell which is in anaphase and label it **A**.

(1)

(iii) Give **one** reason why you chose this cell.

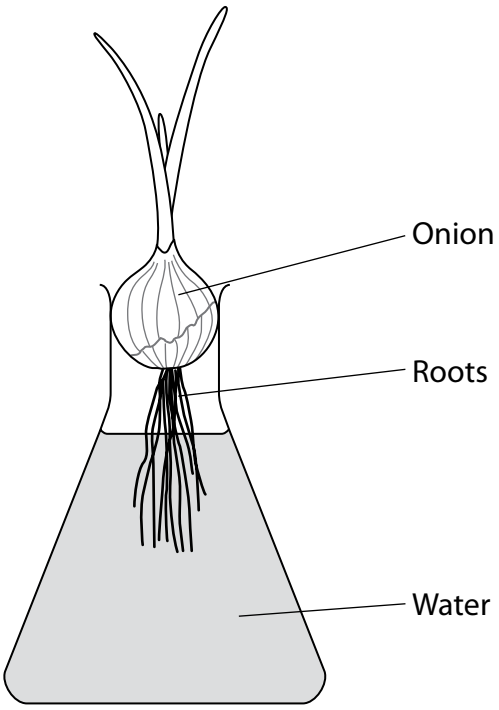
(1)

.....

.....

.....

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



(i) In class, she had prepared a root tip squash.
To see the chromosomes in the cells, she had to stain them and observe them using a microscope.

Name a suitable stain for observing chromosomes.

(1)

.....

(ii) She counted the number of cells undergoing mitosis and the total number of cells in the field of view and calculated the mitotic index.

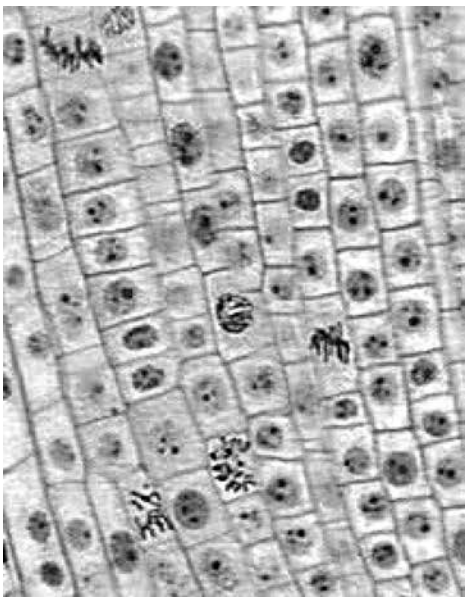
The formula is shown below.

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

Calculate the mitotic index for the root cells shown in the photograph below. There is a total of 84 cells.

Show your working.

(3)



Answer = ... %

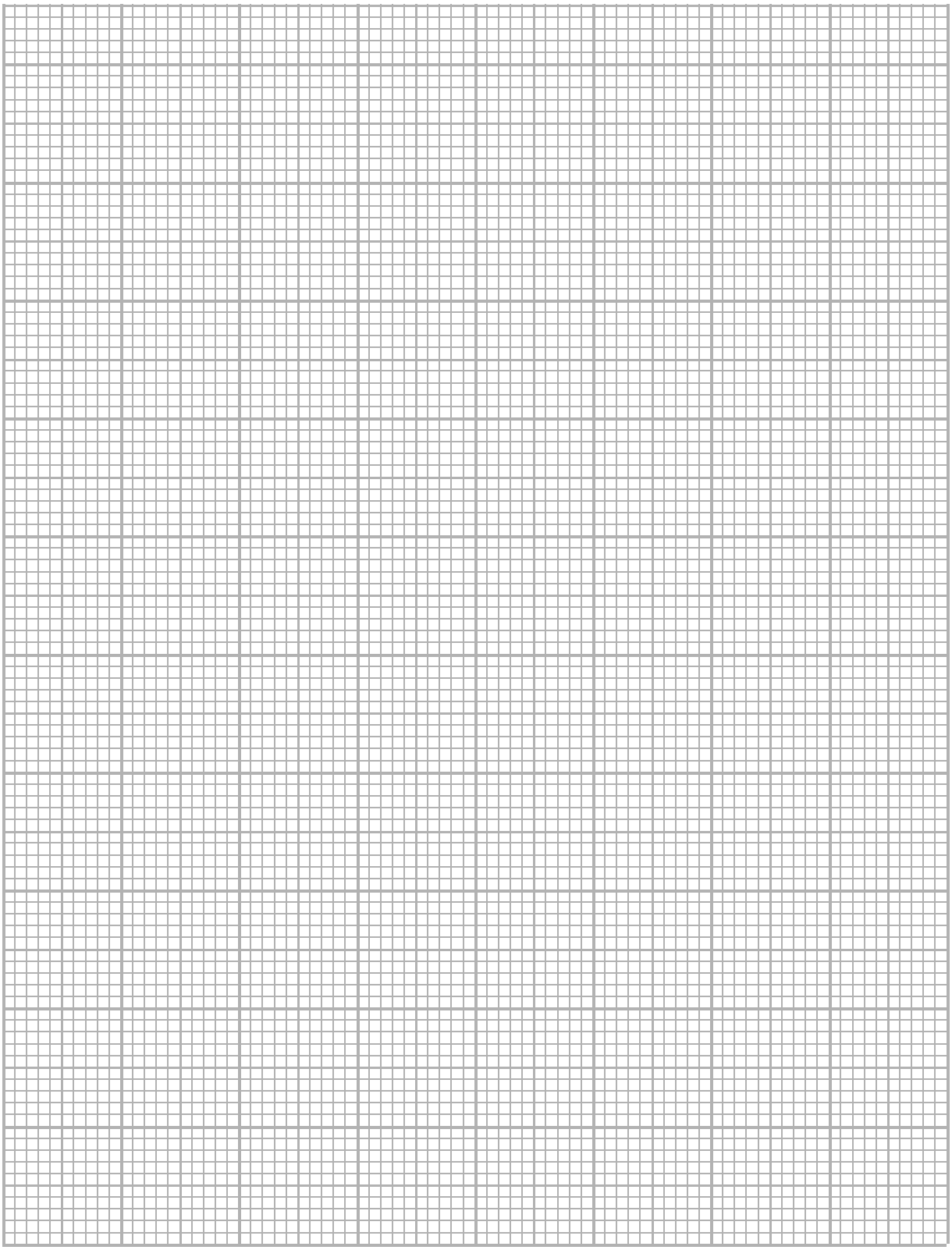
(d) The student determined the mitotic index of cells at five distances from an onion root tip. She repeated this procedure on another five root tips.

Her results are shown in the table below.

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

(i) Plot the distance from the root tip, mean mitotic index and standard deviations (SD) in a suitable graphical form.
Draw a straight line of best fit through the points.

(5)



(ii) Use your line of best fit to predict the distance from the tip at which there will be no mitosis. Write your prediction below.

(1)

Answer = ... mm

(iii) State the relationship between mean mitotic index and distance from the root tip.

(1)

.....

.....

(iv) The student was confident that there is a difference between the mean mitotic index at 0.5 mm and the one at 0.9 mm. She was not confident that there is a difference between the mean mitotic index at 0.3 mm and the one at 0.5 mm.

Using the information in the table, suggest why she thought this.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 1 = 20 marks)

2 The following is an extract from a student's report on the topic of artificial blood.

Making Blood

1. Blood loss for patients during operations can be significant, resulting in an ever increasing demand for blood. Blood donation through transfusion services is likely to remain the main source to meet this demand. However, more reliable and less costly sources of blood are being sought. This is partly because of projected donation supply shortfalls and contamination of natural blood.

2. Blood is complex and performs many functions, such as the transport of oxygen, defence against disease, the promotion of clotting and the transport of food, hormones and other substances.

3. Whole blood is too complex to synthesise, so research has focused on creating substitutes for two of its important functions; oxygen transport and clotting.

4. The structure of haemoglobin was first determined in 1959 and researchers have been trying to develop products which mimic red blood cells (RBCs) to deliver oxygen to damaged body tissues ever since. Several blood substitute products have been developed over the past fifty years. Some products have reached advanced clinical trials in patients whose lives were threatened. They are as effective as natural blood for carrying oxygen. However, we are still not sure if there are any side-effects for patients.

5. Three approaches to develop blood products for oxygen transport have been used. Haemoglobin-based oxygen carriers (HBOCs*)* are solutions of modified haemoglobin from human, other animals and genetically engineered sources in plasma-like fluids.

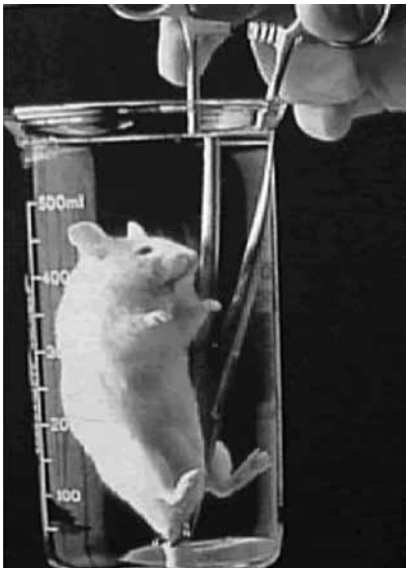
6. **Haemoglobin-based oxygen carriers (HBOCs)**

   HBOCs have benefits over natural red blood cells. They show faster and better oxygen distribution. The sterile HBOC manufacturing process virtually eliminates the risk of viral infection versus red cells in natural blood. 100% screening of donated blood for infections such as AIDS/HIV, Creutzfeld-Jacob, smallpox and SARS is not practical or even possible. HBOCs can survive over a wide range of storage temperatures, no refrigeration is required and there is a longer shelf life. There are no intact red blood cells with ABO antigens so there is no need for cross-matching of patients' blood types prior to use. They are a universal product, meaning that patients who only accept bloodless medical care can be treated. They can deliver oxygen quickly to damaged tissues because of their lower viscosity than RBCs.

7. HBOCs also have some drawbacks. They may increase the chances of deaths and heart attacks in patients with high blood pressure. They can cause an immune response with adverse side-effects. Haemoglobin does not last long outside red blood cells (3–4 days) and breaks down within the body, sometimes resulting in renal failure. RBCs typically live for up to 3 months. The manufacturing process requires very large quantities of haemoglobin. This is likely to be a constraint.

8. **Perfluorocarbons (PFCs)**

   Perfluorocarbon (PFC) based oxygen carriers are fully synthetic hydrocarbon-based compounds. PFCs are chemically inert organic fluids, but have the ability to dissolve 20 times more oxygen than plasma. The potential of PFCs was widely publicised in the 1960s when a photo appeared of a mouse submerged in a container "breathing" an oxygen-saturated PFC solution.



Magnification ×0.50

9. Some oxygen can dissolve in plasma but usually less than 1% of the total oxygen content in arterial blood. A major advantage of PFCs, such as Perflubron, is that they can increase dissolved oxygen to between two to three fold over the norm, depending on the oxygen partial pressure. A PFC called 'Oxygent' underwent clinical trials in the USA and Europe. It is universally compatible with all blood types, has a two year approximate shelf-life and can be manufactured on a large-scale, using commercially available raw materials. However, Phase III trials have shown an increased risk of stroke in treated patients compared to controls.

10. **Embryonic stem cells (ESCs)**

    A third approach taken in some recent work has been to look at the possibility of using embryonic stem cells (ESCs) to make blood. Work on ESCs almost completely ceased in 2001 in the USA due to the ban by President George Bush. However, in 2009 President Barack Obama reversed the ban, saying that sound science and moral values are not inconsistent with each other.

11. Work by Robert Lanza and his colleagues has led to the production of human RBCs from ESCs. These have been shown to be just as good at carrying oxygen as natural RBCs. They can be mass-produced very easily. The dream is to make RBCs from ESCs of blood type O negative, which can then be transfused into any patient as they do not cause an immune response.

12. While these are positive scientific developments, the powerful emotions raised by the use of ESCs and IVF embryos continue to be debated in public forums. Objections have been raised by religious communities. Scientists are accused of interfering with nature. Some groups are making legal claims of unethical behaviour in the creation or destruction of life. However, another type of stem cell which can also be coaxed into turning into other cell types does not require an embryo. These are called 'induced pluripotent stem cells' or iPSCs.

(a) (i) It was suggested that the information on the benefits and drawbacks of haemoglobin-based oxygen carriers (HBOCs) in comparison with red blood cells (RBCs) could be summarised in a table.
The student attempted this but it is unfinished.

Complete the empty boxes in the table using information from the report.

(4)

Feature	HBOCs	RBCs
Onset of oxygen carriage action		About a day
Risk of disease transmission		Attempts to minimise it by screening but never 100% successful
Duration of oxygen carriage action in body		
Viscosity		
Shelf life	Many months	A few days

(ii) Suggest **two** further features of HBOCs and RBCs, given in the extract, that could be included in this comparative table.

(2)

1 .....

.....

2 .....

.....

(b) The student needed data to illustrate some of the points he made in his report.

He found the data below for the PFC Perflubron.

Partial pressure of oxygen / kPa	Oxygen concentration in plasma / cm^3 per 100 cm^3	Oxygen concentration in Perflubron / cm^3 per 100 cm^3
0.0	0.0	0.0
13.3	0.2	0.8
26.7	0.5	1.5
40.0	0.8	2.1
53.2	1.0	3.0
79.8	1.8	4.6

(i) Draw a sketch graph to represent this data.

(3)

(ii) Suggest where in the extract this graph should be placed and describe the extent to which the graph supports the information in the extract.

(4)

(c) Identify a paragraph in the report in which the student has referred to an economic issue. State the issue referred to and suggest what additional information you could include in this paragraph.

(3)

Paragraph .....

Issue .....

Additional information .....

(d) Part of the student's reference list is shown below.

References

1. Changing age distribution of the blood donor population in the United States. In the journal *Transfusion* (Vol. 48, issue 2, pages 251–257) by Shimian Zou, Fatemeh Musavi, Edward P. Notari, Chyang T. Fang. 2007

2. Riess J. G. Understanding the Fundamentals of Perfluorocarbons and Perfluorocarbon Emulsions Relevant to In Vivo Oxygen Delivery. *Art Cells Blood Subs Immob Biotech.* 2005

3. Eric Niiler, *Nature Biotechnology* Vol. 20, 962–963 (2002)

4. New Scientist, Issue 23 August 2008. Page 10, article written by Andy Coghlan

His teacher gave him a note explaining how to do references properly.
The teacher suggested he should reorganise what he had done and find out any missing information. Here is the note:

Journal refs should have all the following information, in the order shown:

- Author(s) (family name and then initials)
- Year published (in brackets)
- Article title
- Journal title (in *italics*)
- Journal volume number followed by issue number in brackets
- Start and finish page numbers of the article in the journal

An example:

Wolanski, E., Richmond, R., McCook, L. and Sweatman, H. (2003) Mud, Marine Snow and Coral Reefs. *American Scientist* 91(1), 44–51.

(i) Choose **one** reference from the list above, which has all the required information and re-write it as the teacher suggested.

(2)

Reference number .....

.....

.....

.....

.....

.....

(ii) Choose another reference and list the pieces of information you would need to make it complete.

(2)

Reference number .....

.....

.....

.....

(Total for Question 2 = 20 marks)

TOTAL FOR PAPER = 40 MARKS

BLANK PAGE

Mark Scheme (SAM)

Pearson Edexcel International Advanced Subsidiary in Biology

Unit 3: Practical Biology and Research Skills

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- 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 may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed-out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of Quality of Written Communication, are being assessed. The strands are as follows:
    i. ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
    ii. select and use a form and style of writing appropriate to purpose and to complex subject matter
    iii. organise information clearly and coherently, using specialist vocabulary when appropriate.

Using the Mark Scheme

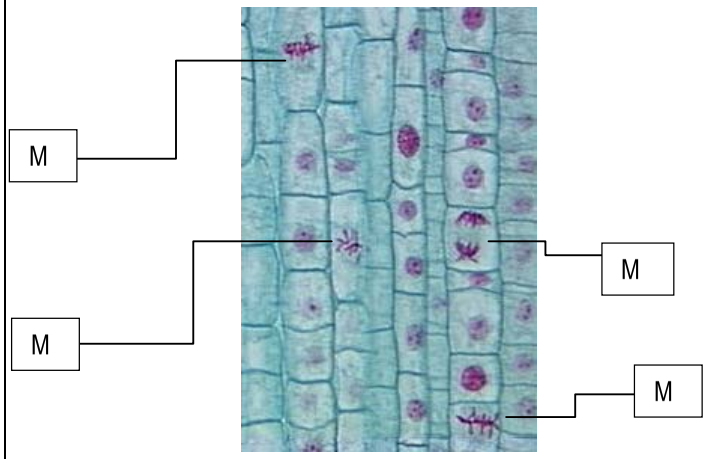
Examiners should NOT give credit for incorrect or inadequate answers, but allow candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected, it may still be creditworthy.

