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AS Biology A (Salters-Nuffield)

Sample Assessment Materials

Pearson Edexcel Level 3 Advanced Subsidiary GCE in Biology A (Salters-Nuffield) (8BN0)

First teaching from September 2015

First certification from 2016

Issue 1

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Sample Assessment Materials

First certification 2016

Edexcel, BTEC and LCCI qualifications

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Contents

Introduction

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

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

General marking guidance

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

Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Biology A (Salters Nuffield)

Advanced Subsidiary
Paper 1: Lifestyle, Transport, Genes and Health

Sample Assessment Material for first teaching September 2015
Time: 1 hour 30 minutes

Paper Reference
8BN0/01

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

Total Marks

Instructions

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

Information

- The total mark for this paper is 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.

Advice

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

Turn over ▶

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S 4 7 5 6 1 A 0 1 2 4

PEARSON

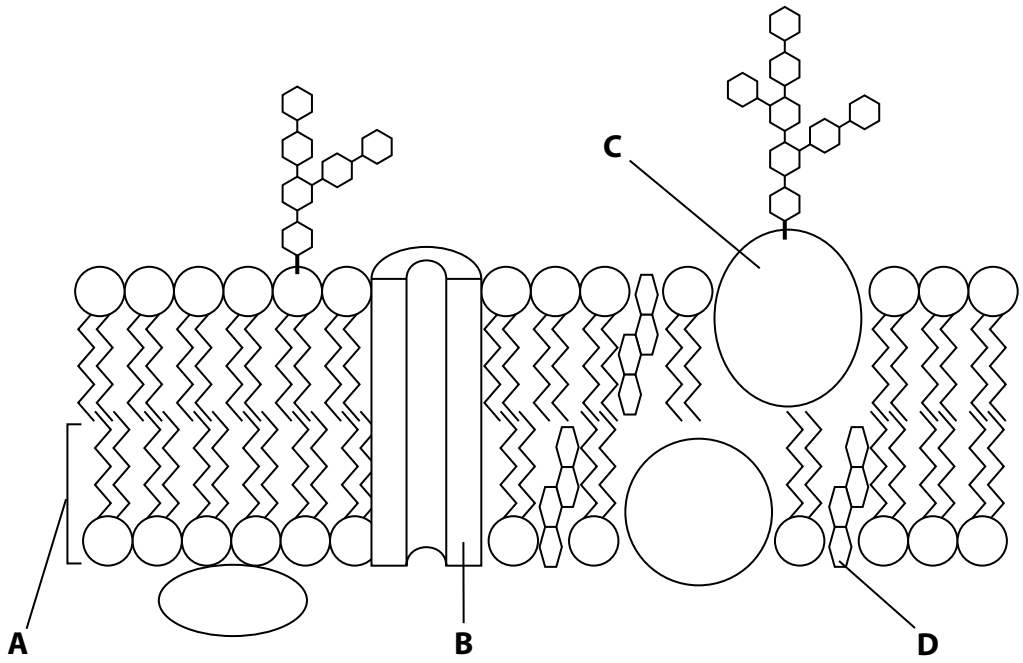
Answer ALL questions.

Write your answers in the spaces provided.

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

1 Cell membranes are involved in the transport of molecules.

The diagram shows the structure of a cell membrane.



(a) Which letter in the diagram labels a phospholipid?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which of the following statements is true about a phospholipid?

(1)

☒ **A** it has a hydrophobic tail of three fatty acids

☒ **B** it has a hydrophilic tail of three fatty acids

☒ **C** it has a hydrophobic tail of two fatty acids

☒ **D** it has a hydrophilic tail of two fatty acids

(c) Describe how the structure labelled **B** is involved in passive transport.

(3)

(Total for Question 1 = 5 marks)

2 A student investigated the effect of caffeine on human heart rate.

Three males of the same age were given cups of coffee containing caffeine. Their heart rates were measured 10 minutes after drinking the coffee.

Two hours later they were given cups of coffee with no caffeine and after 10 minutes their heart rates were measured.

The results are shown in the table.

Male	**Heart rate / beats min^{-1}**	
	Coffee containing caffeine	**Coffee with no caffeine**
1	75	72
2	78	71
3	70	70
Mean ± sd	74 ± 4	71 ± 1

(a) The student concluded that caffeine increases human heart rate.

Analyse the data to explain why these results may not support the conclusion.

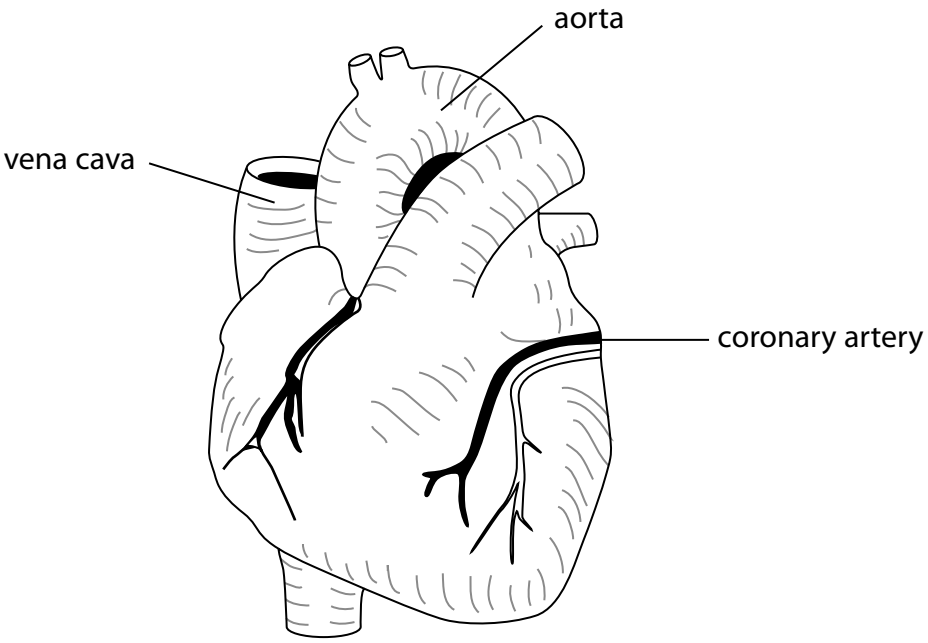
(3)

(b) Describe how this investigation could be improved.

(3)

(Total for Question 2 = 6 marks)

3 A student studied the external view of a mammalian heart, as shown in the diagram.



(a) The student wanted to compare the size of the aorta and the vena cava of this heart.

She determined the cross-sectional area of the aorta, which was 72.22 mm^2.
She also measured the diameter of the vena cava which was 17.0 mm.

(i) Calculate the difference in the cross-sectional area of the vena cava and the aorta.

(2)

Answer ..... mm^2

(ii) The student also compared the thickness of the aorta wall of this heart with the thickness of the aorta wall in a giraffe. The thickness of the aorta wall in this heart is 3 mm and in a giraffe it is 15 mm.

Give one reason why the aorta wall in a giraffe is much thicker.

(1)

.....

.....

(b) Blood clots can reduce the cross-sectional area of arteries and lead to cardiovascular disease (CVD).

Thromboplastin is a catalyst in the blood clotting process.

(i) Which of the following shows the reaction catalysed by thromboplastin?

(1)

☒ **A** fibrinogen converted to fibrin

☒ **B** fibrin converted to fibrinogen

☒ **C** prothrombin converted to thrombin

☒ **D** thrombin converted to prothrombin

(ii) Which of the following shows the ions involved in the blood clotting process?

