

GCSE (9–1) Biology B (Twenty First Century Science)

H

J257/03 Breadth in biology (Higher Tier)

Sample Question Paper

Date – Morning/Afternoon

Version 2.1

Time allowed: 1 hour 45 minutes

You may use:

- a scientific or graphical calculator
- a ruler



First name

Last name

Centre number

Candidate number

INSTRUCTIONS

- Use black ink.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION

- The total mark for this paper is **90**.
- The marks for each question are shown in brackets [].
- This document consists of **32** pages.

Answer **all** the questions.

1 Sarah is feeling unwell and feels very tired. Her doctor thinks that she may have Chronic Fatigue Syndrome (CFS).

(a) CFS is difficult to diagnose.

Before diagnosis, doctors rule out a condition called anaemia by carrying out a blood test.

A blood test checks the number of blood cells in Sarah's blood.

(i) What is the role of **red** blood cells?

.....
..... **[1]**

(ii) Extreme tiredness is one symptom of CFS.

The table shows the results of Sarah's blood test.

	Red blood cell (per mm³)	White blood cell (per mm³)	Platelets (per mm³)
Normal level	3 800 000	8 500	250 000
Sarah	2 700 000	9 000	245 000

Explain how the results in the table show the possible cause of Sarah's tiredness.

.....
.....
.....
.....
..... **[3]**

- (iii) The table below shows some information about red blood cells and cheek cells taken from a human.

	Red blood cell	Cheek cell
Surface area (μm^2)	136	7854
Volume (μm^3)	90	65 450
Surface area : volume ratio		0.12 : 1

Calculate the surface area : volume ratio of the red blood cell.

Show your working.

Give your answer to **two** significant figures.

Surface area : volume ratio = [1]

- (iv) Red blood cells have a greater surface area : volume ratio than cheek cells.

Explain how this allows red blood cells to carry out their function.

.....

 [1]

- (v) The doctor will check to see if Sarah has an underactive thyroid gland as this could also make her feel tired.

The thyroid gland produces a hormone.

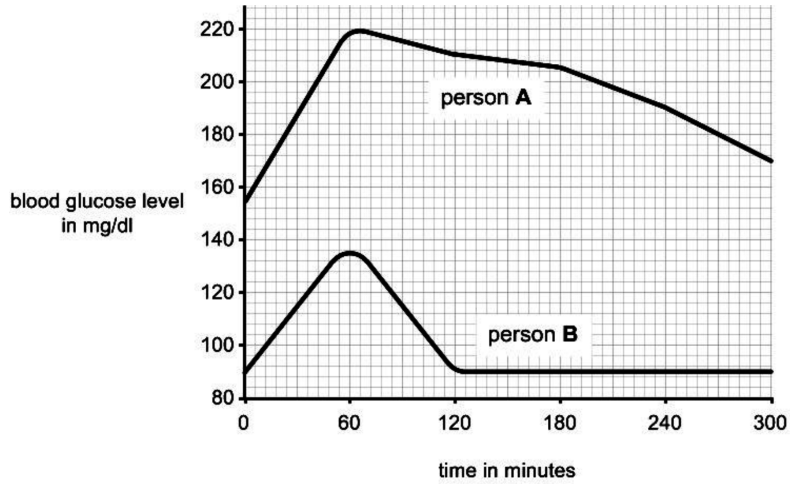
What is the role of a hormone?

..... [1]

(b) (i) Insulin is a hormone produced by the pancreas.

The graph shows data from two people who were given a sugary drink.

Their blood sugar level was recorded every 60 minutes.



There are two types of diabetes – type 1 and type 2.

- Person **A** has type 2 diabetes.
- Person **B** does not have diabetes.

Describe how the graph shows this and explain why there is a difference in the blood sugar level.

.....

.....

..... [2]

(ii) The statements below apply to type 1 and type 2 diabetes.

Draw **two** lines to link the sentences to **type 1 diabetes**.

Type 1 diabetes	body no longer responds to the insulin produced
	should eat a diet high in complex carbohydrates and exercise
	will need to inject insulin
	pancreas stops producing insulin

[2]

2 Limpets are molluscs that are found on rocky shores.



Limpet

A student wants to find out if there is a different population of limpets on different parts of the shore.