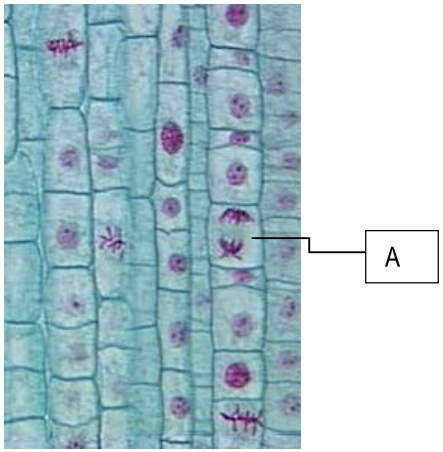
The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/	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.
Bold	Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq	(error carried forward)(transfer erro)(consequential) 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. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Question Number	Answer	Mark
1(a)	C	(1)

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	 All 4 for 2 marks 2 or 3 for 1 mark 0 or 1 zero marks	If all four labelled correctly but one extra M = 1 mark. Two extra M = 0 marks.	(2)

Question Number	Answer	Mark
1(b)(ii)		(1)

Question Number	Answer	Additional Guidance	Mark
1(b)(iii)	Chromosomes separated/chromosomes V shape/eq	At the opposite ends/poles pulled apart/split to two sides. ACCEPT chromatids. IGNORE centromeres.	(1)

Question Number	Answer	Additional Guidance	Mark
1(c)(i)	(Ethanoic/acetic) orcein/toluidine (blue)/methylene blue/Schiff's reagent/Giemsa/Feulgen stain/acetocarmine	ACCEPT phonetic spelling.	(1)

Question Number	Answer	Additional Guidance	Mark
1(c)(ii)	Correct answer gets all three marks. 1. Number of mitotic cells = 6 2. 6 ÷ 84 3. = 7.14/7.1 (%)	 1. ACCEPT 4 or 5 2. 4/5 ÷ 84 3. (for 4) = 4.76/4.8 (for 5) = 5.95/6.0 ACCEPT Mp2 and 3 if number other than 4/5/6 divided by 84 to get correct percentage, e.g. 78 to give 92.86/92.9.	**(3)**

Question Number	Answer	Additional Guidance	Mark
1(d)(i)	A axes correct orientation and appropriate scale (x –distance from tip, y – mitotic index) L axes correctly labeled, and with units (mm and %) P correct plotting S line of best fit E SDs plotted correctly	If bar graph accept Mp A, L, P and E. A. ACCEPT identified interrupted scale but this stops candidates from answering (d)(ii) correctly S. NOT if extrapolation towards Y-axis Must have at least one point but no more than 3 points on either side of the line.	**(5)**

Question Number	Answer	Mark
1(d)(ii)	Answer within range 1.3 to 1.5 (mm)	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(d)(iii)	Mitotic index decreases with increasing distance/eq	ACCEPT negative relationship/inversely proportional.	**(1)**

Question Number	Answer	Mark
1(d)(iv)	1. Idea that because there is a (large/small) difference in the means (linked to the relevant pair) **0.5 and 0.9** 2. Credit use of SD data and reference to no overlap **0.3 and 0.5** 3. Credit recognition of fact that some figures for 0.3 mm are the same as some for 0.5 mm (namely 8.9) or very close 4. Credit use of SD data and reference to – overlap **For either** credit manipulation of figures to calculate upper and lower limits, e.g. (0.5 mm lower limit 7.5, 0.9 mm upper limit 4.3, 0.3 mm lower limit 8.3, 0.5 mm upper limit 8.5/OR comment on 0.8 SD	**(4)**

Total for Question 1 = 20 Marks

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>2(a)(i)</td><td>Each row correct for one mark.

<table>
<tr><th>Feature</th><th>HBOCs</th><th>RBCs</th></tr>
<tr><td>Onset of oxygen carriage action</td><td>less than a day/immediate/ eq</td><td></td></tr>
<tr><td>Risk of disease transmission</td><td>none(virtually) eliminates/sterile manufacture/eq</td><td></td></tr>
<tr><td>Duration of oxygen carriage action in body</td><td>3-4 days</td><td>(up to) 3 months/ eq</td></tr>
<tr><td>Viscosity</td><td>low(er)/less</td><td>high(er)/ more/eq</td></tr>
<tr><td>Shelf life</td><td></td><td></td></tr>
</table>
</td><td>ACCEPT {quicker/faster/less time} than RBC.</td><td>(4)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	1. Risk of death from heart attack/eq 2. Risk of renal failure/eq 3. Cost/eq 4. Use in bloodless medicine/eq 5. Immune response/cross-matching/side effects/eq 6. Storage (temperature)/eq	 5. ACCEPT reference to antigens. 6. ACCEPT refrigeration.	**(2)**

Question Number	Answer	Mark
2(b)(i)	1. Line graph 2. X-axis pp oxygen, y-axis oxygen concentration 3. Identified (line/bar) for plasma lower than perflubron and increasing to the right	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	1. Paragraph {8/9} 2. Idea that perflubron is better than plasma for carrying oxygen 3. Highest is 4x, lowest is 2.6x 4. So supports '2-3 times as much' 5. Does not support 20 x in paragraph 8 6. Manipulation of data (e.g. division of oxygen concentration in perflubron by oxygen concentration in plasma)	2. IGNORE word for word quotes from the passage 3. When mp3 awarded also gets Mp6 4. This mp more likely to be awarded if paragraph 9 chosen Mp2, 4 and 5 the examiner needs an idea that data supports or does not support what the passage says.	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(c)	1. Paragraph 1 2. Issue – talks about seeking less costly/more reliable sources/ORA 3. Additional information – idea that cost likely to rise because of donation supply shortfalls OR 4. Paragraph 7 5. Issue – idea that Hb is needed in huge amounts 6. Additional information - how much does it cost {to get this Hb/make the HBOCs}	Mp 3 and 6 could be awarded in the issue section. 3. ACCEPT any specific transfusion cost	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(d)(i)	1. All elements, including all authors for reference 1 present 2. Correct order, e.g. author, year in brackets, title, journal, volume, issue in brackets, page number	1. ACCEPT in any order and all authors without initials NOT if words: in the journal, issue, pages, volume or by included 2. IGNORE words listed above ALLOW single initial for author and using first names as family name 2 marks for: {Zou S, Musavi F, Notari E P. and Fang C T/Zou S et al} (2007) *Changing age distribution of the blood donor population in the United States. Transfusion* 48(2), 251-257.	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(d)(ii)	Reference 2 1. Missing items – pages, issue number, volume OR Reference 3 2. Missing items – article title, issue number OR Reference 4 3. Missing items – article title, volume, (end) page number	A mark for each of two missing items in context of reference chosen. Apply list rule to deal with the inclusion of items that are present.	**(2)**

Total for Question 2 = 20 Marks

Total for Paper = 40 Marks

Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number	Candidate Number

Biology

Advanced

Unit 4: The Natural Environment and Species Survival

Sample Assessment Material
Time: 1 hour 30 minutes

Paper Reference
WBI04/01

You do not need any other materials.

Total Marks

Instructions

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

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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*

Advice

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

Turn over ▶

S45357A

S 4 5 3 5 7 A 0 1 2 0

PEARSON

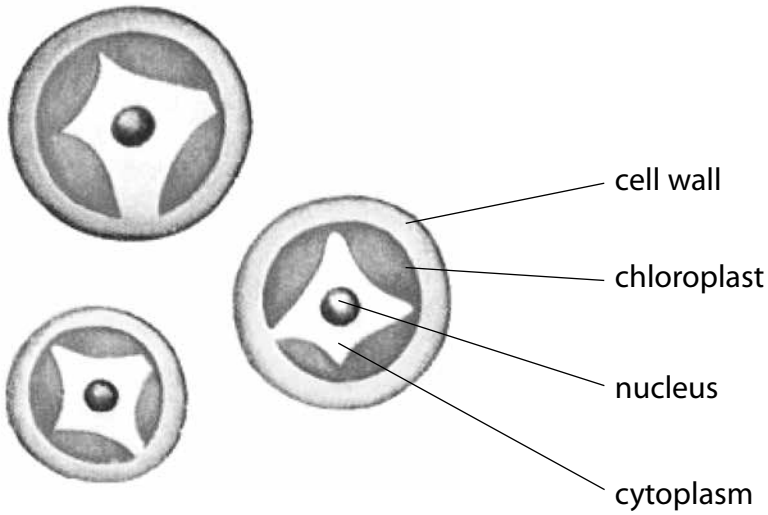
BLANK PAGE

Answer ALL questions.

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 *Pleurococcus* is a unicellular organism that can be found on the bark of trees. Where *Pleurococcus* is growing, it appears as green patches on the bark. Each of the patches is a colony of genetically-identical cells of *Pleurococcus,* formed from a single original cell.

The diagram below shows some of the individual cells of *Pleurococcus* as they might appear using a light microscope.



(a) Place a cross ☒ in the box next to the names of the two structures that show that *Pleurococcus* would be classified as a eukaryotic organism.

(1)

☐ **A** cell wall and chloroplast

☐ **B** cell wall and cytoplasm

☐ **C** chloroplast and nucleus

☐ **D** cytoplasm and nucleus

(b) Explain how a colony of genetically-identical *Pleurococcus* cells could develop from a single original cell.

(2)

(c) The distribution of *Pleurococcus* on 20 trees was investigated. The percentage cover of *Pleurococcus* was measured using a quadrat measuring 10 cm × 10 cm, divided into 100 small squares.

This quadrat was placed at eight points around the trunk of each tree. Each point on the tree faced a different direction. At each point, light intensity and moisture content were measured at mid-day.

The mean results are shown in the table below.

Point	Direction	Mean percentage cover (%)	Mean light intensity / arbitrary units	Mean moisture content / arbitrary units
1	North	89	6.6	8.8
2	North-east	86	6.4	8.6
3	East	84	6.9	8.7
4	South-east	67	7.3	7.5
5	South	46	8.7	5.2
6	South-west	51	8.4	5.1
7	West	60	8.1	7.0
8	North-west	78	7.6	8.2

(i) Suggest how this 10 cm × 10 cm quadrat was used to obtain the percentage cover of *Pleurococcus* at each point.

(2)

(ii) Place a cross ☒ in the box next to the best conclusion that can be drawn from these results, about the distribution of *Pleurococcus*.

(1)

☒ **A** it is affected by both light intensity and moisture content

☒ **B** it is affected by light intensity more than moisture content

☒ **C** it is affected by moisture content more than light intensity

☒ **D** it is not affected by either light intensity or moisture content

(iii) Suggest how more evidence for the relationship between light intensity and the distribution of *Pleurococcus* could be obtained.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(iv) Name **one** biotic factor and suggest how this factor might affect the distribution of *Pleurococcus* on the trees.

(2)

Biotic factor .....

Effect .....

.....

.....

(Total for Question 1 = 11 marks)

2 The photograph below shows part of a leaf, as seen using a hand lens.

Magnification ×20

(a) Suggest why each of the following is important for the production of carbohydrates in the photosynthetic cells.

(i) The thin lamina

(2)

(ii) Vessels in the midrib

(2)

(b) The photosynthetic cells contain many chloroplasts.

(i) Complete the table below by naming the part of the chloroplast where each of the reactions, **R**, **S** and **T**, takes place.

(3)

Reaction	Details	Part of the chloroplast
R	ADP + inorganic phosphate → ATP	
S	RuBP + CO_2 → 2 × GP	
T	2 × GP → 2 × GALP	

(ii) Place a cross ☒ in the box next to the name of reaction **R**.

(1)

☒ **A** carbon fixation

☒ **B** hydrolysis

☒ **C** phosphorylation

☒ **D** photolysis

(iii) Place a cross ☒ in the box next to the name of the enzyme involved in reaction **S**.

(1)

☒ **A** endonuclease

☒ **B** phosphorylase

☒ **C** RUBISCO

☒ **D** transcriptase

(iv) Suggest how GALP, formed by reaction **T**, can be used to synthesise the cellulose in plant cell walls.

(4)

(Total for Question 2 = 13 marks)

3 The carbon cycle describes the movement of carbon within an ecosystem.

In this cycle, carbon neutral processes do not change the concentration of carbon dioxide in the atmosphere.

The table below shows the main sources and combustion products of some fuels.

Fuel	Main sources	Main combustion products
Biodiesel	Oils from crops such as soya beans, rape seeds, palm seeds	Carbon dioxide and water vapour
Ethanol	Fermented sugars from crops such as sugar cane, sugar beet	Carbon dioxide and water vapour
Hydrogen	Catalysis of methane from fossil deposits or biogas generation using waste biomass	Water vapour
Methane	Extracted from fossil deposits or biogas generation using waste biomass	Carbon dioxide and water vapour
Propane	Refining of crude oil from fossil deposits	Carbon dioxide and water vapour

(a) Place a cross ☒ in the box next to the names of the four fuels, shown in the table, that could be considered to be biofuels.

(1)

☒ **A** biodiesel, ethanol, hydrogen, methane

☒ **B** biodiesel, ethanol, hydrogen, propane

☒ **C** biodiesel, ethanol, methane, propane

☒ **D** biodiesel, hydrogen, methane, propane

*(b) Large areas of land may need to be cleared in order to produce biofuels. This might involve deforestation.

Discuss why the production of biofuels may not be carbon neutral.

(5)

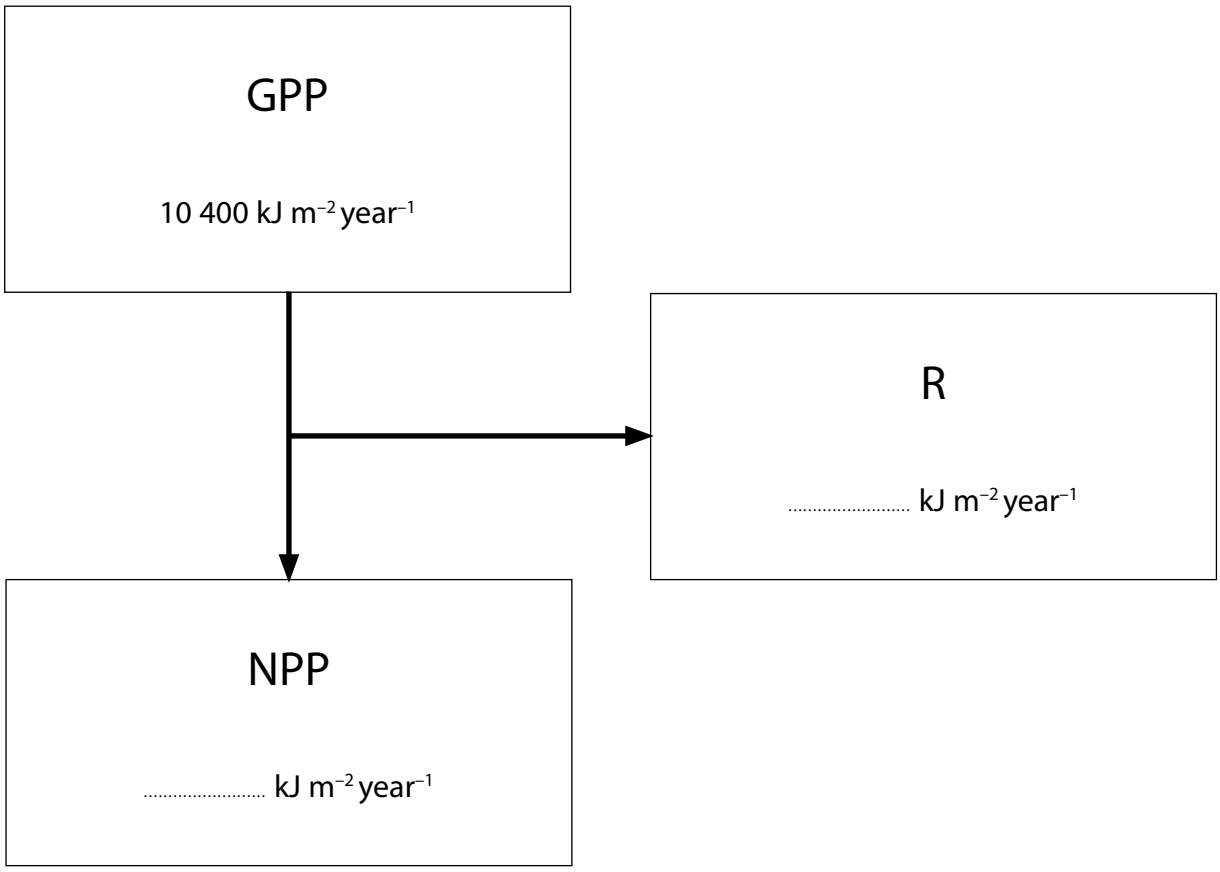
(c) Explain how the combustion products, from the burning of fuels, may lead to global warming.

(4)

(Total for Question 3 = 10 marks)

4 Farmers find it helpful to know the productivity of their land.

The diagram below shows the relationship between GPP (gross primary productivity), NPP (net primary productivity) and R (plant respiration) for an area of grassland.