(1)

☒ **A** calcium

☒ **B** iron

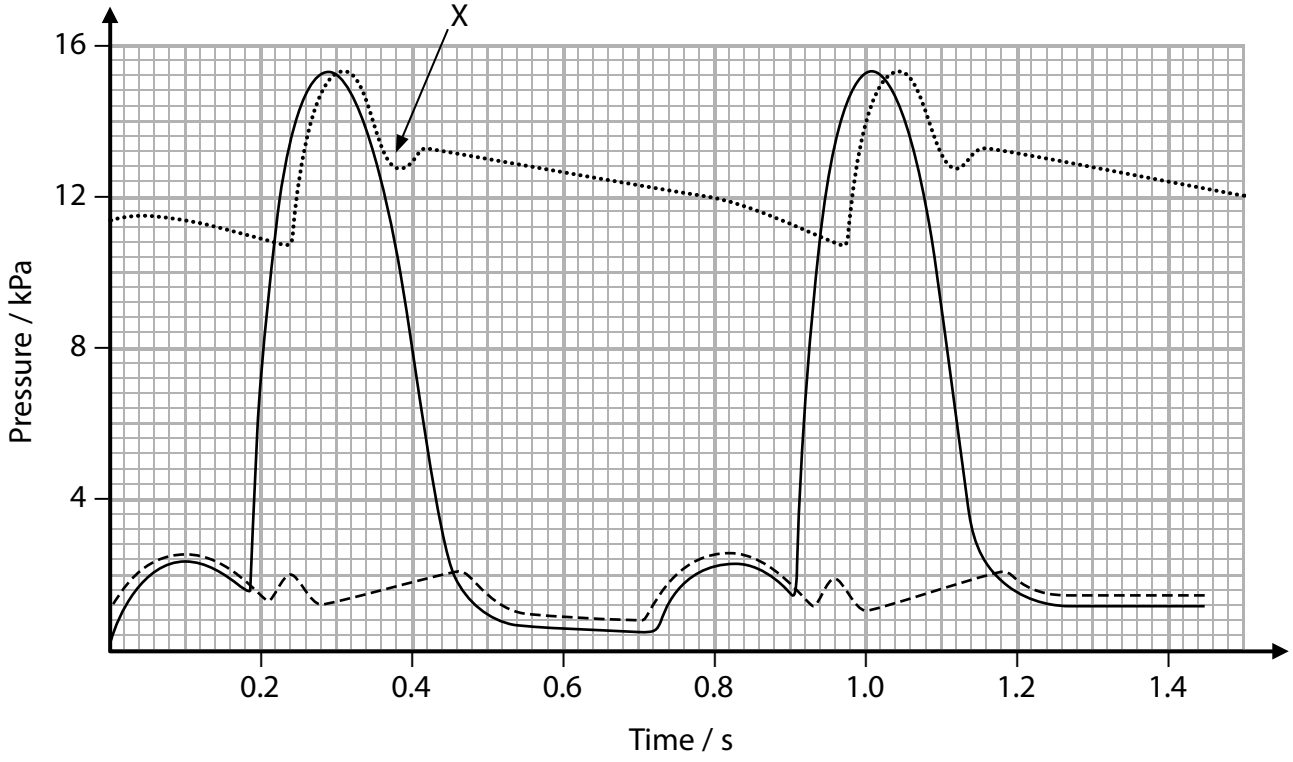
☒ **C** nitrate

☒ **D** sodium

(Total for Question 3 = 5 marks)

4 During the cardiac cycle, there are pressure changes in the left atrium, left ventricle and aorta.

The graph shows these pressure changes in the left atrium, left ventricle and aorta of a person.



Key

..... aorta

——— left ventricle

- - - - - left atrium

(a) (i) Which time period corresponds with ventricular systole?

(1)

☒ **A** 0.52 to 0.72

☒ **B** 0.72 to 0.92

☒ **C** 0.92 to 1.20

☒ **D** 0.24 to 0.98

(ii) Which of the following is occurring in the heart at 1.0 second on the graph?

(1)

☒ **A** semilunar valve is closed and atrioventricular valve is closed

☒ **B** semilunar valve is closed and atrioventricular valve is open

☒ **C** semilunar valve is open and atrioventricular valve is closed

☒ **D** semilunar valve is open and atrioventricular valve is open

(iii) Use the information on the graph to calculate the heart rate of this person.

(2)

Answer ..... beats per minute

(b) When the heart valves close, they make a sound. This sound can be detected and recorded.

(i) State a time from the graph when the sound of an atrioventricular valve closing would be detected.

(1)

.....

.....

(ii) Explain why the atrioventricular valves need to close.

(2)

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.....

(Total for Question 4 = 7 marks)

5 The diagram shows a shrew, a small mammal.

Source: http://museum2.utep.edu/archive/mammals/DDshrew.htm

Different species of shrew have different mean body masses. An investigation was carried out to find the relationship between mean body mass and oxygen consumption during respiration.

The table below gives the results for five species of shrew.

Species of shrew	Mean body mass / g	Oxygen consumed during respiration / $cm^3\ g^{-1}\ h^{-1}$
Sorex cinereus	2.5	10.8
Sorex vagrans	4.5	8.6
Sorex montereyensis	6.5	7.2
Sorex sonomae	11.5	5.2
Blarina brevicauda	20.0	4.0

(a) Analyse the data to explain the correlation between body mass and oxygen consumption.

(3)

(b) (i) Calculate the oxygen consumed in one day by one *Sorex cinereus* shrew.

(2)

Answer ..... cm^3

(ii) Explain why the oxygen consumption was measured per gram per hour.

(2)

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(c) Mammals, such as shrews, need lungs that provide efficient gas exchange.

Explain how the lungs of mammals are adapted for efficient gas exchange.

(3)

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(Total for Question 5 = 10 marks)

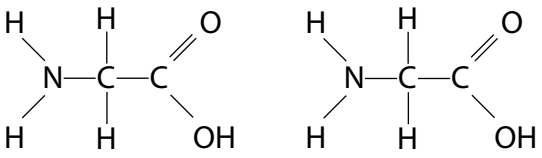
6 (a) Proteins, such as collagen, are made from amino acids joined together.

(i) Which of the following is the name of the bond used to join amino acids together?

(1)

- ☒ **A** ester
- ☒ **B** glycosidic
- ☒ **C** peptide
- ☒ **D** phosphodiester

(ii) This diagram shows the structure of two amino acids that can be joined together by a reaction.



Draw a diagram to show the products of this reaction.

(2)

(iii) Which of the following is the R group in these amino acids?

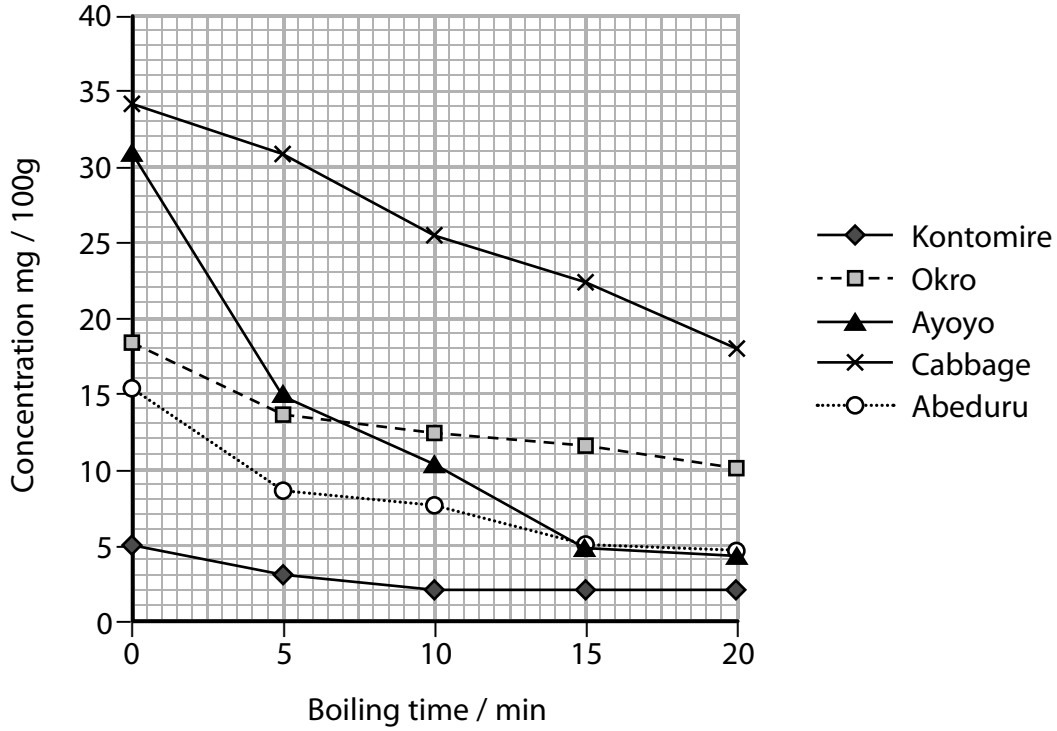
(1)

- ☒ **A** COOH
- ☒ **B** NH_2
- ☒ **C** H
- ☒ **D** OH

(b) Vitamin C is important in the growth and repair of skin tissue because it helps in the synthesis of a protein called collagen.

For this reason, the food given to hospital patients after surgery should contain vitamin C to help their recovery. A hospital chef suggested that the cooking time of vegetables affects their vitamin C content.