(a) Describe a method that the student could use to find out which parts of the rocky shore have more limpets.

.....

.....

.....

.....

.....

..... [3]

(b) The student counted the number of limpets on three parts of the rocky shore.

The results are shown in the table.

Part of shore	Number of limpets			
	Test A	Test B	Test C	Mean
Low shore (closest to sea)	15	16	17	
Mid shore	45	47	49	
High shore (furthest away from sea)	2	1	8	

(i) The student thinks that one of the results is an outlier.

Circle the outlier in the table above.

[1]

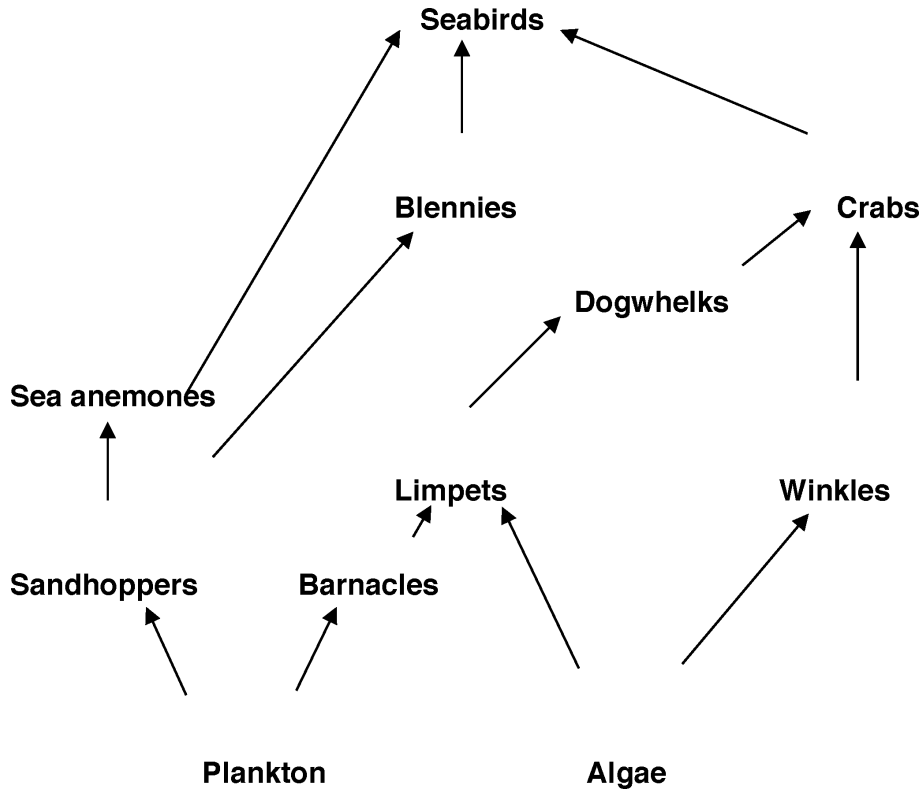
(ii) Calculate the mean number of limpets found on the mid shore.

Show your working.

Number = [2]

Turn over

(c) This is a food web for the species that can live on a rocky shore.



Explain the impact of an increase in the number of **dogwhelks** on one species in this food web.

.....

.....

.....

..... [2]

(d) In some areas of the UK, dogwhelk numbers are decreasing. This reduces biodiversity.

Give **two** benefits of maintaining biodiversity.

1

.....

2

..... [2]

(e) Sea anemones can reproduce asexually.

Give **one** advantage and **one** disadvantage of reproducing asexually.

Advantage

.....

Disadvantage

..... [2]

(f) (i) Sea anemones are mainly found in rock pools.

During the summer, the water temperature in a rock pool can increase. This can be dangerous for a sea anemone.

Put a tick (✓) in the box that best explains why this temperature increase is a problem.

Enzyme catalysed reactions will speed up.

Enzyme catalysed reactions will slow down.

Enzymes will be killed.

Enzymes will become denatured.

[1]

(ii) When it rains, the concentration of the sea water in a rock pools decreases.

What effect will this change in concentration have on a sea anemone's cells?

Put a tick (✓) in the box next to the correct answer.