(a) The efficiency of the transfer of energy from GPP to NPP for this grassland is 45%.

(i) Calculate the values for NPP and R. Write your answers in the diagram above.

(2)

(ii) Using the information given, explain the relationship between GPP and NPP.

(3)

(b) Suggest why NPP values would be of use to a farmer who wanted to use this land for cattle.

(3)

(c) The units (kJ m^{-2} $year^{-1}$) used in the diagram show a rate of energy production. Suggest why this is more useful than measurements of biomass in the grassland on a particular day.

(2)

(Total for Question 4 = 10 marks)

5 The diagram below shows the base sequence on a short section of DNA consisting of 12 mononucleotides. This base sequence contains the genetic code for a short section in the primary structure of a polypeptide.

Section of DNA	**A**	**A**	**T**	**A**	**A**	**C**	**C**	**A**	**G**	**T**	**T**	**T**
Amino acids	leucine			leucine			valine			lysine		

(a) Name each of the bases represented by the letters, **A**, **C**, **G** and **T** in the diagram.

(1)

A .....

C .....

G .....

T .....

(b) Using the sequence shown in the diagram, explain the meaning of each of the following terms.

(i) Triplet code

(2)

.....

.....

.....

.....

(ii) Non-overlapping

(2)

.....

.....

.....

.....

(iii) Degenerate

(2)

(c) Place a cross ☒ in the box next to the names of the two components, other than the bases, that form part of each mononucleotide in this sequence.

(1)

☒ **A** deoxyribose and nitrate

☒ **B** deoxyribose and phosphate

☒ **C** ribose and nitrate

☒ **D** ribose and phosphate

*(d) Transcription of this section of DNA forms a complementary strand of mRNA.

Describe how translation of this mRNA synthesises part of a polypeptide molecule.

(5)

(Total for Question 5 = 13 marks)

6 Human diseases can be caused by many different types of organism, such as bacteria and viruses.

(a) Give **two** differences between the genetic material of bacteria and viruses.

(2)

(b) Tuberculosis (TB) is caused when droplets, containing the bacterium *Mycobacterium tuberculosis,* are inhaled into the lungs.

In the lungs, large numbers of the bacterium are formed rapidly. These can be ingested by macrophages. Eventually, tubercles (tissue masses), containing dormant bacteria inside macrophages, may form.

(i) Describe how macrophages ingest the bacteria.

(2)

(ii) Suggest why treatment with antibiotics may not be effective against the dormant bacteria in the tubercles.

(2)

(iii) TB can be prevented by vaccination. Explain how a person can develop artificial active immunity following vaccination.

(3)

(c) In a person with TB, the dormant bacteria in tubercles may be activated after several years. The bacteria multiply rapidly, resulting in severe lung damage.

The bacteria are released from the tubercles. These bacteria can inhibit the activity of T cells and infect other organs.

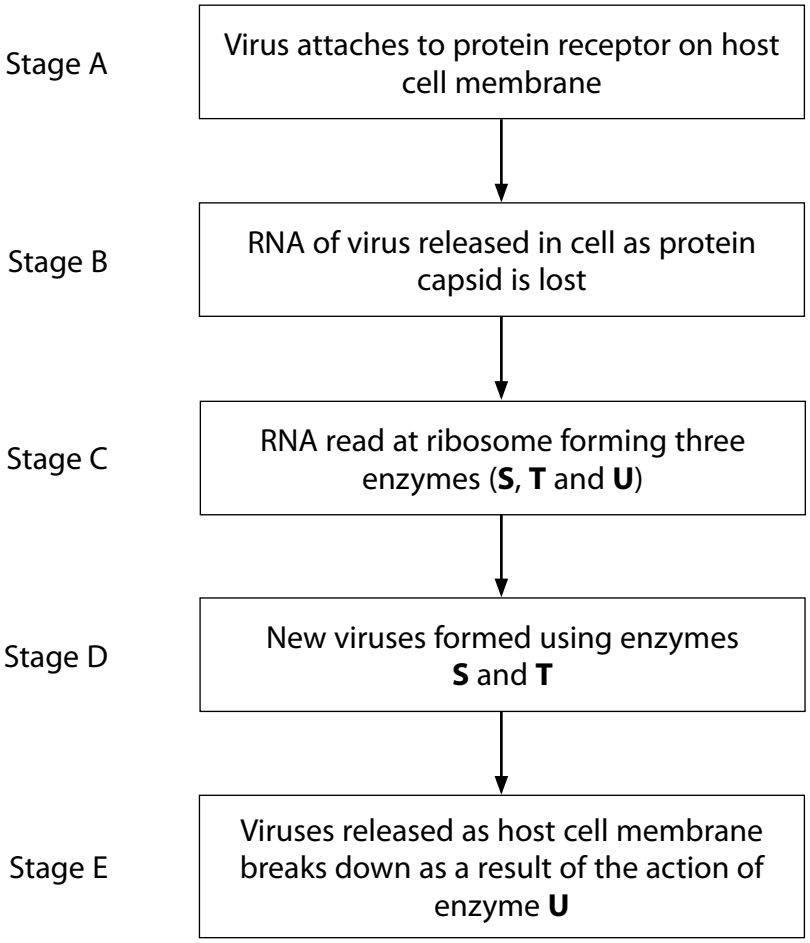
Explain why the activity of these bacteria and the inhibition of T cells means that a person may quickly develop severe symptoms leading to death.

(4)

(Total for Question 6 = 13 marks)

7 The common cold is a disease caused by a variety of viruses.

The flow diagram below describes how common cold viruses attack the cells on the inside of the nose.



(a) Common cold viruses infect only the cells inside the nose.

(i) Suggest why common cold viruses cannot infect cells if they land on unbroken skin.

(2)

(ii) Suggest why common cold viruses cannot infect cells if they enter the blood through a cut in the skin.

(2)

(b) Compare the action of the RNA in the common cold virus with that found in HIV.

(2)

(c) At Stage C, three enzymes are formed.

(i) Suggest why two of these enzymes, **S** and **T**, are needed at Stage D.

(2)

(ii) Suggest how enzyme **U** might catalyse the breakdown of the host cell membrane at Stage E.

(3)

(Total for Question 7 = 11 marks)

8 The group of birds, known as warblers, contains many species which are very similar in external appearance.

Two of these species, the chiffchaff, *Phylloscopus collybita*, and the willow warbler, *Phylloscopus trochilus*, are so similar that many experts can identify them only by listening to their individually-characteristic songs.
These songs are used during breeding to mark territory and attract mates.

The photographs below show these two warblers.

Chiffchaff

Willow warbler

Magnification × 0.75

(a) Although chiffchaffs and willow warblers are often found at the same time in the same woodlands, they do not interbreed.

(i) Suggest why successful interbreeding between chiffchaffs and willow warblers would make some scientists doubt their classification as separate species.

(3)

(ii) Suggest reasons why the two species do not interbreed.

(3)

(b) Records show that very little change in the appearance of chiffchaffs and willow warblers has occurred during the last two hundred years.

Suggest why the rate of change in the appearance of these two species is relatively slow.

(3)

(Total for Question 8 = 9 marks)

TOTAL FOR PAPER = 90 MARKS

Mark Scheme (SAM)

Pearson Edexcel International Advanced Level in Biology

Unit 4: The Natural Environment and Species Survival

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- 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 may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed-out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of Quality of Written Communication, are being assessed. The strands are as follows:
    i. ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
    ii. select and use a form and style of writing appropriate to purpose and to complex subject matter
    iii. organise information clearly and coherently, using specialist vocabulary when appropriate.

Using the Mark Scheme

Examiners should NOT give credit for incorrect or inadequate answers, but allow 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 still be creditworthy.

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.
Bold	Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq	(error carried forward)(transfer error)(consequential) 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. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions that involve the writing of continuous prose require candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where Quality of Written Communication is likely to be particularly important are indicated (Quality of Written Communication) in the mark scheme, but this does not preclude others.

Question Number	Answer	Mark
1(a)	C	(1)

Question Number	Answer	Additional Guidance	Mark
1(b)	1. Reference to mitosis 2. (Followed by) cytokinesis/{cells divide into 2 cells/eq} 3. Reference to repeated (many times)	NOT meiosis. IGNORE binary fission, asexual reproduction.	(2)

Question Number	Answer	Mark
1(c)(i)	1. Idea that each (small) square represents 1% 2. {Count/determine} number of squares containing *Pleurococcus* 3. Credit an indication of how the percentage was calculated	(2)

Question Number	Answer	Mark
1(c)(ii)	A	(1)

Question Number	Answer	Additional Guidance	Mark
1(c)(iii)	1. Idea of obtaining more data (outside) 2. Reference to processing the data, e.g. plotting a (scatter) graph, correlation test 3. Credit correct reference to interpretation of {test/graph 4. Reference to an extended study, e.g. laboratory experiments 5. Idea that the extended study would be repeated 6. Idea of looking at results of previous studies	Do NOT credit reference to collecting data at different times of day. ACCEPT Spearman's rank, Pearson's correlation. 2. For example, draw a line of best fit.	**(3)**

Question Number	Answer	Additional Guidance	Mark
1(c)(iv)	1. Suitable named factor 2. Description of the possible effect on {numbers/distribution}	IGNORE predators. snails/grazers /herbivores/primary consumers — less as being eaten disease on trees — less as smaller habitat disease in *Pleurococcus* — less as being destroyed competition (from other organisms) — less due to lack of resources,e.g. light, space	**(2)**

Total for Question 1 = 11 Marks

Question Number	Answer	Additional Guidance	Mark
2(a)(i)	1. Idea of {fast/maximum} {gas exchange/uptake of carbon dioxide/eq} 2. Idea of penetration of light 3. Idea that carbon dioxide is used in the {light-independent stage/Calvin cycle/formation of GP} OR Idea that light is used in {light-dependent stage/photolysis/photophosphorylation/eq}	ACCEPT CO_2 but IGNORE incorrect formula.	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	1. Transport (in xylem) of water (to the leaves)/eq 2. Transport (in phloem) of {sucrose/sugar/carbohydrates} (away from the leaves)/eq 3. (Water) for {light-dependent reaction/photolysis /source of hydrogen (ions)} OR Idea of (transporting sugar) to make more room for more carbohydrate synthesis	ACCEPT H_2O but IGNORE incorrect formula. IGNORE mineral ions. NOT glucose or any other name sugars. ACCEPT reducing power, NADPH.	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(i)	<table><tr><th>Reaction</th><th>Structure</th></tr><tr><td>R</td><td>{thylakoid (membrane)/grana/ granum}</td></tr><tr><td>S</td><td>stroma</td></tr><tr><td>T</td><td>stroma</td></tr></table>	NOT thylakoid space. IGNORE electron transport chain. NOT stoma/stomata. NOT stoma/stomata.	(3)

Question Number	Answer	Mark
2(b)(ii)	C	(1)

Question Number	Answer	Mark
2(b)(iii)	C	(1)

Question Number	Answer	Additional Guidance	Mark
2(b)(iv)	1. Reference to conversion (of GALP) to glucose/eq 2. (Which is) β glucose 3. Reference to formation of glycosidic bonds 4. Between C_1 and C_4/these bonds are 1-4 (glycosidic bonds) 5. By condensation 6. Reference to {straight/unbranched} (chains of glucose) 7. Reference to cellulose as a {polysaccharide/polymer of glucose/eq}	N.B. this is a question about the **formation** of cellulose, not its structure. N.B. a reference to these bonds being formed must be made.	**(4)**

Total for Question 2 = 13 Marks

Question Number	Answer	Mark
3(a)	A	(1)

Question Number	Answer	Additional Guidance	Mark
*3(b) Quality of Written Communication	(Quality of Written Communication – the answer must be organised in a logical sequence.) 1. Idea that biofuel production may (overall) results in more carbon dioxide in the atmosphere OR Idea that carbon neutral means that the carbon dioxide produced equals the carbon dioxide used 2. Idea of forests as carbon {sinks/eq} 3. Idea that {clearing land/deforestation} results in (net) increase in carbon dioxide (in atmosphere) 4. (Fewer plants means) less carbon dioxide {removed/used/eq} by photosynthesis 5. {Burning/eq} trees produces carbon dioxide 6. Idea that (increased) decomposition produces carbon dioxide 7. Idea of using {(fossil) fuels/petrol/diesel} by {lorries/machinery/eq}produces carbon dioxide 8. {Burning/eq} of biofuels produces carbon dioxide	ACCEPT stores.	(5)

Question Number	Answer	Additional Guidance	Mark
3(c)	1. Reference to production of {greenhouse gases/named greenhouse gas} 2. Idea that these gases {build up/remain/form a layer} in (upper) atmosphere 3. Which {absorb/trap/eq} {heat energy/infra-red /IR/eq} 4. Reflected from earth's surface 5. Idea that increased levels of these gases increase the greenhouse effect 6. Idea that (mean) temperature of earth's {surface/atmosphere} is increasing	ACCEPT carbon dioxide, water vapour, sulphur dioxide, oxides of nitrogen. NOT methane. ACCEPT short wavelength light.	**(4)**

Total for Question 3 = 10 Marks

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	NPP = 4680 R = 5720	N.B. if there are no answers in the box, look for answers in the space below question. If both answers are wrong, ACCEPT R = 10168.9/10169.	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	1. NPP = GPP – R/eq 2. 55% (GPP energy) is lost/eq 3. Energy lost as heat/eq 4. To provide energy for {active transport/any other named energy-requiring process} 5. NPP is {(stored) energy/energy available for next trophic level/eq}	ACCEPT correct description in words. For example, movement (opening of flowers, turning of leaves), glycolysis. IGNORE idea that energy is used for respiration unqualified. ACCEPT biomass.	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(b)	1. Cattle {are primary consumers/herbivores/eat grass/eat plants/eq} 2. (Therefore) gain energy (available as NPP) 3. Idea of grazing capacity of the grassland 4. Idea of affect on yield of {meat/milk/eq} 5. Idea of changing to a more {efficient/NPP yielding} crop	ACCEPT idea that farmer is ensuring that there is enough NPP available for his cattle. ACCEPT growth rate.	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(c)	1. Idea of variation over short periods of time 2. Idea that whole year gives an {average/overall/eq} value 3. Idea that biomass includes {all/undigestible/inedible/eq} organic material 4. Idea that rate of productivity may influence how much grazing is possible	For example, more NPP on a sunny day, seasonal.	**(2)**

Total for Question 4 = 10 Marks

Question Number	Answer	Additional Guidance	Mark
5(a)	A = adenine C = cytosine G = guanine T = thymine	ACCEPT reasonable phonetic spellings. NOT: Adenosine Cysteine Glycine Thiamine, thyosine, tyrosine.	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	1. Idea that each amino acid is coded for by three {nucleotides/bases} 2. Credit quoted example/idea that 12 {nucleotides/bases} code for 4 amino acids	ACCEPT in context of RNA. AAT/AAC = leucine, CAG = valine, TTT = lysine.	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(b)(ii)	1. Idea that each {triplet is discrete/each base is used only once in a triplet/eq} 2. Idea that AAT + AAC + CAG + TTT gives 4 (distinct) {triplets/codes}	ACCEPT a specific example such as the first T can only be used in code for first leucine. ACCEPT a description of how the code could be read if overlapping.	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(b)(iii)	1. Idea that more than one code can be used for a {particular amino acid/stop code} 2. AAT and AAC code for leucine	ACCEPT more codes than are needed to code for all the amino acids (and stop code).	**(2)**

Question Number	Answer	Mark
5(c)	B	**(1)**

Question Number	Answer	Additional Guidance	Mark
***5(d) Quality of Written Communication**	(Quality of Written Communication – the answer must be organised in a logical sequence.) 1. Reference to mRNA with sequence UUA UUG GUC AAA 2. Idea that ribosome is involved 3. Idea that each tRNA molecules is attached to one (specific) amino acid 4. Credit example of tRNA anticodon with specific amino acid 5. Reference to anticodons on tRNA {bind/link to/line up against/eq} codons on mRNA 6. Credit a specific example (from this DNA) 7. Idea of hydrogen bonds between bases (of tRNA and mRNA) 8. Reference to formation of peptide {bonds/links} between (adjacent) amino acids	N.B. The Mps do not have to be given in this order necessarily. NOT tRNA carries amino acids. AAU/AAC = leucine, CAG = valine, UUU = lysine. IGNORE complementary. For example, UUA codon and AAU anticodon. ACCEPT between codon and anticodon.	**(5)**