An investigation was carried out on the effect of cooking time on the vitamin C content of five different vegetables. The results are shown in the graph.



(i) Analyse the data to explain the effect of cooking time on the vitamin C content in vegetables.

(3)

(ii) Analyse the data to conclude which of the vegetables should be given to patients recovering from surgery.

(2)

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.....

(Total for Question 6 = 9 marks)

7 Amniocentesis and chorionic villus sampling are methods used in prenatal tests.

(a) Compare and contrast the procedures used in amniocentesis and in chorionic villus sampling to obtain fetal cells in prenatal tests.

(3)

(b) A woman is 12 weeks pregnant and wants to use one of these prenatal tests.

Explain the issues she needs to consider before deciding which prenatal test to use.

(4)

(Total for Question 7 = 7 marks)

8 LDL cholesterol found in plasma binds to receptor proteins and is taken into cells by endocytosis.

A gene found on chromosome 19 is responsible for making LDL receptor proteins in human cell membranes.

*(a) Familial hypercholesterolaemia (FH) is an inherited condition.

The recessive allele (**f**) makes normal LDL receptor proteins.
The dominant allele (**F**) makes LDL receptor proteins that do not function.

Explain why people who inherit the dominant allele have an increased risk of dying early.

(6)

(b) Very few people have the homozygous dominant genotype for FH.
The heterozygous genotype is more common and affects 1 in 500 people.

In women with FH, 30% will develop coronary heart disease if untreated.

In men with FH, 50% will develop coronary heart disease if untreated.

Calculate the number of women who will develop coronary heart disease, as a consequence of FH, in a population of 60 million, with equal numbers of men and women.

(2)

Answer .....

(Total for Question 8 = 8 marks)

9 Cystic fibrosis is a disorder caused by a gene mutation.

(a) Explain **one** treatment used to reduce the lung symptoms of people with cystic fibrosis.

(2)

(b) One mutation causes a change in the primary structure of CFTR, a membrane transport protein.

(i) Explain why this change in the primary structure would result in the CFTR protein being non-functional.

(3)

(ii) Another mutation reduces the quantity of CFTR protein in membranes.

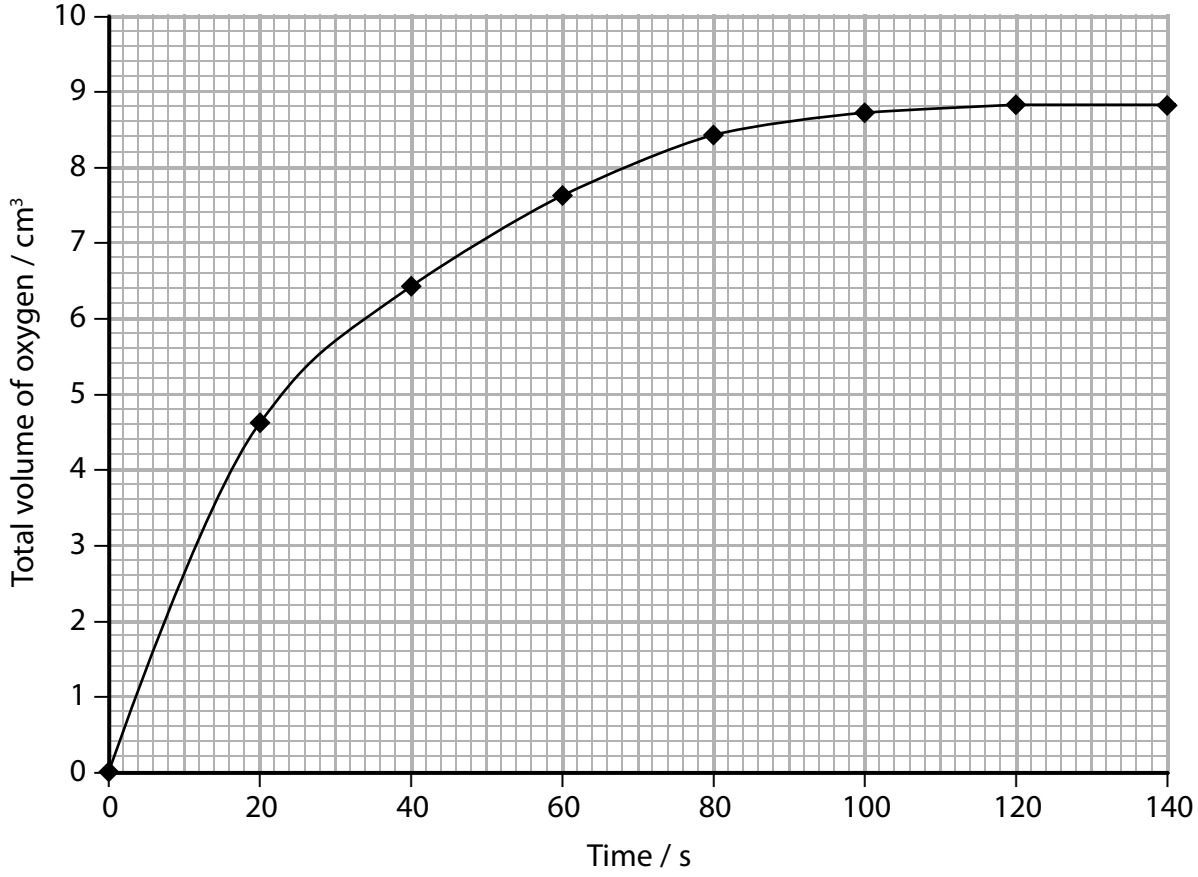
Explain the effects of having smaller quantities of CFTR protein in membranes.

(5)

(Total for Question 9 = 10 marks)

10 Catalase is an enzyme present in many tissues of most living organisms, but can be found in high concentrations in liver cells. Its role is to break hydrogen peroxide down into oxygen and water. Hydrogen peroxide is produced by cells and is very harmful if it is not broken down.

A student carried out an investigation into the action of catalase. Some liver was chopped into small pieces, and added to hydrogen peroxide. The volume of oxygen gas produced was recorded and a graph was drawn.



(a) (i) Calculate the initial rate of reaction.

(3)

Answer .....

(ii) Analyse the graph to explain the change in the total volume of oxygen produced over the course of reaction.

(4)

(iii) Draw on the graph the line you would expect if the student repeated the investigation with the same concentration of hydrogen peroxide but with double the mass of liver.

(2)

(b) Describe how transcription is involved in the synthesis of an enzyme.

(4)

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 80 MARKS

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

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

Question Number	Acceptable Answer	Additional guidance	Mark
1(c)	A description that makes reference to the following: • B is a channel protein (1) • which allows the movement of {large / charged / polar} molecules (1) • by diffusion from high concentration to low concentration / down concentration gradient (1)		(3)

(Total for Question 1 = 5 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
2(a)	An explanation that makes reference to the following: • male 3 had same heart rate in both conditions so suggests no effect (1) • standard deviations overlap so difference may be chance (1) • caffeine concentration unknown / sample size small so may be unrepresentative (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(b)	A description that makes reference to three of the following: • take into account resting heart rate (1) • include females in the sample (1) • have a range of ages in the sample (1) • take into account previous coffee drinking habits (1) • as heart rate is affected by exercise, need to take this into account (1)		**(3)**

(Total for Question 2 = 6 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
3(a)(i)	8.5 x 8.5 = 72.25 72.25 x π= 226.98 (mm^2) (1) 226.98 – 72.22 = 154.76 (mm^2) (1)	Allow rounded values of π (e.g. 3.142) Correct answer gains full marks, no working	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
3(a)(ii)	Answer that makes refernce to the following: • Need to withstand hihger pressure from the left ventricle / need to have more elastic tissue to create pressure to move blood against gravity		**(1)**

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

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

(Total for Question 3 = 5 marks)

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

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

Question Number	Acceptable Answer	Additional guidance	Mark
4(a)(iii)	one cycle = 0.72 s (1) 60 ÷ 0.72 = 83.3 (1)	Allow ± 0.02 s for the duration of the cycle Allow full marks for the correct answer, no working	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(b)(i)	0.19 s / 0.91 s (1)	Allow ± 0.01 s	**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(b)(ii)	An explanation that makes reference to the following: • ventricle needs to contract and force blood into the {aorta / pulmonary artery / arteries} (1) • so valves need to close to prevent backflow into the atria on contraction (1)		**(2)**

(Total for Question 4 = 7 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
5(a)	An explanation that makes reference to the following: • as body mass increases, the rate of oxygen consumption decreases (1) • because bigger shrews have smaller surface area to {volume / mass} ratio (1) • so less respiration needed to replace lost heat (1)		**(3)**

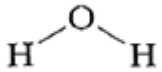
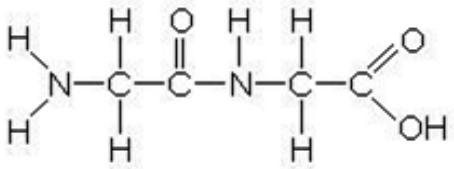
Question Number	Acceptable Answer	Additional guidance	Mark
5(b)(i)	10.8 x 2.5 = 27 (1) 27 x 24 = 648 cm^3 (1)	Allow full marks for correct answer, no working	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
5(b)(ii)	An explanation that makes reference to the following: • idea that {mass of respiring cells / time} affects oxygen consumption (1) • so a valid comparison could be made (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
5(c)	An explanation that makes reference to the following: • there is a large surface area due to {many alveoli / many capillaries} (1) • there is a short diffusion distance due to {alveoli / capillaries} being one cell thick(1) • there is a good blood supply due to many capillaries (1)		**(3)**

(Total for Question 5 = 10 marks)

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

Question Number	Acceptable Answer	Additional guidance	Mark
6(a)(ii)	water molecule indicated (1)  correct dipeptide shown (1) 		**(2)**

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

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(i)	An explanation that makes reference to the following: • idea that {raw food / food cooked for as little time as possible} contains most vitamin C because it has not had time to {diffuse into water / be destroyed by heat} / the longer the cooking time the less the vitamin C content because more time to {diffuse into water / be destroyed by heat} (1) • greatest reduction is in first 5 minutes of cooking for all except cabbage because this is when concentration gradient is greatest / no further loss of vitamin C in kontomire between 10 and 20 minutes because concentration equal in vegetable and cooking water (1) • correct manipulation of figures to support argumenteg the percentage loss (from 0 to 20 minutes) of vitamin C in the vegetables ranged from 42% to 85% / okro had least percentage loss of vitamin C content (42 %) / cabbage (48 %) / kontomire (52 %) / abeduru (70 %) / ayoyo with the highest percentage loss (85 %) (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(ii)	An answer that makes reference to the following: • cabbage because it contains the most vitamin C to start off with (1) • and retains the highest concentration of vitamin C during cooking times (1)		**(2)**

(Total for Question 6 = 9 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
7(a)	An answer that makes reference to the following: • fetal cells obtained from amniotic fluid in amniocentesis, fetal cells obtained from placental cells in cvs (1) • use of needle in both amniocentesis and cvs (1) • amniocentesis via abdomen and cvs either via abdomen or vagina (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)	An explanation that makes reference to four of the following: • cvs can be performed earlier / amniocentesis is later (1) • cvs allows {earlier decision to abort / termination less physically traumatic} / with amniocentesis {later decision to abort / termination more physically traumatic} (1) • first cvs results available sooner / amniocentesis results not available until 2-3 weeks after test (1) • with cvs there is {greater risk / risk is between 1-2% of miscarriage} / with amniocentesis there is a {lower risk / 1% risk of miscarriage} (1) • cvs cannot detect gene problems on X chromosomes (because they are inactivated in fetal placental cells) (1)	• First cvs results after 2-3 days, full results after 2 weeks	**(4)**

(Total for Question 7 = 7 marks)

Question Number	Indicative content	
8(a)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • cholesterol remains in {blood / plasma} / cholesterol not taken into cells by endocytosis • dominant allele expressed making different protein {primary structure / folding / shape} • fewer normal LDL receptor proteins • increases plaque formation leading to narrowing of {arteries / coronary artery} • less oxygen to muscle cells • greater risk of {heart disease / CVD / CHD / cardiac arrest}	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented. Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows some linkages and lines of reasoning with some structure.

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

Question Number	Acceptable Answer	Additional guidance	Mark
8(b)(i)	60 000 000 ÷ 500 = 120 000 (1) 120 000 ÷ 2 = 60 000 women in population 30% of 60 000 = 18 000 (1)	Allow full marks for correct answer, no working	**(2)**

(Total for Question 8 = 8 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
9(a)	An explanation that makes reference to the following: • antibiotic to kill bacteria (1) • because more prone to bacterial infection (1) **Or** • physiotherapy dislodges mucus (1) • therefore more efficient gas exchange (1)	• Gene therapy to produce normal CFTR protein (1) • Therefore mucus will be less sticky (1)	**(2)**

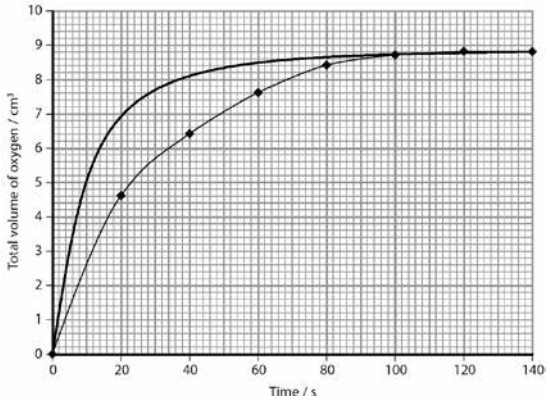
Question Number	Acceptable Answer	Additional guidance	Mark
9(b)(i)	An explanation that makes reference to three of the following: • mutation causes a change in the {number / type / sequence} of {amino acids / R groups} (1) • therefore {bonding / named bond} will be different (1) • resulting in a change in {3D shape / tertiary structure} (1) • therefore it cannot transport chloride ions (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
9(b)(ii)	An explanation that makes reference to the following: • fewer chloride ions transported across cell membranes (1) • therefore less water drawn out of mucus by osmosis (1) • this makes mucus more viscous (1) • cilia cannot remove mucus (1) • resulting in blockage of {airways / reproductive tracts / ducts} (1)		**(5)**

(Total for Question 9 = 10 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(i)	suitable time interval chosen (in range 0 to 20 s, must be on straight line portion) (1) change calculated e.g. 4.6cm^3 ÷ 20 seconds (1) ans = 0.23 cm^3 s^{-1} (1)	Allow full marks for correct answer, no working	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(ii)	An explanation that makes reference to the following: • initial rate of reaction {is fast / shows positive correlation} because {substrate / hydrogen peroxide} is not limiting (1) • therefore there are many {collisions between enzyme and substrate / enzyme substrate complexes} (1) • between {20s and 100s} the total volume produced slows because there is {less substrate / fewer collisions / fewer enzyme substrate complexes} (1) • no oxygen produced after 100s because reaction has stopped because {substrate used / substrate is limiting} (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(iii)	Steeper initial gradient (1) Reaches a plateau faster (1)  		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(b)	A description that makes reference to the following: • DNA {unzips / unwinds} and hydrogen bonds between complementary strands broken (1) • the {antisense / coding / template} strand used for mRNA synthesis (1) • RNA polymerase used to join RNA nucleotides (1) • complementary base pairing of A with U, not T (1)		**(4)**

(Total for Question 10 = 13 marks)

Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Biology A (Salters Nuffield)

Advanced Subsidiary

Paper 2: Development, Plants and the Environment

Sample Assessment Material for first teaching September 2015

Time: 1 hour 30 minutes

Paper Reference

8BN0/02

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

Total Marks

Instructions

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

Information

- The total mark for this paper is 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.*

Advice

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

Turn over ▶

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S 4 7 5 6 2 A 0 1 2 8

PEARSON

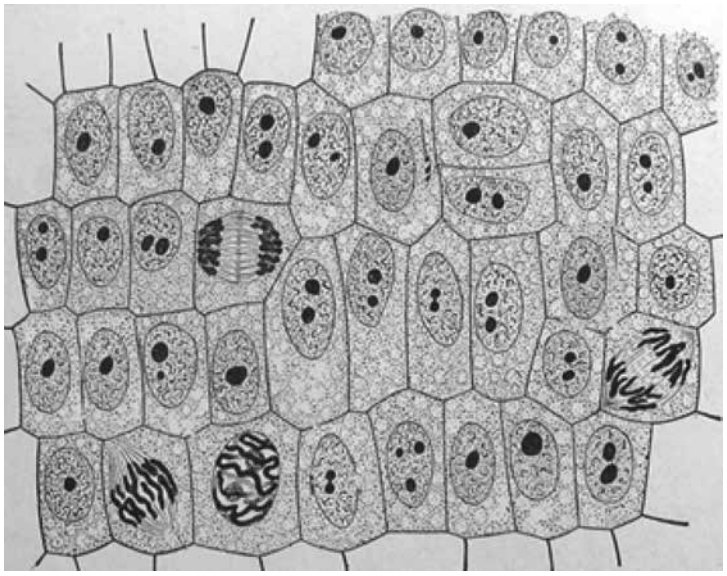
Answer ALL questions.