Total for Question 5 = 13 Marks

Question Number	Answer	Additional Guidance	Mark
6(a)	1. Bacteria have DNA, viruses have DNA or RNA 2. Idea that bacteria have {circular/eq} genetic material, viruses have {linear/straight} 3. Bacterial DNA is double-stranded, viral {DNA/RNA} is single (or double) stranded/eq 4. Bacteria (may) have plasmids, viruses do not have plasmids/eq	N.B. piece answers together throughout. Do NOT ACCEPT in context of plasmid.	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(b)(i)	1. Reference to {phagocytosis/endocytosis/engulfing} 2. Credit details of phagocytosis 3. Reference to bacterium inside a {vacuole/vesicle/phagolysosome}	For example, formation of {pseudopodia/membrane extensions around bacteria}/cytoplasmic streaming/binding to bacteria NOT phagolysozyme.	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	1. Idea that bacteria need to be accessible to antibiotics 2. Idea of bacteria inside macrophages 3. Reference to waxy layer of (these) bacteria 4. Idea that (bacteriostatic) antibiotics affect dividing bacteria 5. Reference to antibiotic resistance (of these bacteria)	NOT bacteriocidal antibiotics.	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(b)(iii)	1. Idea of {dead/attenuated/eq} {organisms/pathogen/bacterium/eq} put into person 2. Reference to (stimulation of) {specific/primary} (immune) response 3. Credit details of T helper cell activation 4. Credit details of B cell activation 5. Credit details of T killer cell activation 6. Reference to production of memory cells	N.B. not simply crediting ref to vaccination as in stem of question. ACCEPT antigen. For example, macrophages as APCs. For example, involvement of cytokines, B cells as APCs. For example, involvement of cytokines, infected cells as APCs.	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(c)	1. Reference to {further lung damage/severe breathing problems/eq} 2. Idea that the *Mycobacterium* get into the {blood/lymph} 3. Idea that organ failure (leads to death) 4. Idea of {reduced/weakened} immune response (due to a loss of T cells) 5. Credit detail of role of T (helper) cells 6. Credit detail of effect of no T killer cells 7. Credit detail of effect of no B cells 8. Ref to {secondary/opportunistic/other} infections (causing death)	For example, cannot obtain enough oxygen. For example, production of cytokines. For example, infected cells will not be destroyed. For example, no antibody produced.	**(4)**

Total for Question 6 = 13 Marks

Question Number	Answer	Additional Guidance	Mark
7(a)(i)	1. {Skin/epidermis} is a barrier/eq 2. Reference to keratin 3. Reference to lack of receptors (for the virus)	ACCEPT prevents entry but NOT prevents infection. N.B. keratin in skin forms a barrier = 2 marks. ACCEPT skin has different receptors.	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	1. Idea that viruses only {infect/attach to/eq} {specific receptors/specific cells/host cells} 2. Idea that receptors not present on {blood cells/endothelial cells/eq} 3. Reference to {destruction/eq} of viruses by phagocytes	ACCEPT white blood cells, neutrophils, PMN. IGNORE macrophages. NOT lymphocytes, T cells, B cells, plasma cells.	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(b)	1. Reverse transcriptase (required) in HIV, no reverse transcriptase in cold virus 2. DNA formed (using RNA) in HIV, {no DNA formed/RNA used to make protein/translation} in cold virus 3. Reference to {provirus/latency/delay in virus formation/eq} in HIV infection, {no provirus/lytic cycle/(immediate) formation of virus particles/eq} in cold virus	N.B. answers can be pieced together but candidates still have to state both parts of mark point.	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(c)(i)	1. To synthesise (common cold) RNA/eq 2. For amino acids to bind to tRNA/eq 3. To synthesise (common cold) protein (capsid)/eq	 ACCEPT translation.	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(c)(ii)	1. Idea of enzyme affecting {molecules in membrane/proteins/(phospho)lipids/cholesterol} 2. Enzyme breaks {bonds/named bonds/eq} 3. Reference to {(by) hydrolysis/hydrolytic enzymes} 4. Credit detail of enzyme action 5. Reference to enzyme U as {protease/lipase/cholesterase}	 For example, lowers activation energy, binding of active site to substrate (cannot credit reference to catalyst, as in stem of question). IGNORE lysosyme.	**(3)**

Total for Question 7 = 11 Marks

Question Number	Answer	Additional Guidance	Mark
8(a)(i)	1. (Successful interbreeding) produces offspring 2. (Same species produce) fertile (offspring) 3. Credit reason why offspring of different species might be infertile	ACCEPT converse throughout. IGNORE viable. For example, genetic incompatibility, different number of chromosomes, poor quality gametes, low number of gametes.	**(3)**

Question Number	Answer	Mark
8(a)(ii)	1. Reference to reproductive isolation 2. Different breeding times 3. Do not recognise {courtship displays/songs/eq} 4. Physically incompatible, e.g. genitalia	(3)

Question Number	Answer	Additional Guidance	Mark
8(b)	1. Idea that the two species share the same habitat 2. Idea that the two species experience the same environmental conditions 3. (Therefore) the same selection pressures 4. Idea that they are both well-adapted (to their environment) 5. Idea that no mutations have happened that {improve/change} their {phenotypes/survival} 6. {No/few} changes in allele frequency/gene pool is stable 7. Idea that there has been very little change in environment (over the years)	ACCEPT similar. N.B. needs to be in the context of both species being subjected to the same selection pressures. ACCEPT similar.	(3)

Total for Question 8 = 9 Marks

Total for Paper = 90 Marks

Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number	Candidate Number

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Sample Assessment Material
Time: 1 hour 45 minutes

Paper Reference
WBI05/01

You must have:
A copy of the scientific article adapted from several sources (enclosed)

Total Marks

Instructions

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

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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

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

Turn over ▶

S45358A

S 4 5 3 5 8 A 0 1 2 4

PEARSON

Answer ALL questions.

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 Rod cells in the eye are linked to the brain by neurones.

(a) Place a cross in the box ☒ to identify the answer that correctly completes each statement.

(i) The pigment in a rod cell is made of opsin and

(1)

☒ **A** retina

☒ **B** retinal

☒ **C** retine

☒ **D** retinol

(ii) When light stimulates a rod cell the pigment changes. This pigment is

(1)

☒ **A** iodopsin

☒ **B** phytochrome far red

☒ **C** phytochrome red

☒ **D** rhodopsin

(iii) Once the pigment has changed, the concentration of sodium ions inside the rod cell

(1)

☒ **A** decreases

☒ **B** does not change

☒ **C** increases

☒ **D** reaches equilibrium with the outside of the cell

(iv) After changing, the pigment takes time to become functional again. This is because

(1)

☒ **A** it has to bleach

☒ **B** the membrane has to be polarised

☒ **C** the rod cell needs to reset

☒ **D** two components have to be rejoined

(v) The cell that links a rod cell to a sensory neurone is

(1)

- ☒ **A** a bipolar neurone
- ☒ **B** a multipolar neurone
- ☒ **C** a unipolar neurone
- ☒ **D** an optic nerve

(b) Decreasing the intensity of light entering the eye causes pupil dilation.
Describe the roles of the circular and radial muscles in pupil dilation.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 1 = 7 marks)

2 There are various ways of investigating brain structure and function.

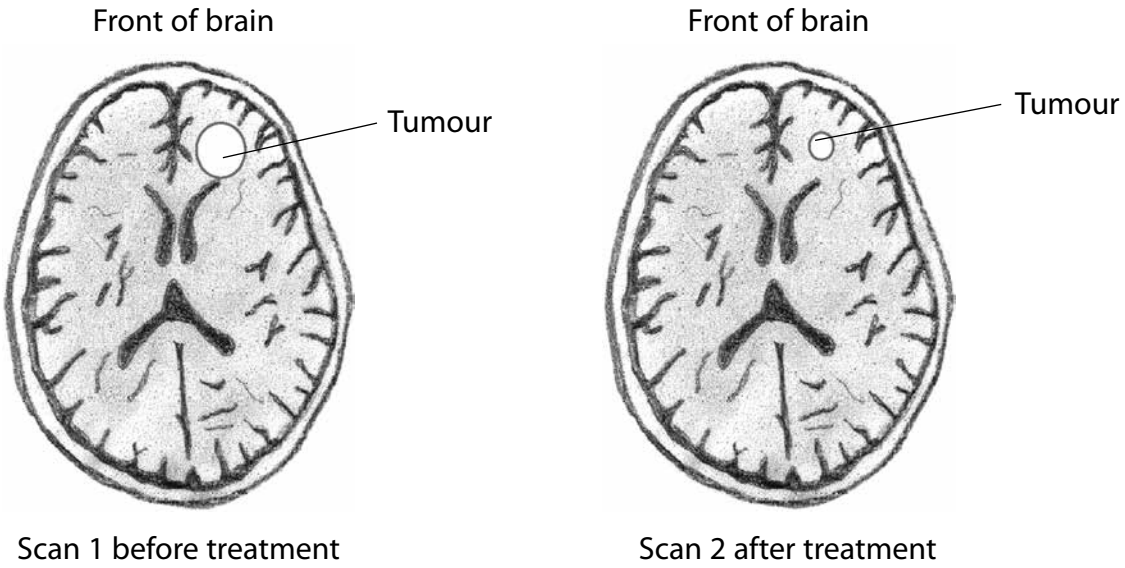
(a) Compare the use of computed tomography (CT) with magnetic resonance imaging (MRI) for studying brain structure.

(3)

(b) Suggest why functional magnetic resonance imaging (fMRI) is considered better than CT for studying brain function.

(2)

(c) The diagrams below show two MRI scans of the brain of a patient with a tumour. Scan 1 was taken before treatment was carried out, and scan 2 after treatment.



Scan 1 before treatment

Scan 2 after treatment

(i) Suggest why the tumour appeared white in the scans.

(2)

.....

.....

.....

.....

(ii) Using the information in the diagrams, describe the effect of the treatment on this tumour.

(2)

.....

.....

.....

.....

.....

.....

(iii) Using the information in the diagrams, suggest **two** brain functions that may have improved after treatment. Give a reason for your answer.

(3)

.....

.....

.....

.....

.....

.....

.....

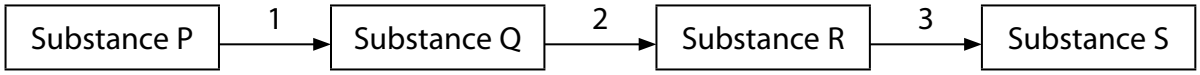
.....

(Total for Question 2 = 12 marks)

3 Respiration is a metabolic process which consists of many steps.

(a) The diagram below shows a metabolic process consisting of three steps.

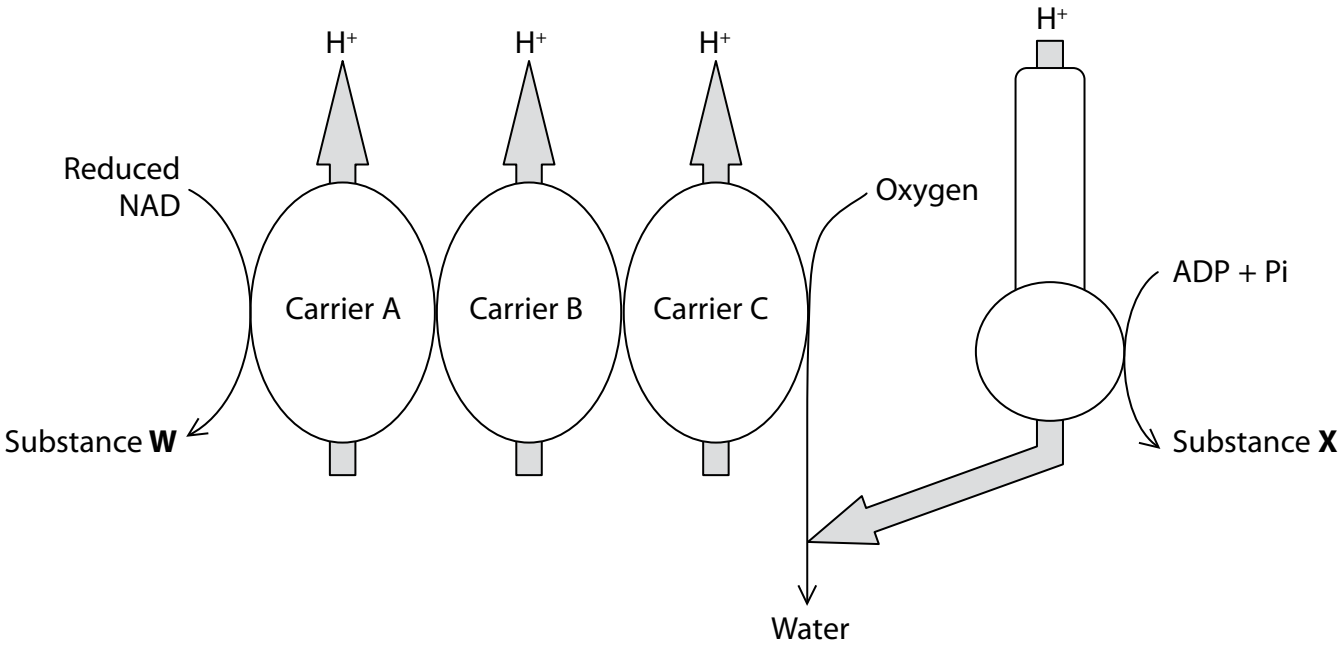
Each letter represents a different substance and each number a different enzyme.



Describe and explain the functions of enzymes in this metabolic process.

(4)

(b) The diagram below shows the electron transport chain, which is part of aerobic respiration.



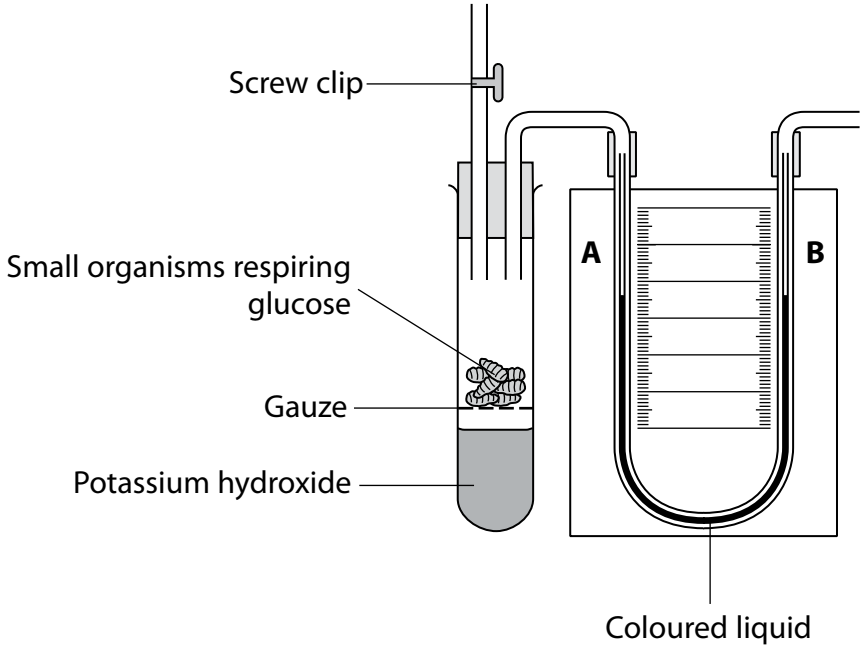
(i) Using the information in the diagram, name substance **W** and explain how it is formed.

(3)

(ii) Name substance **X**.
Explain the link between the formation of substance **X** and the H^+ shown on the diagram.

(3)

(c) The diagram below shows a respirometer used to measure the rate of aerobic respiration in small organisms.



Potassium hydroxide absorbs carbon dioxide.
The table below describes three different situations.
Place a cross in the box ☒ that correctly shows the movement of the coloured liquid in the U-shaped tube for each situation.

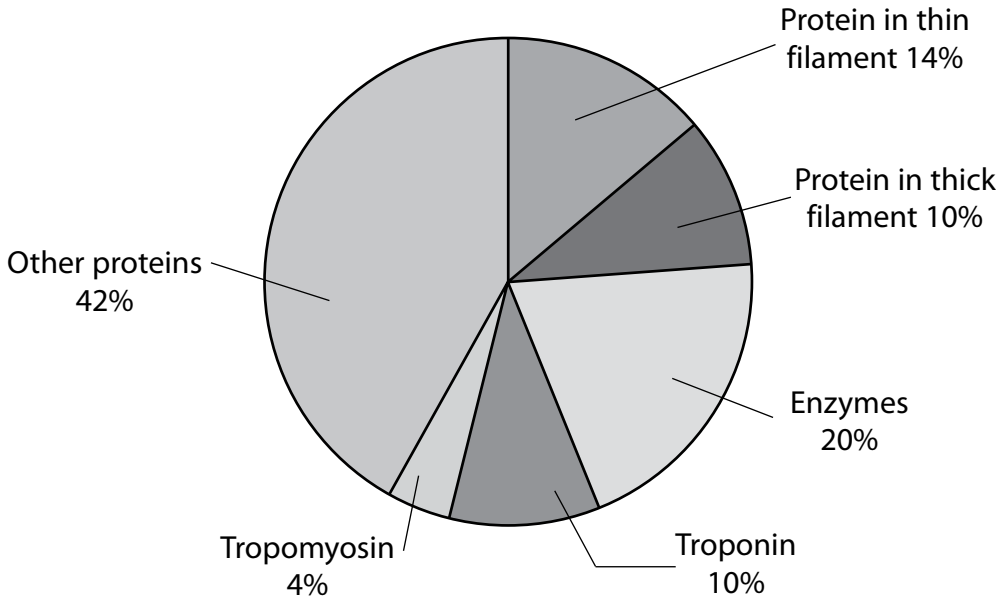
(3)

Situation	Movement of coloured liquid		
	towards A	**towards B**	**does not move**
Screw clip is open	☒	☒	☒
Screw clip is closed	☒	☒	☒
Potassium hydroxide is replaced with water and screw clip is closed	☒	☒	☒

(Total for Question 3 = 13 marks)

4 Skeletal muscle and cardiac muscle have some of the same proteins.

(a) Some of these proteins found in cardiac muscle are shown in the chart below.