Write your answers in the spaces provided.

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

1 A student prepared a root tip squash to view stages of mitosis.

The diagram shows the drawing made by the student.



(a) The ratio of cells in the drawing showing anaphase compared to those showing metaphase is

(1)

☒ **A** 2:1

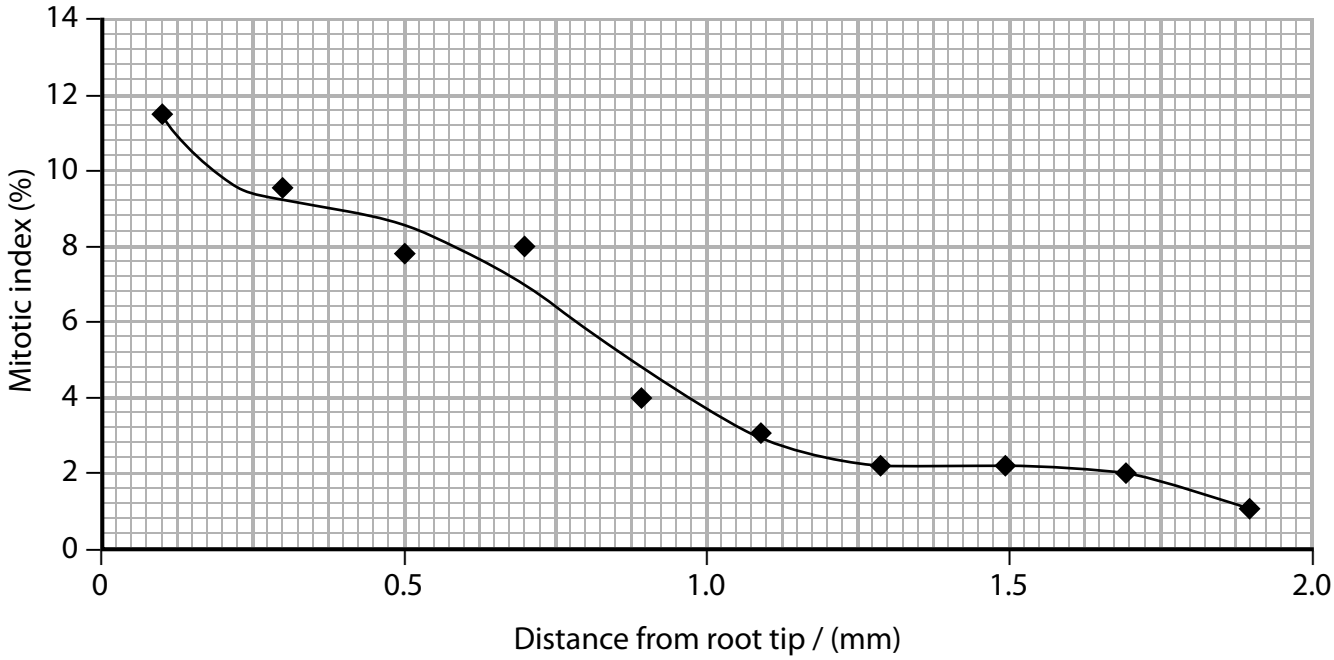
☒ **B** 1:2

☒ **C** 1:1

☒ **D** 3:1

(b) The mitotic index is the percentage of cells undergoing mitosis.

The student calculated the mitotic index at different distances from the root tip. She used this information to plot the graph shown.



Calculate the distance from the root tip of the cells in the student's drawing.

(2)

Answer .....

(c) (i) Which row shows the correct events that take place at each stage of cell division?

(1)

		Stage of cell division	
		Interphase	**Prophase**
☒	**A**	DNA replicates	chromosomes condense
☒	**B**	centromeres separate	nuclear membrane breaks down
☒	**C**	chromatids are formed	spindle formation begins
☒	**D**	chromosomes decondense	nuclear membrane reforms

(ii) Which of the following occurs during metaphase?

(1)

☒ **A** separation of chromatids

☒ **B** breakdown of the nuclear membrane

☒ **C** division of the centromeres

☒ **D** alignment of chromosomes at the equator of the cell

(Total for Question 1 = 5 marks)

2 The Hardy-Weinberg equation can be used to predict the number of people in a population who are carriers for a recessive allele.

The Hardy-Weinberg equation is shown below.

$$p^2 + 2pq + q^2 = 1$$

(a) Cystic fibrosis is a condition caused by a recessive allele. Approximately 1 in 2 500 newborn babies has cystic fibrosis.

Use this information and the Hardy-Weinberg equation to complete the table below.

(4)

Statement	Calculated number
The frequency of the recessive allele in the population	
The frequency of the dominant allele in the population	
The percentage of heterozygous individuals (carriers) in the population	
The number of babies in a sample of 100 000 that are likely to be carriers	

(b) Explain how use of the Hardy-Weinberg equation allows scientists to determine whether evolution has occurred.

(2)

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(c) The use of the Hardy-Weinberg equation is valid only if the following condition occurs.

(1)

☒ **A** mutation

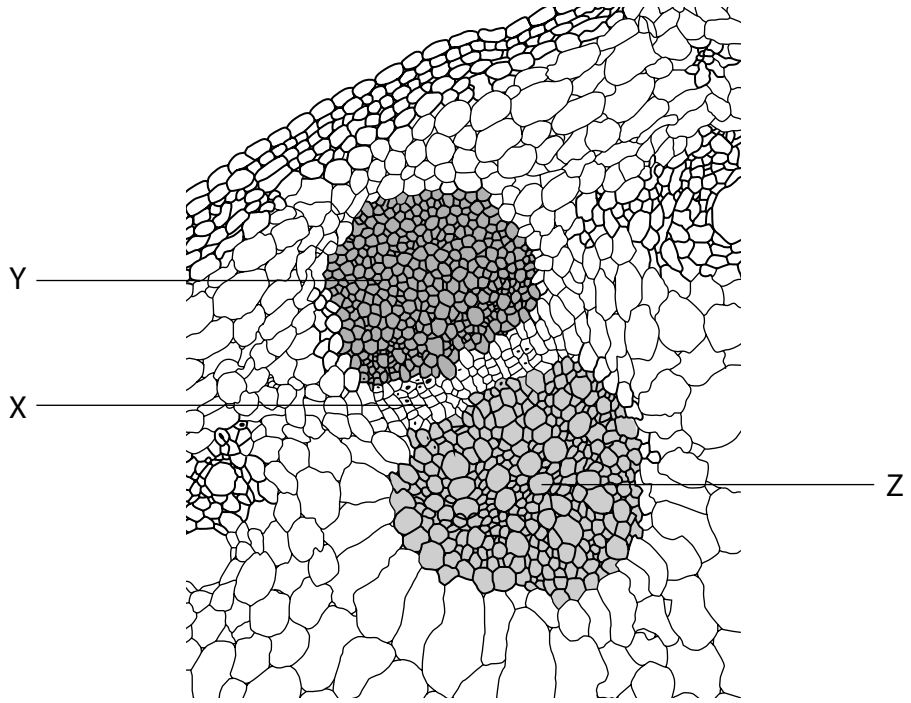
☒ **B** migration of individuals

☒ **C** random mating

☒ **D** natural selection

(Total for Question 2 = 7 marks)

3 The diagram below shows a cross section through part of a sunflower stem.



(a) (i) Which row shows the correct names for tissues X, Y and Z?

(1)

	Tissue X	Tissue Y	Tissue Z
☒ **A**	sclerenchyma	xylem	phloem
☒ **B**	phloem	sclerenchyma	xylem
☒ **C**	phloem	xylem	sclerenchyma
☒ **D**	xylem	sclerenchyma	phloem

(ii) Which row shows the correct function for tissues X, Y and Z?

(1)

	Tissue X	Tissue Y	Tissue Z
☒ **A**	transports water and mineral ions	provides mechanical support	translocates organic solutes
☒ **B**	provides mechanical support	translocates organic solutes	transports water and mineral ions
☒ **C**	translocates organic solutes	provides mechanical support	transports water and mineral ions
☒ **D**	translocates organic solutes	transports water and mineral ions	provides mechanical support

(b) The roots of this sunflower plant were put into a solution containing a metabolic poison. A metabolic poison prevents the production of ATP.