(i) Using the chart, name the protein that makes up each of the two types of filament.

(2)

Protein in thin filament .....

Protein in thick filament .....

(ii) Describe the interaction between troponin and tropomyosin when a skeletal muscle fibre contracts.

(2)

.....

.....

.....

.....

.....

(iii) In the chart, some of the other proteins are neurotransmitter receptors. These are found on the cell surface membrane of cardiac muscle cells in the sinoatrial node (SAN).

Suggest **one** neurotransmitter substance that might bind to these receptors.

(1)

.....

(b) Troponin T is found in cardiac muscle cells. It can leak into the blood if the heart is damaged as a result of cardiovascular disease.

Testing for troponin T in blood can be used to study patients with damaged hearts.

The table below shows the concentration of troponin T in the blood of patients. The table also shows the mean number of days in hospital and the range of stay.

Concentration of troponin T in the blood / arbitrary units	Mean number of days of stay in hospital and the range
6.0 +	9 ± 2.0
4.0 – 5.9	6 ± 1.0
1.0 – 3.9	3 ± 0.5

Using the information in the table suggest what prediction a doctor could make and comment on the reliability of this prediction for patients with damaged hearts.

(3)

.....

.....

.....

.....

.....

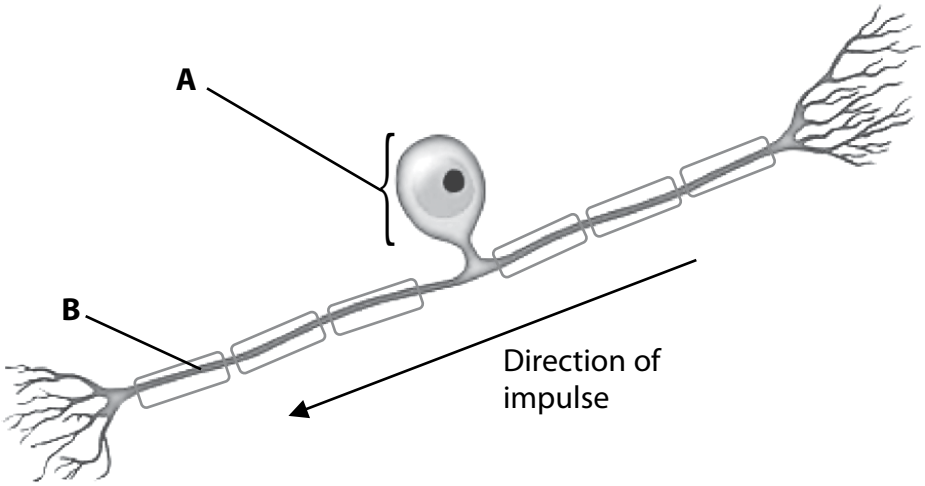
.....

.....

.....

(Total for Question 4 = 8 marks)

5 The diagram below shows a sensory neurone.



(a) Name the structures labelled **A** and **B**.

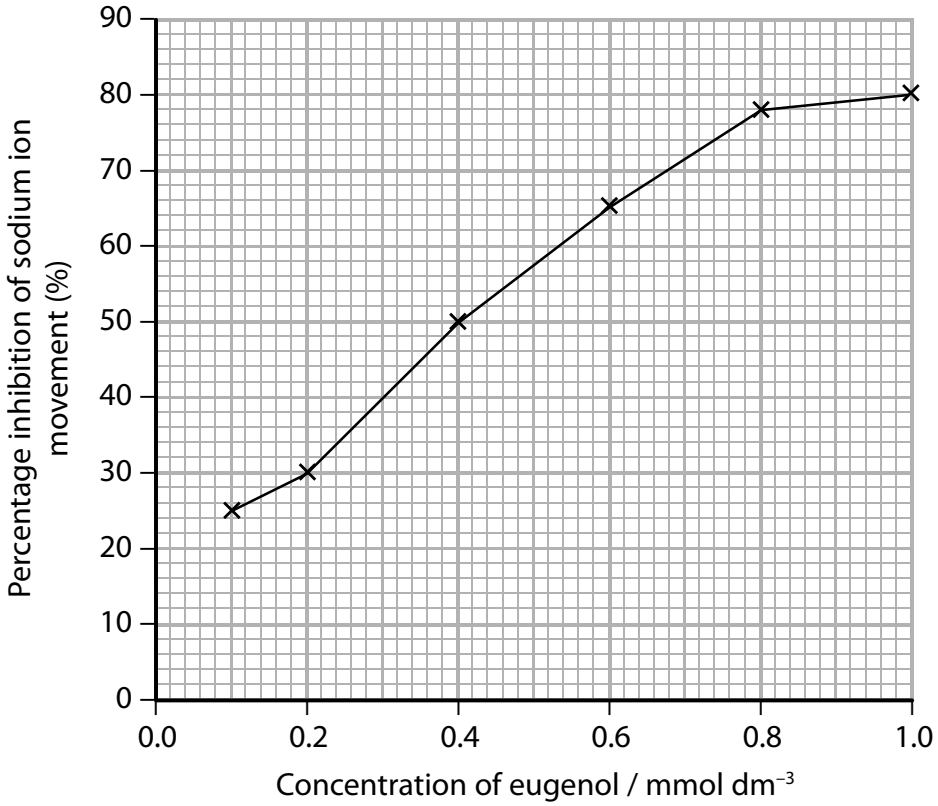
(2)

A .....

B .....

(b) Eugenol is a drug that inhibits the movement of sodium ions and calcium ions through the cell surface membranes of sensory neurones.

The graph below shows the effect of eugenol concentration on the percentage inhibition of sodium ion movement.



(i) Describe the relationship between the concentration of eugenol and the percentage inhibition of sodium ion movement.

(2)

*(ii) Eugenol can be used to reduce pain.

Suggest an explanation for how eugenol affects the movement of calcium ions and reduces pain.

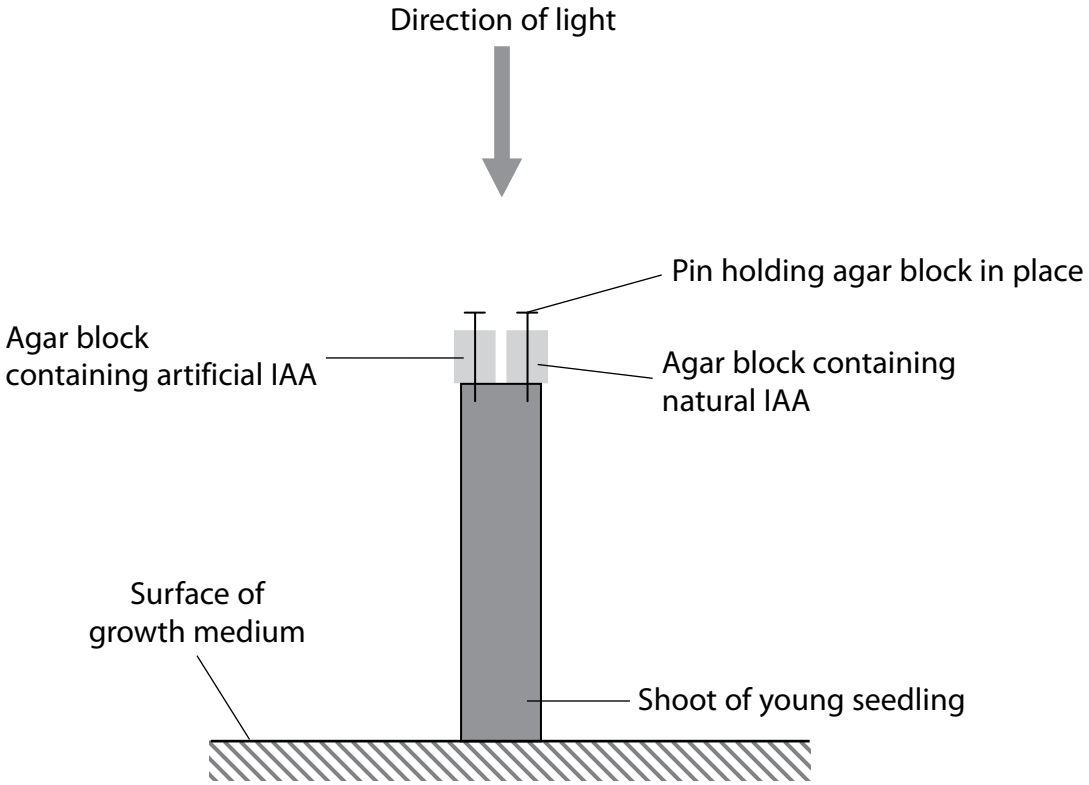
(6)

(Total for Question 5 = 10 marks)

6 IAA (auxin) is a plant growth substance.

(a) A student investigated the effect of natural IAA and artificial IAA on shoot growth.

The diagram below shows how she set up her investigation.



(i) The student also set up a control.

Describe a suitable control for this investigation.

(1)

.....

.....

.....

(ii) After 48 hours, the student recorded her observations of the growth of the shoots.
From her observations, she concluded that both natural and artificial IAA affected growth. She also concluded that the artificial IAA had a greater effect than the natural IAA.

Suggest what she recorded and explain how the IAA in the agar affected the growth of the shoot.

(5)

(b) IAA is known to bind to transcription factors.

Suggest how IAA can stimulate cells to synthesise proteins.

(4)

(Total for Question 6 = 10 marks)

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

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

(a) The sweet potato eaten by naked mole rats (paragraph 3) is very rich in cellulose and starch.

Give **two** structural differences between cellulose and starch.

(2)

(b) Naked mole rats show evidence of poikilothermy (paragraph 5) whilst other mammals, such as humans, maintain a nearly constant body temperature.

(i) Describe the role of the human nervous system in returning a slightly raised body temperature to its normal level.

(4)

(ii) Explain how shivering generates heat to return a slightly reduced body temperature to its normal level.

(2)

(c) Suggest how Buffenstein and Horsby introduced cancer-causing genes into cells from naked mole rats (paragraph 13).

(3)

*(d) If we had to breathe the 'rank air' found in the tunnels of naked mole rats, it would leave us 'gasping for air' (paragraph 33).

Describe how the mechanism involved in the control of breathing rate in humans would respond to this 'rank air'.

(5)

(e) Suggest how a study of the naked mole rat could help in the design of prosthetic limbs (paragraph 47).

(2)

(f) Using the information in paragraph 48, name **one** hormone and state its target organ.

(1)

Hormone .....

Target organ .....

(g) Suggest **two** reasons why the structure of the sperm may make it non-motile (paragraph 48).

(2)

.....

.....

.....

.....

.....

.....

(h) The 'coefficient of band sharing' (paragraph 49) is a measure of the number of bands that different DNA samples have in common. The higher the coefficient the more bands the samples share. The maximum coefficient is 1.00.

Suggest why the coefficient of band sharing ranges from 0.93 to 0.99 within a colony of naked mole rats.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(i) Suggest the importance of dispersers in naked mole rat colonies (paragraphs 50, 51 & 52).

(2)

(j) Describe and explain **two** ways in which naked mole rats are adapted to their environment.

(4)

(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 90 MARKS

Pearson Edexcel International Advanced Level

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Sample Assessment Material
Scientific Article for use with Question 7

Paper Reference
WBI05/01

Do not return the Insert with the question paper.

Turn over ▶

S45358A

PEARSON

Scientific article for use with Question 7

Naked and ugly: The new face of lab rats

1. In a small room in the lab-animal wing of the University of Illinois at Chicago, biologist Thomas Park peers into a plastic box full of naked mole rats. "You guys are so cute," he says softly, in a voice usually reserved for babies or puppies.

2. Park is mistaken. Naked mole rats are not cute. They are bald, wrinkled and purply pink, with tiny near-blind eyes and huge yellow teeth. Ranging from the size of a large mouse to that of a small rat, these odd rodents are among the strangest looking mammals on the planet. But don't judge a naked mole rat by its unfortunate appearance. These bizarre creatures could help us tackle all sorts of human maladies, from cancer and stroke to pain relief and ageing.

3. A dozen species of mole rat exist, all native to sub-Saharan Africa. Naked mole rats stand out, though, not least because they appear completely bald. They are also extremely social, living underground in elaborate networks of tunnels and chambers in groups of up to 300. Here in the lab, Park mimics their burrow system by connecting several dozen plastic boxes with long tubes. The animals spend their days pushing bedding around the tubes and nibbling on bits of sweet potato.

4. "Naked mole rats are a really odd mammal species," Park tells me. "Their social structure is like that of insects." Akin to bees and ants, they live in a eusocial society in which a single breeding queen churns out all the offspring, with help from between one and three kings. The rest of the animals work for a living: soldiers defend the colony against predators and rivals, while housekeepers forage for root vegetables and tidy up the tunnels.

5. Many features of the skin of the naked mole-rat, such as the lack of an insulating layer and the loosely folded morphological arrangement contribute to poikilothermic responses to changing temperatures of this mammal. Further evidence for poikilothermy in the naked mole-rat is indicated by the presence of pigment containing cells in the dermis, rather than the epidermis, as commonly occurs in homeotherms. Lack of fur is compensated by a thicker epidermal layer and a marked reduction in sweat glands.

6. This unusual social arrangement is what first drew scientists to study the wrinkled rodents. "For many years, most of the studies were on their behaviour," says Rochelle Buffenstein, a physiologist at the University of Texas Health Science Center in San Antonio. In time, though, researchers couldn't help but notice another intriguing aspects of naked mole rat biology. "They are incredibly long-lived creatures," she says.

7. In general, lifespan tends to correlate with body size. Large animals, on average, live longer than small ones. However, while mice and rats are lucky to survive three years in captivity, similar-sized naked mole rats live three decades, making them the longest-lived rodents on Earth. That's not all. They also maintain excellent health well into their sunset years. Their bones remain strong, their bodies stay fit and they don't show signs of heart disease or mental decline. Breeding females continue to produce pups right up to the end and, to top it off, naked mole rats don't even get cancer.

8. Naturally, scientists are eager to understand the secrets of this small, bald Methuselah. Buffenstein, who has been studying naked mole rats for 30 years, is among those looking for molecular explanations for their astounding longevity. She began by investigating their response to oxidative stress, one of the leading theories of how the ageing process works.

9. According to this theory, oxygen-containing free radicals damage the molecules of the body, causing them to deteriorate over time until they stop functioning altogether. This oxidative damage, as it is known, is apparent as extra molecules that attach to DNA and proteins "like chewing gum stuck to the bottom of a shoe", Buffenstein says. If oxidative stress is truly an important mechanism of ageing, she predicted, naked mole rats should have lower rates of oxidative damage than more short-lived species.

10. To her surprise, Buffenstein found the opposite: more telltale oxidative damage in 6-month-olds than in mice of the same age. Remarkably, however, the damage had no obvious impact on their well-being.

Keeping in shape

11. Why is this? To find out, Buffenstein took a closer look at the 3D structure of proteins, which is critical to their functioning. Mouse proteins begin misfolding very quickly after suffering oxidative damage – a kind of anti-origami that causes them to stop working properly. But naked mole rat proteins can withstand significantly more damage before they lose their shape (*Proceedings of the National Academy of Sciences*, vol 106, p 3059). "We think [protein stability] is a very important component of their extraordinary longevity," she says. "If your proteins maintain their integrity, if they have the mechanisms to protect themselves, it doesn't matter what stress comes along."

12. Another factor that helps naked mole rats reach an advanced age is their remarkable ability to avoid cancer. Nearly all mice have cancerous cells lurking in their bodies by the time they die but cancer has never been seen in a naked mole rat. "Every time one of our animals die, we try to figure out what they die of," Buffenstein says. "We haven't seen a tumour, we haven't seen lesions, we haven't seen signs of lymphoma. We know they don't get age-related cancer."

13. To understand why, Buffenstein and her colleague Peter Hornsby introduced cancer-causing genes into cells from rats, mice, humans and naked mole rats. They then inserted the altered cells into immune-compromised mice. In two to four weeks, the mice injected with modified cells from rats, mice and humans developed highly invasive tumours. "In the case of naked mole rats, six months lapsed and there were still no tumours," Buffenstein says.

14. The abnormal cells were still alive but had stopped replicating. "We think mole rats have better surveillance mechanisms to assess what's going on in their DNA," she says. When things go awry, the deviant cells are essentially locked away, unable to replicate and cause tumours (*Aging Cell*, vol 9, p 626).

15. This is probably just one of several tricks that allow these animals to avoid cancer. Another possible mechanism being investigated centres on how cells multiply. When cultured in a Petri dish, cells from both mice and humans multiply until they form a single dense layer. At that point, they stop dividing, halted by a process called contact inhibition. In cancerous tissues, however, the abnormal cells continue to multiply, piling up and growing out of control.

16. "We think we've found the reason these mole rats don't get cancer, and it's a bit of a surprise," says Vera Gorbunova, associate professor of biology at the University of Rochester and lead investigator on the discovery.

17. Naked mole rats can live up to 30 years, which is exceptionally long for a small rodent. Despite large numbers of naked mole-rats under observation, there has never been a single recorded case of a mole rat contracting cancer, says Gorbunova. Adding to their mystery is the fact that mole rats appear to age very little until the very end of their lives.

18. Over the last three years, Gorbunova and Andrei Seluanov, research professor of biology at the University of Rochester, have worked an unusual angle on the quest to understand cancer: Investigating rodents from across the globe to get an idea of the similarities and differences of how varied but closely related species deal with cancer.

19. In 2006, Gorbunova discovered that telomerase – an enzyme that can lengthen the lives of cells, but can also increase the rate of cancer – is highly active in small rodents, but not in large ones.

20. Until Gorbunova and Seluanov's research, the prevailing wisdom had assumed that an animal that lived as long as we humans do needed to suppress telomerase activity to guard against cancer. Telomerase helps cells reproduce, and cancer is essentially runaway cellular reproduction, so an animal living for 70 years has a lot of chances for its cells to mutate into cancer, says Gorbunova. A mouse's life expectancy is shortened by other factors in nature, such as predation, so it was thought the mouse could afford the slim cancer risk to benefit from telomerase's ability to speed healing.

21. While the findings were a surprise, they revealed another question: What about small animals like the common grey squirrel that live for 24 years or more? With telomerase fully active over such a long period, why isn't cancer rampant in these creatures?

22. Gorbunova sought to answer that question, and in 2008 confirmed that small-bodied rodents with long lifespans had evolved a previously unknown anti-cancer mechanism that appears to be different from any anticancer mechanisms employed by humans or other large mammals.

23. At the time she was not able to identify just what the mechanism might be, saying: "We haven't come across this anticancer mechanism before because it doesn't exist in the two species most often used for cancer research: mice and humans. Mice are short-lived and humans are large-bodied. But this mechanism appears to exist only in small, long-lived animals."

24. Now, Gorbunova believes she has found the primary reason these small animals are staying cancer-free, and it appears to be a kind of overcrowding early-warning gene that the naked mole rat expresses in its cells.

25. When Gorbunova and her team began specifically investigating mole rat cells, they were surprised at how difficult it was to grow the cells in the lab for study. The cells simply refused to replicate once a certain number of them occupied a space. Other cells, such as human cells, also cease replication when their populations become too dense, but the mole rat cells were reaching their limit much earlier than other animals' cells.

26. "Since cancer is basically runaway cell replication, we realized that whatever was doing this was probably the same thing that prevented cancer from ever getting started in the mole rats," says Gorbunova.

27. Like many animals, including humans, the mole rats have a gene called *p27* that prevents cellular overcrowding, but the mole rats use another, earlier defense in gene *p16*. Cancer cells tend to find ways around *p27*, but mole rats have a double barrier that a cell must overcome before it can grow uncontrollably.

28. "We believe the additional layer of protection conferred by this two-tiered contact inhibition contributes to the remarkable tumor resistance of the naked mole rat," says Gorbunova in the *PNAS* paper.

29. Gorbunova and Seluanov are now planning to delve deeper into the mole rat's genetics to see if their cancer resistance might be applicable to humans.

30. This finding could be an important step towards new cancer therapies. Gorbunova and her colleagues are now trying to decipher the extracellular signals that prompt early contact inhibition. In theory, such a signal might be co-opted to stimulate the process in human cells, and prevent tumours from forming. "If this is some kind of extracellular molecule, then we could actually apply it to people as an injection or a drug," she says.

31. Exciting as that research may be, cancer and ageing are only the tip of the iceberg as far as the naked mole rat's peculiar biology is concerned. The rodent's neurobiology is also of interest, as Park is discovering. Setting out to better understand their sense of touch, he stumbled across something surprising: they lack a receptor that transmits messages about chemical pain. Inject lemon juice or the essence of chilli pepper, capsaicin, beneath the skin of a mouse's paw, and it will shake and lick it like crazy. "If you do that with naked mole rats, they don't do anything," Park says. "They couldn't care less." Naked mole rats do feel acute pain such as cuts and burns, he says, but they are impervious to chemical pain (*PLoS Biology*, vol 6, p e13).

32. This finding is particularly significant because the nerve fibres associated with chemical pain are also involved in post-traumatic pain in people – precisely the type of discomfort researchers would like to eliminate. "It's OK to have pain sensation to tell you to get your hand off the stove, or to stop exercising because your knee is in trouble," says Park. "But post-surgical pain, or joint pain after a knee injury, those types of pain we could do without. The naked mole rats are laying the groundwork for potentially finding new ways to treat the kinds of pain we don't want."

33. Though the applications are intriguing, Park's own interests are more basic: why would naked mole rats lack this type of pain? The answer, he suspected, stemmed from their unusual habitat. Although many animals live underground, few live in such close quarters and in such large numbers as naked mole rats. The air in their burrows is rank, with low oxygen levels and extremely high levels of carbon dioxide. While normal air is about 0.03 per cent CO_2, levels in naked mole rat burrows can easily reach 5 per cent or more – an intensity that would sting our eyes and noses and leave us gasping for air. The rodents, however, are unaffected. "They will stay away from 10 per cent CO_2, but they're perfectly happy to wallow around in 5 per cent," Park says. "It turns out that high levels of CO_2 affect the types of nerves that the naked mole rats have disconnected," he says. "I think that's the evolutionary driving force to disconnect these pain nerves."

34. This isn't the only effect the naked mole rat's burrows have on their physiology. The low oxygen levels are just as important. Fresh air contains about 21 per cent oxygen, whereas levels in the burrows can be as low as 12 per cent in captive colonies, and are probably much lower in the wild. Park has found that naked mole rat brains are incredibly resistant to oxygen deprivation, with their brain tissue able to bounce back after 30 minutes without the gas (*NeuroReport*, vol 20, p 1634).

35. Two University of Illinois at Chicago researchers report that adult naked mole rat brain tissue can withstand extreme hypoxia, or oxygen deprivation, for periods exceeding a half-hour – much longer than brain tissue from other mammals.

36. The findings may yield clues for better treatment of brain injuries associated with heart attack, stroke and accidents where the brain is starved of vital oxygen.

37. John Larson, associate professor of physiology in psychiatry, and Thomas Park, professor of biological sciences, studied African naked mole rats – small rodents that live about six feet underground in big colonies of up to 300 members. The living is tight and the breathing even worse, with the limited air supply low in oxygen.

38. But naked mole rats studied were found to show systemic hypoxia adaptations, such as in the lungs and blood, as well as neuron adaptations that allow brain cells to function at oxygen and carbon dioxide levels that other mammals cannot tolerate.

39. "In the most extreme cases, naked mole rat neurons maintain function more than six times longer than mouse neurons after the onset of oxygen deprivation," said Larson.

40. "We also find it very intriguing that naked mole rat neurons exhibit some electrophysiological properties that suggest that neurons in these animals retain immature characteristics."

41. All mammal fetuses live in a low-oxygen environment in the womb, and human infants continue to show brain resistance to oxygen deprivation for a brief time into early childhood. But naked mole rats, unlike other mammals, retain this ability into adulthood.

42. "We believe that the extreme resistance to oxygen deprivation is a result of evolutionary adaptations for surviving in a chronically low-oxygen environment," said Park.

43. "The trick now will be to learn how naked mole rats have been able to retain infant-like brain protection from low oxygen, so we can use this information to help people who experience temporary loss of oxygen to the brain in situations like heart attacks, stroke or drowning," he said.

44. Larson said study of the naked mole rat's brain may yield clues for learning the mechanisms that allow longer neuronal survival after such accidents or medical emergencies, which may suggest ways to avoid permanent human brain damage.

Sociable by nature

45. Medical benefits may even arise from continuing research into naked mole rat behaviour. Previous studies in voles and other mammals have shown that behaviours such as monogamy and maternal performance can be explained, in part, by genetic differences that influence the patterns of certain hormone receptors in the brain. To find out whether naked mole rats' sociability has a genetic factor, Chris Faulkes at Queen Mary, University of London and colleagues compared their brains with those of the solitary cape mole rat. They were looking for receptors that bind to the "cuddle chemical" oxytocin. The team found that the naked mole rat has far more of these receptors in several brain regions including the nucleus accumbens, an area known as the brain's pleasure centre, and assume this is under genetic control (*Journal of Comparative Neurology*, vol 518, p 1792). "It's a good example of a change in a gene giving a change in complex behaviour," says Faulkes. Changes in the oxytocin receptor in humans are associated with certain kinds of autism, he adds, so the finding could have direct implications for humans.

46. The possibilities don't end there. Naked mole rats do not experience menopause or osteoporosis, so perhaps they could help researchers develop osteoporosis treatments without the side effects of hormone replacement therapy. And, as they spend 24 hours a day in the dark, naked mole rats don't follow normal circadian rhythms. Studies of their sleep patterns could feasibly help treat disordered sleep in humans.

47. Even their incisors are fascinating. Instead of staying put in their mouths, they grow right through the skin of the lips, something of great interest to prosthetics designers. Traditional prosthetics put pressure on delicate soft tissue causing sores and cell death, so a team led by Gordon Blunn and Catherine Pendegrass at University College London are testing new prosthetics that are attached directly to the bone of an amputated limb. To avoid infection, however, there needs to be a permanent seal where the skin meets the metal implant. This is where naked mole rats come in. Understanding the interface between their teeth and skin may help in the development of new coatings or structures that can be applied to the prosthetics.

48. Our current hypothesis is that behavioural interactions between the queen and non-breeders are translated into a suppression of gonadotrophin-releasing hormone in the hypothalamus, which in turn suppresses the release of gonadotrophins from the anterior pituitary. This results in a suppression of ovulation in non-breeding females, while in non-breeding males testosterone concentrations and sperm numbers are lower, and in most males sperm are non-motile. Not only does the queen suppress reproductive function in the non-breeders, but she also apparently exerts some control over the breeding male(s), such that concentrations of testosterone in the latter are suppressed except around the time of ovulation in the queen. Despite these endocrine deficiencies in non-breeders that may persist for many years, the block to reproduction is reversible. Non-breeding males and females will rapidly become reproductively active if they are removed from the suppressing influences of their colony and housed singly or in male-female pairs, or if the queen in a colony dies.

49. Patterns of genetic structure in naked mole-rat populations were quantified within and among geographically distant populations using DNA fingerprinting. Individuals within colonies were genetically almost monomorphic, having coefficients of band sharing estimated from DNA fingerprints ranging from 0.93 to 0.99.

50. Prolonged inbreeding is usually associated with lowered fitness, and it has been shown that most highly inbred small mammals have inbreeding-avoidance mechanisms that promote some degree of outbreeding. Although rare, a dispersive morph exists within naked mole-rat colonies that may occasionally promote outbreeding. These dispersers are morphologically, physiologically and behaviourally distinct from other colony members. They are laden with fat, exhibit elevated levels of luteinizing hormone, have a strong urge to disperse, and only solicit matings with non-colony members.

51. Kin recognition and female mate choice using a series of choice tests in which the odour, social and mate preferences of females were determined. Discrimination by females appears to be dependent on their reproductive status.

52. Reproductively active females prefer to associate with unfamiliar males, whereas reproductively inactive females do not discriminate. Females do not discriminate between kin and non-kin suggesting that the criterion for recognition is familiarity, not detection of genetic similarity *per se*. In the wild, naked mole-rats occupy discrete burrow systems and dispersal and mixing with non-kin is thought to be comparatively rare. Thus, recognition by familiarity may function as a highly efficient kin recognition mechanism in the naked mole-rat. A preference by reproductively active females for unfamiliar males is interpreted as inbreeding avoidance. These findings suggest that, despite an evolutionary history of close inbreeding, naked mole-rats may not be exempt from the effects of inbreeding depression and will attempt to outbreed should the opportunity arise.

53. With so much to offer science, it is no surprise that naked mole rats are becoming more common in labs. Unlike mice, the naked mole rat hasn't yet had its genome sequenced yet. "With naked mole-rats, we have to start from scratch with many things," Gorbunova says. "It's not very convenient, but I think it's definitely worth it."

Acknowledgements

Adapted text taken from: 'Naked and ugly: The new face of lab rats', Kirsten Weir, New Scientist Magazine, 23 October 2010, Issue 2783 © Copyright Reed Business Information Ltd

Adapted text taken from: University of Rochester (October 26 2009), Scientists Discover Gene That 'Cancer-proofs' Naked Mole Rat's Cells, *ScienceDaily*, retrieved 11 November 2011, from http://www.sciencedaily.com/releases/2009/10/091026152812.htm

Adapted text taken from: 'A dispersive morph in the naked mole-rat', O'Riain, MJ, Jarvis, JUM and Faulkes, CG, *Nature* 380, 619–621 (18 April 1996); doi: 10.1038/380619a0, retrieved 11 November 2011 from: http://webspace.qmul.ac.uk/cgfaulkes/abstract7.html

Adapted text taken from: University of Illinois at Chicago (November 30 2009), 'Naked mole rats may hold clues to surviving stroke', *ScienceDaily*, retrieved 11 November 2011, from http://www.sciencedaily.com/releases/2009/11/091130141313.htm

Adapted text taken from: 'A Reproductive Dictatorship: The Life and Times of the African Naked Mole-Rat', http://webspace.qmul.ac.uk/cgfaulkes/CGFNMR.htm

Adapted text taken from: 'Micro- and macrogeographical genetic structure of colonies of naked mole-rats Heterocephalus glaber', Faulkes, CG, Abbott, DH, O'Brien, HP et al. (1997), *Mol Ecol* vol. 6, (7) 615–628, retrieved 11 November 2011, from http://www.ncbi.nlm.nih.gov/pubmed/9226945

Adapted text taken from: 'Kin discrimination and female mate choice in the naked mole-rat Heterocephalus glaber', Clarke, FM and Faulkes, CG (1999), *Proc Biol Sci* vol. 266, (1432) 1995–2002, 10.1098/rspb.1999.0877

Adapted text taken from: Skin morphology and its role in thermoregulation in mole-rats, Heterocephalus glaber and Cryptomys hottentotus, Daly TJ and Buffenstein R (1998) J Anat. 193(Pt 4): 495–502; doi: 10.1046/j.1469-7580.1998.19340495, retrieved 11 November 2011 from PMCID: PMC1467874

BLANK PAGE

Mark Scheme (SAM)

Pearson Edexcel International Advanced Level in Biology

Unit 5: Energy, Exercise and Coordination

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- 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 may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed-out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of Quality of Written Communication, are being assessed. The strands are as follows:
    i. ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
    ii. select and use a form and style of writing appropriate to purpose and to complex subject matter
    iii. organise information clearly and coherently, using specialist vocabulary when appropriate.

Using the Mark Scheme

Examiners should NOT give credit for incorrect or inadequate answers, but allow 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 still be creditworthy.

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.
Bold	Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq	(error carried forward)(transfer error)(consequential) 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. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions that involve the writing of continuous prose require candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where Quality of Written Communication is likely to be particularly important are indicated (Quality of Written Communication) in the mark scheme, but this does not preclude others.

Question Number	Answer	Mark
1(a)(i)	B	(1)

Question Number	Answer	Mark
1(a)(ii)	D	(1)

Question Number	Answer	Mark
1(a)(iii)	A	(1)

Question Number	Answer	Mark
1(a)(iv)	D	(1)

Question Number	Answer	Mark
1(a)(v)	A	(1)

Question Number	Answer	Additional guidance	Mark
1(b)	1. Ideas of (muscles) work antagonistically 2. Circular muscle relaxes 3. Radial muscle contracts	ACCEPT stretched. IGNORE for mp3 constrict.	(2)

Total for Question 1 = 7 Marks

Question Number	Answer	Additional guidance	Mark
2(a)	1. CT therefore can only identify {larger/main} structures/MRI can identify smaller structures/eq		**(3)**
	2. Reference to tissue identified/eq	ACCEPT both identify soft tissue, MRI better for soft tissue, CT for bone/tissues of different density, both for tumours. ACCEPT aligning hydrogen atoms for MRI.	
	3. MRI uses {radio waves/magnetic field}, CT uses X-rays/eq		
	4. Idea of both give {2D/3D} images	ACCEPT easier to get 3D from MRI.	
	5. Limitation of MRI or CT	ACCEPT MRI – noisy, need to keep still, not so good for people with metal implants, pacemakers. **CT** reference to safety aspects of X-rays.	
	6. Idea of images for both are at one point in time		
	7. Reference to comparative cost of use	ACCEPT MRI more expensive than CT.	