Explain how this would affect the transport of substances in these tissues.

(3)

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(Total for Question 3 = 5 marks)

4 Some shopping bags can be made from bioplastic.

Bioplastic can be made from plant starch or cellulose.

(a) Describe the differences between the structure of starch and cellulose.

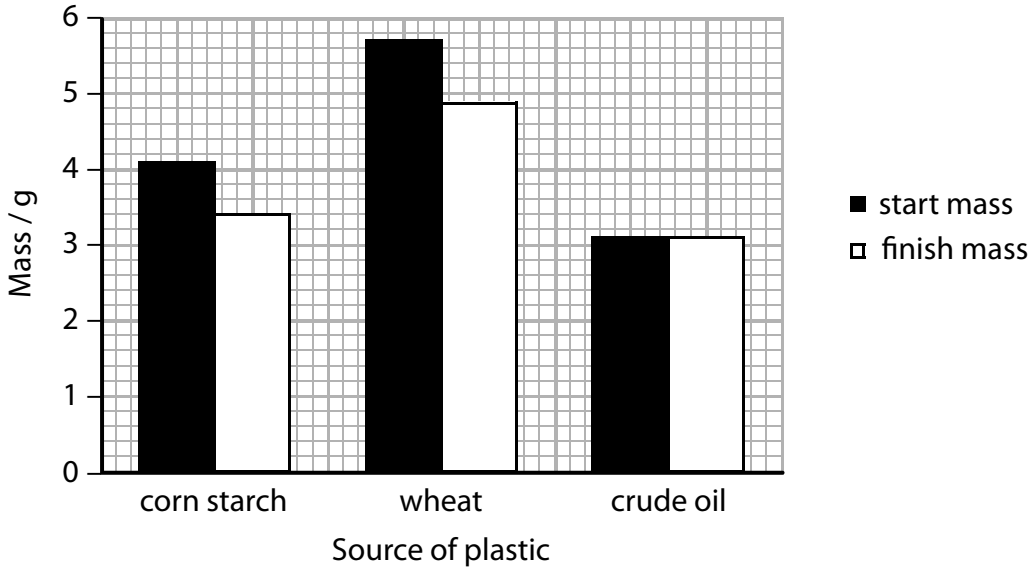
(3)

(b) It is believed that bags made from bioplastic are better for the environment because they biodegrade faster than those made from crude oil.

An investigation compared the biodegradation of bags made from bioplastic and bags made from crude oil.

Small squares of plastic were cut from the bags. They were then weighed and buried in soil. After a period of time the small squares were reweighed.

The graph below shows the results of the investigation.



(i) Give a reason why the soil in which the plastic squares were placed needed to be kept the same.

(1)

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(ii) State with a reason what needed to be done to the plastic squares after they had been removed from the soil for weighing.

(1)

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(c) Analyse the data to explain the advantages of using bioplastic to make bags rather than crude oil.

(3)

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(Total for Question 4 = 8 marks)

5 Biodiversity can be measured by calculating species richness, genetic diversity or an index of diversity.

(a) Describe the differences between what is meant by the terms species richness and genetic diversity.

(2)

(b) An index of diversity (*D*) can be used to compare the diversity of living organisms in different locations.

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

n = total number of organisms of a particular species

N = total number of organisms of all species

The table shows the number of insect species found living in a hedge.

Insect species	Number of individuals
A	1
B	2
C	12
D	8
E	9
F	3
G	3
H	2
I	5
J	7

Calculate an index of diversity (*D*) for insects living in this hedge.

(3)

Answer .....

(c) The legless lizard, *Lialis burtonis*, belongs to the family Pygopodidae. The map shows the distribution of *Lialis burtonis*.

Give one reason why this lizard cannot be regarded as endemic.

(1)

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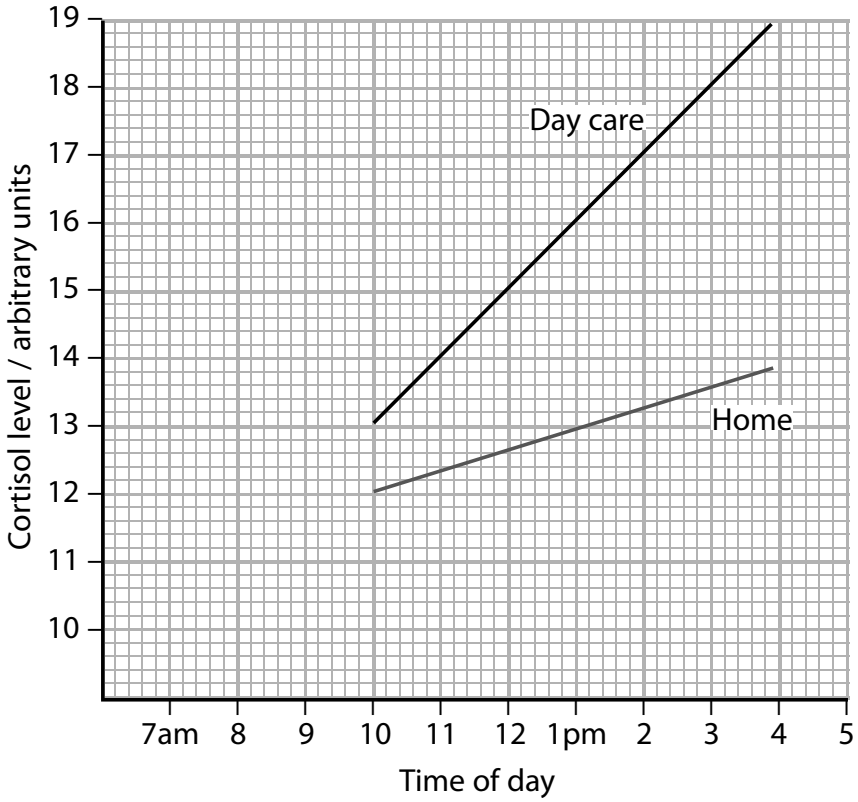
(Total for Question 5 = 6 marks)

6 Pre-school aged children respond to stress by producing the hormone cortisol.

A study found that levels of cortisol were raised for children attending day care, compared with those remaining at home with their mother.

The graph below shows the results of this study.



The percentage change in cortisol levels from 10am to 4pm for children who stayed at home with their mother was 13%.

(a) Calculate the percentage change in cortisol levels for the children in day care over the same time period.

Give your answer as a whole number.

(3)

Answer .....

(b) It is thought that this difference may cause epigenetic changes.

Explain how these changes might affect the functioning of the genome.

(3)

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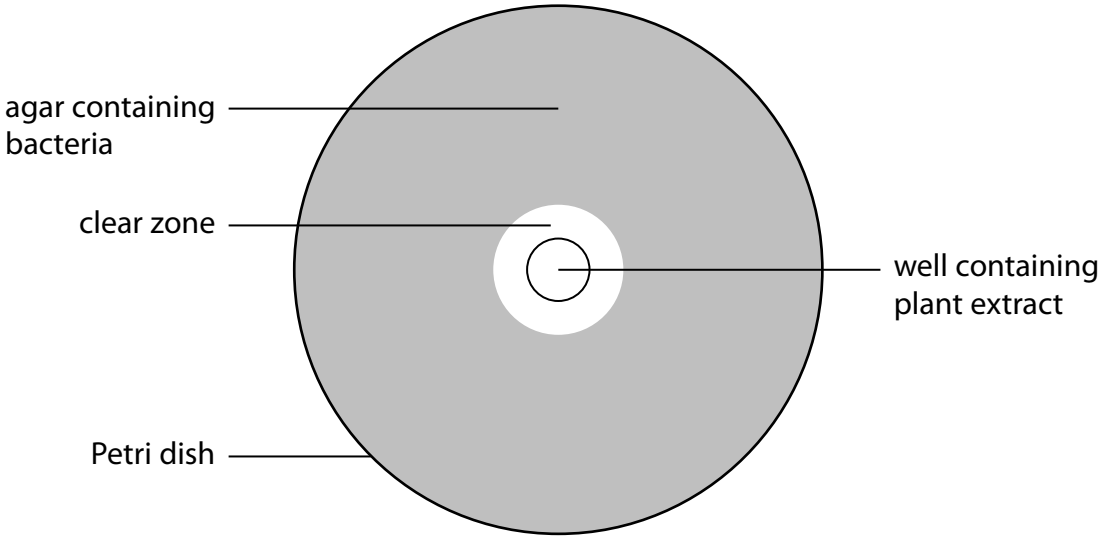
(Total for Question 6 = 6 marks)

7 Plants can be used as sources of chemicals with antimicrobial properties.

In an investigation, Petri dishes were prepared with agar containing bacteria. Plant extracts were placed in wells cut into the agar.