Question Number	Answer	Additional guidance	Mark
2(b)	1. View brain activity directly/eq 2. Idea of seeing brain activity over a period of time 3. Safer as does not use X rays 4. No need to use special dyes	ACCEPT MRI identifies active areas by greater blood flow, greater oxygen uptake, presence of more oxyhaemoglobin in these areas. ACCEPT see in real time, quotes figures such as fMRI takes up to 4 frames a second or moving image, CT is still image.	**(2)**

Question Number	Answer	Additional guidance	Mark
2(c)(i)	1. Idea that tumour tissue differs from brain tissue 2. Detail of effect on scan, e.g. {energy source/magnetic field/radio waves/eq} {absorbed/blocked/eq} 3. Reference to difference in blood supply	ACCEPT1 reference to relative densities, tumour growing/dividing/mutated cells. ACCEPT reference to oxygen presence.	**(2)**

Question Number	Answer	Additional guidance	Mark
2(c)(ii)	1. Idea that (treatment) has been partially successful 2. Tumour reduced/eq 3. Reduction qualified, e.g. in contact with less brain tissue or size reduction quoted	 ACCEPT affecting less brain tissue. Halved in size.	**(2)**

Question Number	Answer	Additional guidance	Mark
2(c)(iii)	1. and 2. Two appropriate functions given, e.g. think, learn, show emotions, memory, personality, reasoning, eq 3. Because tumour is situated in the frontal lobe/cerebral hemispheres/cerebrum	ACCEPT decision making, problem solving, planning, intelligence, controls voluntary behaviour, forming associations (combining information from rest of cortex), ability to carry out different movements IGNORE control/coordinates movement. ACCEPT frontal cortex.	**(3)**

Total for Question 2 = 12 Marks

Question Number	Answer	Additional guidance	Mark
3(a)	1. Idea an enzyme converts a named substrate into named product, e.g. enzyme 1 converts P to Q 2. Idea that this product becomes the substrate of next step 3. Idea of specificity 4. {Controls/eq} the conversion/eq 5. Speeds up the conversion/eq 6. By reducing activation energy/eq 7. Credit reference to control of whole process	ACCEPT answers in context of respiration. ACCEPT reference to an enzyme converting one named intermediate to the next, e.g. {named enzyme/enzyme} used to convert hexose to phosphorylated hexose or enzyme converts 6C compound to 5C compound (in Krebs cycle) ACCEPT respiration example given, e.g. pyruvate from glycolysis is substrate/intermediate for lactate formation. ACCEPT this product can be used by the next enzyme. ACCEPT description of specificity, e.g. active site of enzyme 1 only accepts substance P or in context of named respiratory intermediate. ACCEPT regulates, one enzyme may limit the rate of process. ACCEPT catalysis/enzyme acts as a catalyst. ACCEPT end product inhibition or description.	**(4)**

Question Number	Answer	Additional guidance	Mark
3(b)(i)	1. W = {NAD/NAD^+/NAD_{ox}/eq} Any two of the following: 2. (Due to) reduced NAD {releasing/eq} {electrons/eq} 3. Idea of electrons go to {carrier A/ETC/eq} 4. Idea of H^+ moved into inter-membranal space	 ACCEPT being oxidized. Releasing hydrogen (atoms), H^+/protons $^-$ ACCEPT 1st electron carrier/correctly named carrier, e.g. FAD, flavoprotein, ETC. ACCEPT released to matrix, pumped through the inner membrane.	**(3)**

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	1. Substance **X** is ATP Any two of the following: 2. Due to H^+ pass through {stalked particle/ATPase} 3. (H^+ passes) down an electrochemical gradient 4. (Sufficient) energy is {released/eq} 5. To join ADP and {Pi/eq} 6. Reference to chemiosmosis	 ACCEPT ATP synthase. ACCEPT 3 description of electrochemical gradient/reference to electromotive force NOT 4 produced. ACCEPT phosphorylation of ADP but not reference to phosphorus (P).	**(3)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>3(c)</td><td>
<table>
<tr><th rowspan="2">Situation</th><th colspan="3">Movement of coloured liquid</th></tr>
<tr><th>towards A</th><th>towards B</th><th>does not move</th></tr>
<tr><td>Screw clip is open</td><td></td><td></td><td>☒</td></tr>
<tr><td>Screw clip is closed</td><td>☒</td><td></td><td></td></tr>
<tr><td>Potassium hydroxide is replaced with water and screw clip is closed</td><td></td><td></td><td>☒</td></tr>
</table>
</td><td>(3)</td></tr>
</table>

Total for Question 3 = 13 Marks

Question Number	Answer	Mark
4(a)(i)	1. (protein in thin filament) - actin/G actin 2. (protein in thick filament) - myosin	**(2)**

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	1. {Ca^{2+}/calcium ions} bind to troponin 2. Troponin {changes shape/moves/eq} 3. This displaces tropomyosin (away from myosin)/eq	 ACCEPT pulls/shifts/moves tropomyosin.	**(2)**

Question Number	Answer	Additional guidance	Mark
4(a)(iii)	Acetylcholine/{noradrenaline/eq }	Accept ACh, noradrenalin, norepinephrine. IGNORE reference to adrenaline, epinephrine.	**(1)**

Question Number	Answer	Additional guidance	Mark
4(b)	1. The higher troponin T, the longer the stay/eq 2. Reliability of prediction decreases as troponin T concentration increases 3. Because {range/eq} increases 4. Least reliable for 6.0+ as range is largest 5. One range stated, e.g. for 6.0+ it is 7 to 11 days 6. Reference to range overlapping between 4.0-5.9 and 6.0+ 7. Idea that 6.0+ is too wide a category for concentration of troponin T 8. Idea that the higher the troponin T, the greater the damage to the heart	ACCEPT 1 converse. ACCEPT 2 converse, less reliable at high troponin T. ACCEPT 3 range of the length of stay, range of data. ACCEPT 4 converse for 1.0-3.9/4.0-5.9.	**(3)**

Total for Question 4 = 8 Marks

Question Number	Answer	Additional guidance	Mark
5(a)	**A** - cell body **B** - axon	Accept axoplasm.	**(2)**

Question Number	Answer	Additional guidance	Mark
5(b)(i)	1. Increasing Eugenol concentration increases percentage inhibition /positive correlation 2. Description of non-linear correlation 3. Credit correct manipulation of the data, e.g. between 0.1 and 1.0 mmol dm^3 percentage inhibition to increase by 55%	IGNORE any references to rate. ACCEPT for example greatest increase in inhibition is between eugenol concentration of 0.2 and 0.4 mmol dm^{-3}, least increase in inbitition/inhibition plateaus above 0.8 eugenol concentration.	**(2)**

Question Number	Answer	Additional guidance	Mark
***5(b)(ii) Quality of Written Communication**	(Quality of Written Communication – Spelling of technical terms must be correct and the answer must be organised in a logical sequence.) 1. {reduced/eq} Ca^{2+} enters {*presynaptic membrane*/into *sensory neurone*} 2. Due to Ca^{2+} channel not opening/decreased sensitivity of *membrane* to Ca^{2+} 3. Fewer *vesicles* {move towards/fuse} with *presynaptic membrane* 4. Less *neurotransmitter* {released into/less diffuses across} {*synaptic* gap/eq} 5. Less *neurotransmitter* binds to receptors on {*post-synaptic membrane*/adjacent neurone} 6. Idea of reduced depolarisation/less Na^{+} or cation channels open 7. Idea of {threshold intensity/*action potential/impulse*} less likely to occur 8. Idea of pain not being sensed as impulse {stopped before entering CNS/leaving the *sensory neurone*}	ACCEPT into *synaptic* knob/pre-synaptic neurone Allow reference to no calcium ions also calcium . ACCEPT (and for 4 and 5) none as alternative to less. ACCEPT named neurotransmitter example. ACCEPT no diffusion of neurotransmitter. ACCEPT so less neurotransmitter to allow receptors on post-synaptic membrane to be stimulated. ACCEPT not reached as alternative to less likely to be reached.	**(6)**

Total for Question 5 = 10 Marks

Question Number	Answer	Additional guidance	Mark
6(a) (i)	(Cut shoot) without IAA present/without agar blocks	ACCEPT agar block with no IAA, empty agar block, agar block with water. ACCEPT auxin(s) as alternative to IAA.	**(1)**

Question Number	Answer	Additional guidance	Mark
6(a) (ii)	1. (Both sides of) shoot taller/eq 2. Than the control/eq 3. Both IAA's diffuse {down/out of agar/to zone of elongation}/eq 4. Reference to cell elongation/eq 5. Details of cell elongation/eq 6. Shoot bends to the right/eq 7. (Due to) more growth on {left side of shoot/side with artificial IAA}/eq	ACCEPT auxin as alternative to IAA throughout. ACCEPT grow {taller/faster /higher/up/ towards the light}. ACCEPT away from the light/agar block. ACCEPT bends away from side with artificial IAA.	**(5)**

Question Number	Answer	Additional guidance	Mark
6(b)	1. Idea that IAA enters the cell 2. Reference to movement within cell/IAA in cytoplasm to nucleus 3. Effect when binds to transcription factor, e.g. forms a transcription initiation complex or countering an inhibitor 4. Reference to switching on gene 5. Activity at promoter region/eq 6. Allows formation of (m)RNA/eq 7. Idea of translation produces protein	ACCEPT auxin as alternative to IAA throughout. ACCEPT joins to promoter region or activates transcription factor. ACCEPT reference to RNA polymerase activity. ACCEPT RNA/preRNA for Mrna. IGNORE reference to tRNA.	**(4)**

Total for Question 6 = 10 Marks

Question Number	Answer	Additional guidance	Mark
7(a)	1. Alpha glucose in starch and beta glucose in cellulose 2. Only {starch/amylopectin} can be branched/cellulose only a linear molecule 3. Starch contains two types of molecule, cellulose only one 4. Alternate monomers rotated through 180^0 in cellulose only 5. Only {amylopectin/starch} can have 1–6 glycosidic bonds/cellulose has 1–4 glycosidic bonds only	ACCEPT symbols for alpha and beta. ACCEPT starch can be spiralled. ACCEPT 3 the two named molecules of starch – amylose and amylopectin. ACCEPT starch can have 1–6 and 1–4 glycosidic bonds but cellulose only 1–4. ACCEPT starch has alpha 1–4 glycosidic bonds and cellulose beta 1–4.	**(2)**

Question Number	Answer	Additional guidance	Mark
7(b)(i)	1. Thermoreceptors in hypothalamus/eq 2. Detect the increase in (core) blood temperature/eq 3. Reference to heat loss centre activated 4. Reference to autonomic nervous system 5. Reference to impulses down motor neurones 6. To {effectors/named effector}/eq 7. Detail of method of heat loss/eq	ACCEPT receptors in hypothalamus. ACCEPT sympathetic. ACCEPT effector neurone for motor neurone. ACCEPT vasodilation of blood vessels, sweat released, heat loss from blood through radiation. IGNORE – reference to hair erector muscles.	**(4)**

Question Number	Answer	Additional guidance	Mark
7(b) (ii)	1. (Shivering) is muscle contraction 2. Which uses {respiration/ATP/eq} 3. Which release heat (to warm body)/eq	IGNORE movement. ACCEPT oxidative phosphorylation, ATP being converted to ADP and Pi.	**(2)**

Question Number	Answer	Additional guidance	Mark
7(c)	1. (Cancer causing) gene identified/eq 2. Gene {cut/isolated/eq} from DNA/eq 3. Using a {restriction/eq} enzyme/eq 4. Gene in {vector/named vector} 5. Mechanism for getting {gene/vector} into host cells (of naked mole rats)/eq	ACCEPT screen for the gene. ACCEPT named examples – retrovirus, virus, liposome, plasmid, bacteria. ACCEPT reference to (micro)injection, microprojectiles, electroporation, gene gun, inhaler.	**(3)**

Question Number	Answer	Additional guidance	Mark
***7(d) Quality of Written Communication**	(Quality of Written Communication – Spelling of technical terms must be correct and the answer must be organised in a logical sequence.) 1. Idea that this air has higher CO_2 content 2. {CO_2 level in blood increases/pH of blood falls/eq} 3. Change detected by chemoreceptors in {carotid body/carotid artery/aortic body/aorta/medulla} 4. Reference to {ventilation centre/eq} (in medulla) 5. Sends more impulses along neurones/eq 6. To intercostal muscles/diaphragm/eq 7. Causing an increased {ventilation rate/rate of breathing/depth of breathing}/eq	Quality of Written Communication to emphasis logical sequence. ACCEPT high, higher. ACCEPT respiratory centre, inspiratory centre for ventilation centre. ACCEPT impulses sent more often. ACCEPT reference to phrenic nerve. IGNORE reference to faster.	**(5)**

Question Number	Answer	Additional guidance	Mark
7(e)	1. Naked mole rat's {incisors/eq} grow through {skin/lip} without {damage/eq} 2. Lead to new {coatings/permanent seal /eq} at {skin/bone/metal} interface 3. So soft tissue is {not damaged/eq}(by the prosthetic)/eq}	 ACCEPT chance of infection reduced.	**(2)**

Question Number	Answer	Additional guidance	Mark
7(f)	Gonadotrophin-releasing (hormone) and anterior pituitary/gonadotrophins and {ovaries/testes}	ACCEPT testosterone and testes. ACCEPT gonads for testes or ovaries.	**(1)**

Question Number	Answer	Additional guidance	Mark
7(g)	1. Idea of irregularity of flagellum 2. Idea of irregularity associated with mid-region	Context is structural. ACCEPT no or more than one flagellum. ACCEPT tail for flagellum. ACCEPT mitochondria non-functional, less effective, not enough mitochondria.	**(2)**

Question Number	Answer	Additional guidance	Mark
7(h)	1. Idea of high levels of inbreeding 2. Low level of genetic diversity/eq 3. Idea that there is some variation because more than one male is involved in 4. Unfamiliar males used as mates (by queen)/eq 5. Fusion of colonies/eq 6. Arrival of a dispersal phenotype (from a different colony) 7. Mutations/eq	ACCEPT accept idea in context of only one queen/female breeds. ACCEPT restricted gene pool, low genetic variation Ignore reference to biodiversity for Mp2.	**(3)**

Question Number	Answer	Additional guidance	Mark
7(i)	1. Reduces inbreeding (depression)/eq 2. Increases outbreeding/outbreeding qualified 3. (Leading to) increase in genetic diversity 4. Idea of colony size regulation 5. Idea of increase in fecundity 6. Idea of increased chance of survival	ACCEPT less genetic drift. ACCEPT disperser/new comer more likely to breed. ACCEPT increased genetic variation, increase in variety of alleles etc. ACCEPT appropriate reference to natural selection, due to environmental changes.	**(2)**

Question Number	Answer	Additional guidance	Mark
7(j)	Paired responses: 1. Reduced sensitivity to chemical pain/disconnection of 'pain nerves' 2. High CO_2 in air (of tunnels) 3. Haemoglobin has higher affinity for oxygen/brain can tolerate eq 4. Low O_2 levels (in tunnels)/eq 5. Increased number of oxytocin receptors in brain 6. Overcrowding/eq 7. Non-pigmented 8. Lack of UV light 9. Outbreeding mechanisms such as dispersal phenotype 10. Low genetic diversity 11. Hairless/naked/reduction of sweat gland/loose skin/no insulating layer/poikilothermic 12. Due to nature of its temperature environment/eq	ACCEPT lack or receptor for chemical pain. ACCEPT reference to brain's hypoxia response, neurones or brain resistance to hypoxia. ACCEPT hairless, naked. ACCEPT size of colony. ACCEPT ectothermic for poikilothermic, or a description.	

Question Number	Answer	Additional guidance	Mark
7(j) continued	13.teeth arrangement/eq: a) for digging underground b) keen sense of smell/reduce eyesight/reference to circadian rhythms dark conditions.	ACCEPT forward of lips or long.	**(4)**

Total for Question 7 = 30 Marks

Total for Paper = 90 Marks

Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number	Candidate Number

Biology

Advanced

Unit 6: Practical Biology and Investigative Skills

Sample Assessment Material
Time: 1 hour 30 minutes

Paper Reference
WBI06/01

You must have:
Ruler, Calculator, HB Pencil

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Write your answers in the spaces provided in this question paper – *there may be more space than you need.*

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.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- Any blank pages are indicated.

Advice

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

Turn over ▶

S45359A

S 4 5 3 5 9 A 0 1 1 6

PEARSON

Answer ALL questions.

1 John thought that there was a difference in breathing when lying down compared with when sitting on a chair.

He decided to test this, using traces from a spirometer.

(a) Describe how he could use data from spirometer traces to compare breathing when lying down and when sitting on a chair.

(4)

(b) (i) State **two** variables which need to be controlled to provide valid spirometer traces.

(2)

.....

.....

.....

.....

(ii) Choose **one** of the variables from (b)(i) above. Suggest how this variable can be controlled. Describe what effect this variable could have on the data from the spirometer traces if it is not controlled.

(2)

Variable .....

How to control the variable .....

.....

.....

.....

Effect on the data from the spirometer traces if this variable is not controlled.

.....

.....

.....

.....

(c) Suggest how breathing is controlled by the nervous system in response to changing position from lying down to sitting on a chair.

(4)

(Total for Question 1 = 12 marks)

BLANK PAGE

2 Earthworms are animals that improve the quality of soil needed for plant growth.

Farmers often plough the soil before planting crops in a field.

A farmer wanted to investigate the effect of ploughing on the presence of earthworms. He used different methods to plough two fields (field A and field B), next to each other. These fields were then left for one month.

The farmer then randomly placed quadrats (0.5 m × 0.5 m) in field A. In each quadrat he poured a weak detergent solution onto the soil. He then counted the number of earthworms that came to the surface in each quadrat.

He repeated this process in field B.

A copy of the farmer's raw results is shown below:

Field A: 10, 4, 13, 9, 9, 3, 8, 5, 4

Field B: 15, 6, 12, 0, 3, 8, 9, 10, 7, 4, 6

(a) Write a suitable null hypothesis for this investigation.

(2)

.....

.....

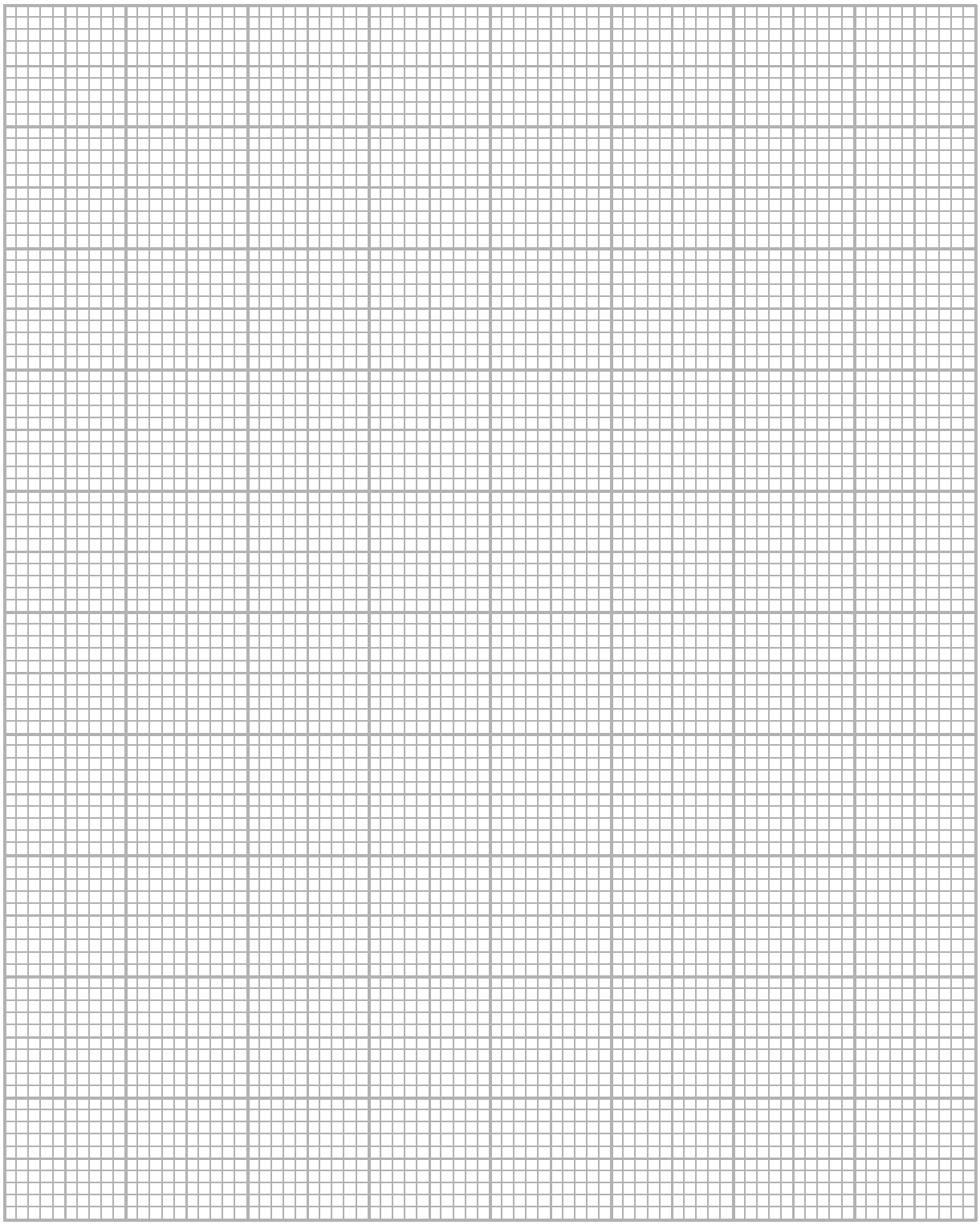
.....

(b) Prepare a suitable table to rank the data obtained. Identify the median number of earthworms from the quadrats in each field.

(4)

(c) On the graph paper below, draw a suitable graph to show the effect of different methods of ploughing on the median number of earthworms from the quadrats in each field. Include on your graph an indication of the variability in the data.

(3)



(d) The farmer decides to apply the Mann-Whitney U test to the data. This statistical test determines if the difference between the medians is significant.

The calculations produced two U values for this set of data. In order to support a difference between the two medians, the smaller U value must be the same as, or less than, the critical value.

He obtained a result of U = 50 from the calculation (the smaller value).

The table below shows the critical values for the Mann-Whitney U test at the $p = 0.05$ level.

	Sample size n_2					
Sample size n_1	**7**	**9**	**11**	**13**	**15**	**17**
7	8	12	16	20	24	28
9	12	17	23	28	34	39
11	16	23	30	37	44	51
13	20	28	37	45	54	63
15	24	34	44	54	64	75
17	28	39	51	63	75	87

What conclusions can be drawn from this investigation? Use the information provided in the table above and in the graph you have drawn.

(4)

(e) Suggest why it may not be reasonable to draw a valid conclusion from the results of this investigation.

(3)

(Total for Question 2 = 16 marks)

3 Plants can be grown in glasshouses, using hydroponics. Hydroponics is a method of growing plants that replaces soil with solutions containing mineral ions.

Plan an investigation to find the optimum concentration of magnesium ions in the mineral ion solution used to grow the plants.

Your answer should give details under the following headings.

(a) A consideration of whether there are any safety or ethical issues you would need to consider.

(2)

(b) Suggestions for preliminary work that you might undertake to ensure your proposed method would provide meaningful data.

(3)

(c) A detailed method, including an explanation of how important variables are to be controlled or monitored.

(10)

[Up to 2 marks are available in this section for the quality of written communication.]

(d) A clear explanation of how your data are to be recorded, presented and analysed in order to draw conclusions from your investigation.

(4)

(e) The limitations of your proposed method.

(3)

(Total for Question 3 = 22 marks)

TOTAL FOR PAPER = 50 MARKS

Mark Scheme (SAM)

Pearson Edexcel International Advanced Level in Biology

Unit 6: Practical Biology and Investigative Skills

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- 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 may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed-out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of Quality of Written Communication, are being assessed. The strands are as follows:
    i. ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
    ii. select and use a form and style of writing appropriate to purpose and to complex subject matter
    iii. organise information clearly and coherently, using specialist vocabulary when appropriate.

Using the Mark Scheme

Examiners should NOT give credit for incorrect or inadequate answers, but allow 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 still be creditworthy.

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.
Bold	Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq	(error carried forward)(transfer error)(consequential) 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. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Question Number	Answer	Additional Guidance	Mark
1(a)	1. and 2. Idea of clear dependent variables, e.g. tidal volume, minute ventilation, breathing rate, rate of oxygen absorption 3. Reference to suitable units for a chosen dependent variable 4. Idea of calibration of spirometer trace 5. Description of how trace used to obtain dependent variable 6. Idea of repeats	ACCEPT Mps from suitably annotated diagram, e.g. Mps 1, 2, 5. Mp1 and 2. NOT 'depth of breathing', 'tidal intake', vital capacity, IRV, ERV. Mp4 detail not required. Mp5 some detail required, e.g. count the number of peaks per minute. ACCEPT repeat in terms of measurement of an individual or using several subjects.	**(4)**

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	Any two from: 1. Same person 2. Same age 3. Same gender 4. Temperature 5. Time of day/eq 6. Diet before testing/eq 7. Speed of kymograph/eq 8. Any other credible alternative variable	Apply list principle – mark first two variables given. Do NOT accept mass volume of soda lime KOH (should be in excess), reference to oxygen source or oxygen concentration/level in spirometer. ACCEPT size/mass/BMI/physical activity of subject, time to acclimatise, humidity.	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	1. Appropriate variable chosen from 1(b)(i), with suitable control method described 2. Description of likely effect on the dependent variable provided	Marks can be awarded as long as the variable chosen was suggested in 1(b)(i) even if not credit worthy in 1(b)(i). Mp1 ACCEPT use a temperature-controlled room/room thermostat/air-conditioned room/eq. NOT carry out at room temperature. Similarly with 'time' they need to give some detail, e.g. record breathing for 5 minutes/use a stopwatch to ensure breathing was recorded for same length of time. When describing the likely effect, we expect to see a reasonable attempt to describe effect of change in control variable on dependent variable. Do NOT ACCEPT: general statements such as 'would give inaccurate results' Mp2 in context of this experiment increased environmental temperature will lead to a reduced breathing rate and tidal volume (converse for decreased temperature). 'At higher temperatures the breathing rate would decrease' gains Mp2.	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(c)	1. More {energy/respiration/oxygen/eq} needed/eq 2. Reference {autonomic/sympathetic (increases)/parasympathetic (decreases)/somatic} nervous system/phrenic nerve/eq 3. Reference {ventilation/respiratory/inspiratory/expiratory} centre 4. (In) medulla 5. Idea of chemoreceptors (carotid/aortic) 6. Reference changes in {carbon dioxide/pH/temperature} (in blood) detected 7. Reference (motor) cortex 8. Idea that nerve impulses go to muscles involved in breathing	ACCEPT converse if it is clear the student is referring to lying down. IGNORE nerve impulses/nervous system. NOT if incorrectly qualified. ACCEPT breathing control centre. Must be in context of controlling breathing. NOT if incorrectly qualified by location. ACCEPT chemoreceptors in arteries. IGNORE stretch receptors.	**(4)**

Total for Question 1 = 12 Marks

Question Number	Answer	Additional Guidance	Mark
2(a)	1. (There will be) no significant difference 2. In the number of worms {coming to the surface in each 0.5 m^2 {quadrat/found/eq} between each {ploughing technique/field/eq}/eq	Different number of worms in the fields OR because of different ploughing.	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)	1. (Median for) field A = 8 2. (Median for) field B = 7 3. Raw data ranked and in suitable table format of rows and columns 4. Accurate headings e.g.	ACCEPT suitable tables turned 90°. IGNORE omission of ruled lines within body of table and unranked data. NOT $0.5m^2$. NOT if no reference to quadrat/area.	**(4)**

	Number of worms in {quadrat/0.25m^2}	
	Field A	Field B
	13	15
	10	12
	9	10
	9	9
	8	8
	5	7
	4	6
	4	6
	3	4
		3
		0

Question Number	Answer	Additional Guidance	Mark
2(c)	**A** axes correct orientation and scale with suitable labels **P** data plotted as bar chart with bars plotted correctly **B** range bar included	A Expect to see 'median' in y-axis label. ACCEPT ecf for units but not no units. P ACCEPT means if in 2(b) means calculated or medians incorrectly calculated.	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(d)	1. The (smaller) value of {U/eq} is higher than the critical value 2. Reference to critical value of 23 3. Therefore there is no **significant difference** between the number of worms {coming to the surface in each quadrat/found in each field/eq} 4. Accept null hypothesis/eq 5. Reference to {wide variability of data/medians are very close together/eq}	ACCEPT clearly marked value in table. Credit 'do not reject' IGNORE overlapping error bars.	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(e)	1. Idea that other factors may not have been taken into consideration 2. Sample size small/sample only taken at one time period/eq 3. Reference to {wide variability of data/eq}	ACCEPT named factor. IGNORE difference in number of quadrats sampled. IGNORE overlapping error/range bars.	**(3)**

Total for Question 2 = 16 Marks

Question Number	Answer	Additional Guidance	Mark
3(a)	1. Suitable ethical argument, e.g. there is no significant ethical issue 2. There are no significant safety issues 3. Safety issue related to minerals, e.g. mineral allergies or irritants 4. Safety issue related to plants, e.g. plant allergies or irritants 5. Safety related to hydroponics, e.g. may provide good growing conditions for bacteria/fungi	IGNORE idea that removing plants from environment is an ethical concern. IGNORE {solutions/chemicals} may be corrosive.	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(b)	1. See if proposed method will work/eq 2. See if the plant chosen will grow in hydroponic unit/eq 3. Idea of selecting range of Mg concentrations 4. Find suitable method of measuring {growth/yield/colour of leaves /number of leaves/eq} 5. Check most suitable conditions (for growth of plants) /eq 6. Select suitable timescale for measuring growth/eq	Ignore 'practice proposed method'.	**(3)**

Question Number	Answer	Additional Guidance	Mark
3 (c)	1. Clear statement of dependent variable, i.e. exactly what is to be measured stated, e.g. mass of plant tissue, mass of fruit, length of shoot, {number/colour} of leaves/eq	Need to see term dependent variable.	**(8) + (2 SPG - see below)**
	2. Clear description of method of measuring change in dependent variable	Description of calculations not required.	
	3. Clear statement of independent variable = concentration of magnesium	Need to see term independent variable.	
	4. Range of suitable concentrations suggested (at least 5)	ACCEPT a statement that 5 different concentrations would be used. IGNORE answers of fewer than 3 days.	
	5. Some clear consideration of time period over which the growth will be measured/eq	ACCEPT volume of solutions for one of these marks.	
	6. and 7. Identification of up to 2 other variables that could affect growth		
	8. and 9. Description of how those 2 identified variables can be controlled	Must describe how variables are controlled. Ignore responses such as 'use a greenhouse'/'put them somewhere with the same light intensity'.	
	10. Idea of need for replica at each concentration		
	11. control of source of plant, e.g. use of same species/variety/source of seeds	Idea of controlling for genetic variability.	
	12. Use of graph to identify other values of concentration to test to identify optimum concentration/eq		

Spelling, Punctuation and Grammar (SPG) - Award up to 2 marks

Start with 2 marks and if criteria not met move to 1 and then 0

Level	Mark	Descriptor
Level 3	**2**	The account is well organised with no undue repetition and a correct sequence. There is good use of scientific vocabulary in the context of the investigation described. The account is written in continuous prose which is grammatically sound with no major spelling errors.
Level 2	**1**	There is some disorganisation in the account which is not always in the correct sequence. Some relevant scientific vocabulary is used. The account is not always in continuous prose and there are grammatical errors and some important spelling mistakes.
Level 1	**0**	The account is very disorganised and is very difficult to follow. Scientific vocabulary is very limited with many spelling and grammatical errors.

Question Number	Answer	Additional Guidance	Mark
3(d)	1. Clear table which matches method described with headings and units 2. Change in {growth/eq} calculated, e.g. by measuring {change in length/percentage change in mass/eq} 3. Means calculated from repeat data 4. {Scatter/line} graph format with correctly-labelled axes/eq 5. Use of graph to {estimate range for optimum/to identify other values of concentration to test to identify optimum concentration/eq}	Table with columns/rows for raw data. Ignore units in body of table.	**(4)**

Question Number	Answer	Additional Guidance	Mark
3(e)	1. Difficult to control all variables affecting plant growth 2. Example of uncontrolled variable, e.g. seeds do not germinate at the same time, genetic differences between the plants 3. Reference to limiting factor(s) 4. Reference to need for more than one type of mineral for effective growth of plants 5. Specified difficulty in measuring dependent variable/eq	Needs to be related to plant growth. Simply stating that a particular variable was not controlled gains only. ACCEPT contamination with microorganisms may affect plant growth. IGNORE reference to poor choice of dependent variable.	**(3)**

Total for Question 3 = 22 Marks

Total for Paper = 50 Marks

edexcel

For information about Edexcel or BTEC qualifications
visit www.edexcel.com or www.btec.co.uk

Pearson Education Limited. Registered in England and Wales No. 872828
Registered Office: Edinburgh Gate, Harlow, Essex CM20 2JE
VAT Reg No GB 278 537121

ISBN 978-1-4469-0966-9