The Petri dishes were incubated. The diagram shows one of the Petri dishes after incubation.



(a) (i) Explain the temperature that should be used to incubate the Petri dishes.

(2)

(ii) Explain why the clear zone is a measure of the antimicrobial properties of the plant extract.

(2)

(b) Extracts of various plant species were tested in this investigation. The results are shown in the table below.

Plant extract	Mean diameter of clear zone / mm	Mean area of clear zone / mm^2
Basil	6	28.3
Lemon balm	8	50.3
Rosemary	6	28.3
Sage	2	3.1
Lavender	12	113.1

(i) Determine which is the better measure to use when comparing the antimicrobial properties of lavender and lemon balm.

(2)

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(ii) Explain why the conclusion that lavender is the plant with greatest antimicrobial properties may **not** be valid.

(2)

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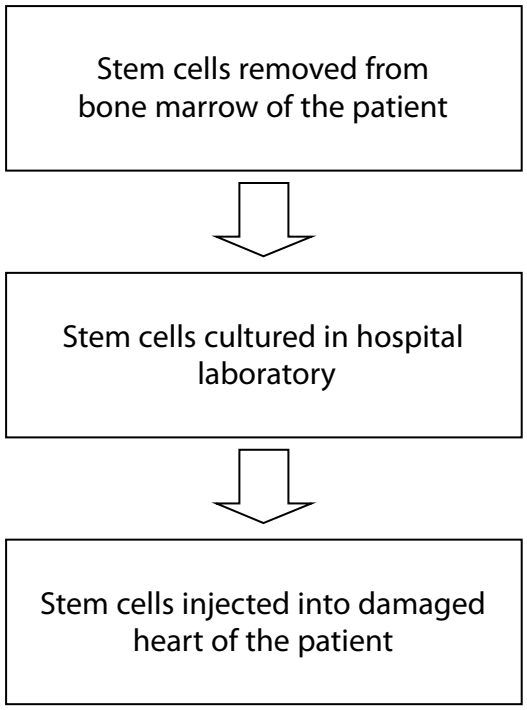
(Total for Question 7 = 8 marks)

8 In February 2014, the largest ever stem cell trial involving heart attack patients started. This trial investigated the use of bone marrow as a source of stem cells to repair damaged heart tissue.

(a) Explain why bone marrow cells were used as a source of stem cells.

(2)

(b) The flow chart below shows some of the steps that would be involved in the production of human tissues from bone marrow stem cells.



(i) Stem cells extracted from bone marrow are **pluripotent**.

State what is meant by the term pluripotent.

(2)

(ii) Explain why these stem cells are able to repair the damaged heart tissue of this patient.

(5)

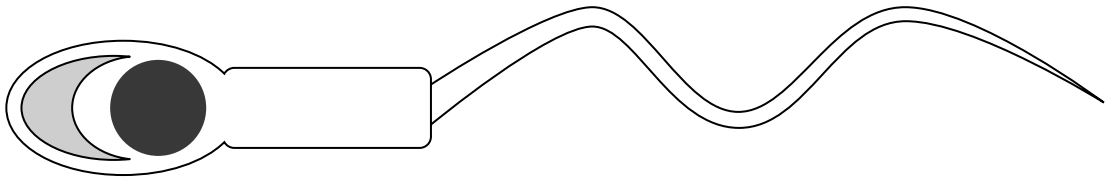
(c) Some medical trials use embryonic stem cells, rather than bone marrow cells.

Describe how society controls the use of embryonic stem cells in medical research.

(4)

(Total for Question 8 = 13 marks)

9 Sperm are needed for the process of fertilisation. The diagram below shows a sperm cell.



(a) (i) The actual size of a sperm head is 5 μm. The magnification of this sperm cell is

(1)

- ☒ **A** × 5.4
- ☒ **B** × 135
- ☒ **C** × 5480
- ☒ **D** × 10800

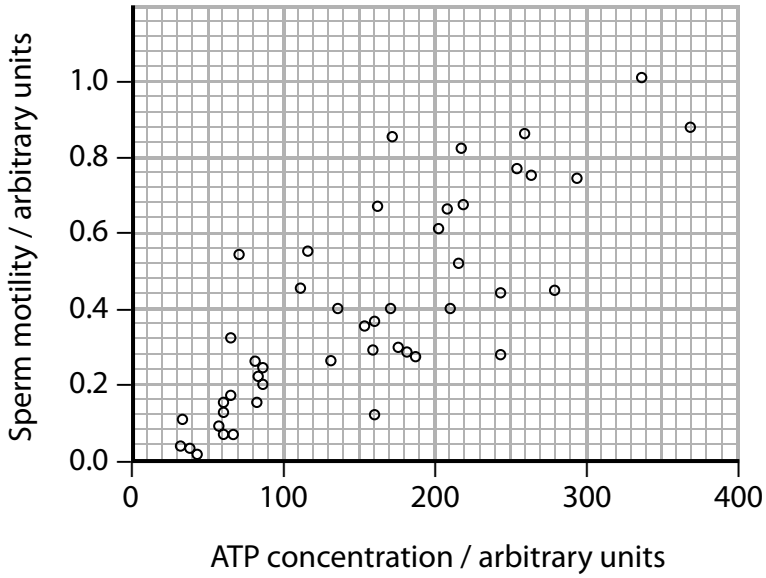
(ii) A structure in a sperm cell also found in prokaryotic cells is a

(1)

- ☒ **A** nucleus
- ☒ **B** mitochondrion
- ☒ **C** plasma membrane
- ☒ **D** lysosome

(b) To be able to swim properly sperm cells need a supply of adenosine triphosphate (ATP).

The graph below shows the correlation between sperm motility and the ATP content of a sperm cell.



Analyse the data to explain the reason for 100% infertility in some men.

(3)

*(c) There are many products that may increase the ability of sperm to swim. One of these products contains zinc sulphate.

Devise an investigation to obtain valid data to show whether taking zinc sulphate tablets affects the ability of sperm to swim.

(6)

(Total for Question 9 = 11 marks)

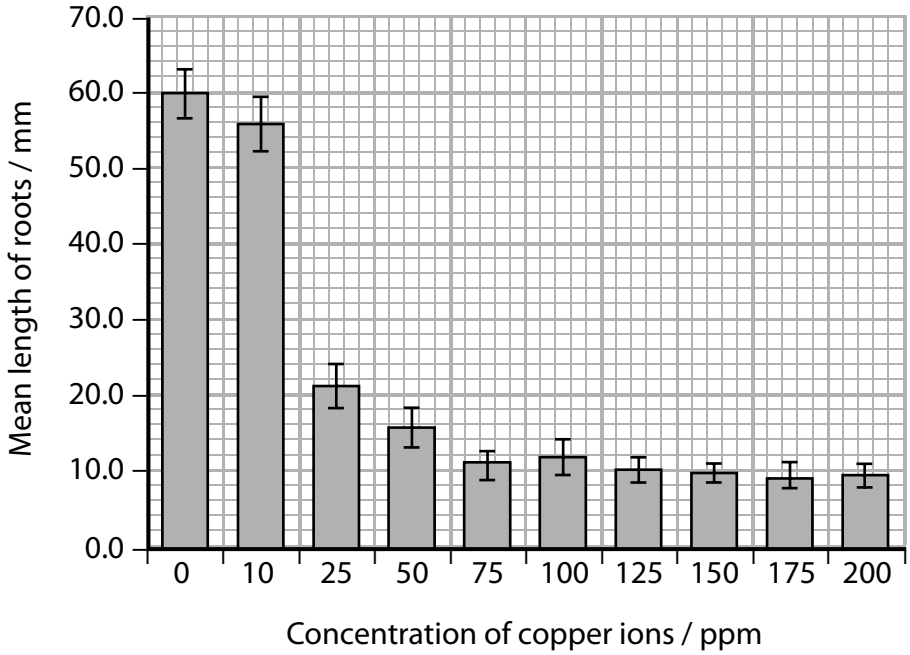
10 Copper ions in soil can affect cell division in roots in plants.

Copper ions affect bonds in proteins, changing their shape. If the proteins are enzymes this may change the shape of the active site.

The effect of copper ions on the growth of mustard seedling roots was investigated. Mustard seeds were germinated on filter paper soaked in copper sulfate solution. These solutions provided copper ion concentrations ranging from 0 parts per million (ppm) to 200 ppm.

After 5 days, the lengths of the roots were measured.

The results are shown in the graph below.



(a) (i) Analyse the data to explain the effect of copper ions on the growth of roots.

(3)

(ii) Explain how this investigation could be improved.

(3)

(b) Some grass plants possess an allele for copper tolerance. This allele allows them to grow in areas where there is a high concentration of copper ions in the soil.

Describe how natural selection has brought about different allele frequencies in the grass plants growing in these sites.

(5)

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 80 MARKS

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

Question Number	Acceptable Answer	Additional guidance	Mark
1(b)	mitotic index is (4 ÷ 40) x 100 = 10% (1) distance from tip = 0.1875 mm (1)	Allow full marks for correct answer, no working Allow answers between 0.1750 mm and 0.2000 mm	**(2)**

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

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

(Total for Question 1 = 5 marks)

Question Number	Acceptable Answer		Additional guidance	Mark
2(a)	The frequency of the recessive allele in the population is	0.02 (1)		**(4)**
	The frequency of the dominant allele in the population is	0.98 (1)		
	The percentage of heterozygous individuals (carriers) in the population is	3.92% (1)		
	The number of babies in a sample of 100 000 that are likely to be carriers is	3920 (1)		

Question Number	Acceptable Answer	Additional guidance	Mark
2(b)	An explanation that makes reference to the following: • Identify changes in the allele frequency over time (1) • if allele frequency stays the same, no evolution / if allele frequency changes, evolution (1)		**(2)**

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

(Total for Question 2 = 7 marks)

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

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

Question Number	Acceptable Answer	Additional guidance	Mark
3(b)	An explanation that makes reference to the following: • translocation inhibited but transpiration stream not inhibited (1) • phloem contains cytoplasm but xylem does not (1) • cytoplasm has organelles/mitochondria involved in metabolism (1)		**(3)**

(Total for Question 3 = 5 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
4(a)	A description that makes reference to three of the following: • starch has α-glucose and cellulose has β-glucose (1) • starch has α 1-4 glycosidic bonds and cellulose has β 1-4 glycosidic bonds (1) • starch has branched chains and cellulose has straight chains (1) • starch has no hydrogen bonds between chains and cellulose has hydrogen bonds between chains (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(b)(i)	An answer that makes reference to the following: • because {pH / microorganism number / water} affect decomposition (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(b)(ii)	An answer that makes reference to the following: • wash off soil to ensure mass is accurate (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(c)	An explanation that makes reference to the following: • bioplastic degrades faster than plastic made from crude oil (1) • bioplastic is a renewable resource whilst crude oil is finite (1) • correct manipulation of data (1)	Allow responses that state that plastics made from crude oil do not degrade	**(3)**

(Total for Question 4 = 8 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
5(a)	A description that makes reference to the following: • species richness is the number of species in a habitat (1) • whereas genetic diversity is the number of alleles in one species (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
5(b)	N(N-1) = 2652 (1) Sum of n(n-1) = 338 (1) D = 2652 ÷ 338 = 7.85 (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
5(c)	• *Lialis burtonis* is found in two locations therefore it is not endemic (1)	No marks if only a definition of endemic is given.	**(1)**

(Total for Question 5 = 6 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
6(a)	19 – 13 = 6 (1) (6*100) / 13 (1) = 46% (1)	Candidate must include percentage sign, or word to gain final marking point / full marks	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)	An explanation that makes reference to the following: • methylation of DNA base, therefore the expression of the gene is changed (1) • if histones are modified, this may affect binding of other proteins to DNA because DNA is wrapped around histones (1) • therefore genes may become activated or repressed (1)		**(3)**

(Total for Question 6 = 6 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
7(a)(i)	An explanation that makes reference to two of the following: • 25 °C to prevent growth of human pathogens / 37 °C would encourage growth of human pathogens (1) • lower temperatures would inhibit growth / make results difficult to obtain (1) • very high temperatures would kill bacteria / no results would be obtained (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(a)(ii)	An explanation that makes reference to the following: • because no bacteria were growing / present in the clear area (1) • therefore this indicates how effective the extracts were at killing or inhibiting the growth of the bacteria (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)(i)	An answer that makes reference to the following: • as diameter increases, the area increases much more dramatically (1) • manipulate the data to demonstrate this e.g. diameter suggest that lavender is 50% or 1.5 times more effective than lemon balm but mean area suggests that it is 2.2 times more effective (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)(ii)	An explanation that makes reference to the following: • it is not valid because concentrations of extracts are not known (1) • therefore increased possibility of anomalous results / no indication of range (1)		**(2)**

(Total for Question 7 = 8 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
8(a)	An explanation that makes reference to the following: • bone marrow contains unspecialised cells (1) • and these are needed because they have the ability to differentiate into heart cells (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
8(b)(i)	An answer that makes reference to the following: • pluripotent stem cells can differentiate and give rise to many cell types (1) • because genes in pluripotent stem cells are inactivated and therefore they cannot differentiate into all cell types (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
8(b)(ii)	An explanation that makes reference to five of the following: • stem cells are from same patient, therefore no rejection (1) • these stem cells receive stimulus from surrounding heart cells (1) • which causes some genes to be activated (1) • these active genes are transcribed to mRNA (1) • this mRNA is translated on ribosomes to produce polypeptide chains / proteins (1) • these proteins ensure that these cells develop into heart cells (1)		**(5)**

Question Number	Acceptable Answer	Additional guidance	Mark
8(c)	A description that makes reference to the following: • regulatory bodies / laws / High Court (1) Plus any three from: • setting or considering ethical / moral aspects (1) • judging what is acceptable / follow a code of practice (1) • checking that source of stem cells is acceptable (1) • decide on maximum age of embryo allowed for research / nervous system develops / feels pain (1) • human cloning is illegal (1)		**(4)**

(Total for Question 8 = 13 marks)

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

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

Question Number	Acceptable Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to the following: • less ATP means poor motility (1) • because movement of flagellum/tail requires ATP as a source of energy (1) • so some sperm are unable to reach / penetrate egg (1)		(3)

Question Number	Indicative content	
***9(c)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • sample size of {several / lots / many} males • sample selection of males of {same age / same mass / same health / same pre-treatment / same diet} • males given tablets and males given placebo • reference to time delay before measuring sperm motility • use of microscope to see sperm • sperm motility measured as distance moved / speed / μms^{-1} • reference to control of temperature (as it affects motility) • reference to clinical trials before testing on humans	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	A description of the investigation may be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made. The description will contain basic information with some attempt made to link knowledge and understanding to the given context.

Level	Mark	Descriptor
Level 2	3-4	A description of the investigation will be given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information. The description shows some linkages and lines of scientific reasoning with some structure.
Level 3	5-6	A description of the investigation is given which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information. The description shows a well-developed and sustained line of scientific reasoning which is clear, coherent and logically structured.

(Total for Question 9 = 11 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(i)	An explanation that makes reference to the following: • above 10 ppm, copper ions inhibit growth of roots, as SDs between 10 and 25 do not overlap (1) • during mitosis (for growth) DNA / proteins need synthesised (1) • this may not occur because the process requires enzymes, which may have been (negatively) affected / denatured by copper ions (1)	Allow no significant difference after 75 ppm, as SDs overlap from then on (1) because majority of enzymes are denatured so further addition has no more effect (1)	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(ii)	An explanation that makes reference to the following: • increase the validity by ensuring repeats and controlling variables (1) Plus any two from the following: • variables controlled in order to ensure that the effect is only due to copper ions (1) • use more concentrations of copper ions particularly between 10-25 ppm (1) • increase time period of experiment to find out more of the effects of copper on root growth (1) • measure shoot growth to see whether effect is only on roots (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(b)	A description that makes reference to the following: • mutation has given rise to allele for copper tolerance, which allows survival in soil with greater concentration of copper ions (1) • selection pressure in that there is a greater concentration of copper ions in one area (1) • plants without the allele do not survive (1) • therefore there are fewer plants and reduced competition for resources (1) • plants that survive pass on the allele for copper tolerance to next generation, therefore the frequency of allele for copper tolerance is higher in areas of high copper ion concentration (1)	Accept converse	**(5)**

(Total for Question 10 = 11 marks)

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