Some cells may burst.

Some cells may shrink.

There will be no change to the cells.

Some cells will burst. Other cells will shrink.

[1]

3 DNA is a nucleic acid. It is found in all living cells.

(a) Read these statements about DNA.

Put ticks (✓) in the boxes next to the **two** correct statements.

DNA is made from four different nucleotides.

Half the nucleotides have a common sugar.

DNA is made from a copy of RNA.

Half the nucleotides have a phosphate group.

DNA is a polymer.

[2]

(b) RNA is another type of nucleic acid. It is involved in protein synthesis.

The table shows the nucleotide sequence in RNA that codes for different amino acids in proteins.

Amino acid	Amino acid abbreviation	Nucleotide sequence
glutamic acid	glu	G A G
leucine	leu	C U G
threonine	thr	A C G
tyrosine	tyr	U A C

Look at the nucleotide sequence in a section of RNA.

G A C U G G A G U A C A C G C C

Write down the sequence of amino acids that this section of RNA codes for.

Use the abbreviation for each amino acid.

..... — — —

[1]

(c) A mutation occurs in the RNA sequence in (b).

The nucleotide sequence that results is:

G A C U G U A G U A C A C G C C

Suggest the effect on the production of a protein.

.....

.....

.....

.....

.....

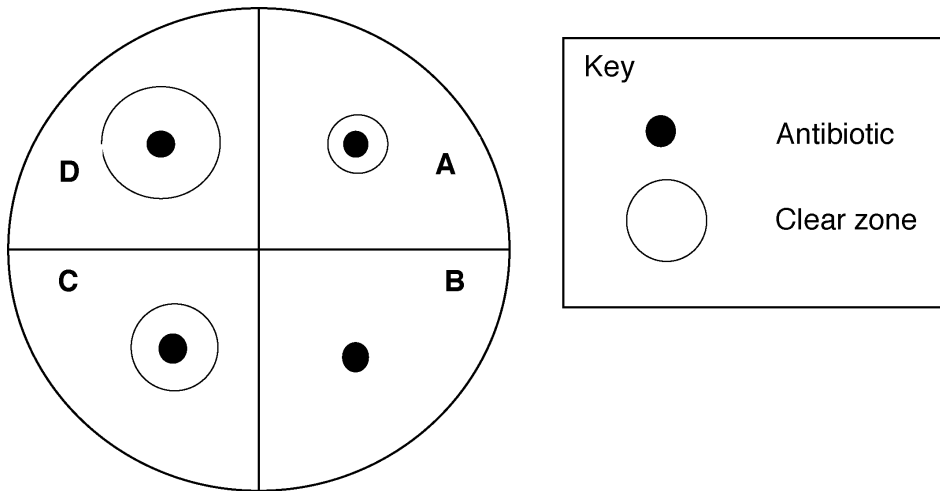
..... **[4]**

4 Jack has a bacterial infection caused by *Streptococcus pneumoniae*.

A doctor takes a sample from Jack to work out which antibiotic will kill the bacteria.

The diagram below shows the effectiveness of four different antibiotics when grown on agar jelly.

- The clear zone for each antibiotic is shown on the diagram.
- The clear zone is the area of the bacteria that has been killed by the antibiotic.
- The table shows the areas of the clear zones.



Antibiotic	Clear zone (mm ²)
A	50.24
B	0.00
C	94.99
D	

(a) (i) Using the formula πr^2 , calculate the clear zone for antibiotic D.

Show your working.

- $\pi = 3.14$

Clear zone = mm² [2]

(ii) Jack's doctor must decide which antibiotic to prescribe him.

Use the information provided at the start of this question to decide which of the following conclusions can be made.

Put a tick (✓) in the box next to the correct conclusion.

Antibiotic **A** works best.
Jack should be given antibiotic **A**.

Antibiotic **B** has the least effect.
Jack should not be given antibiotic **B**.

Antibiotic **C** works best.
Jack should be given antibiotic **C**.

All antibiotics worked equally well.
Jack can be given any antibiotic.

[1]

(iii) The control for this test could have been a disc which did not contain any antibiotic.

State a reason for using a control in this experiment.

.....
..... **[1]**

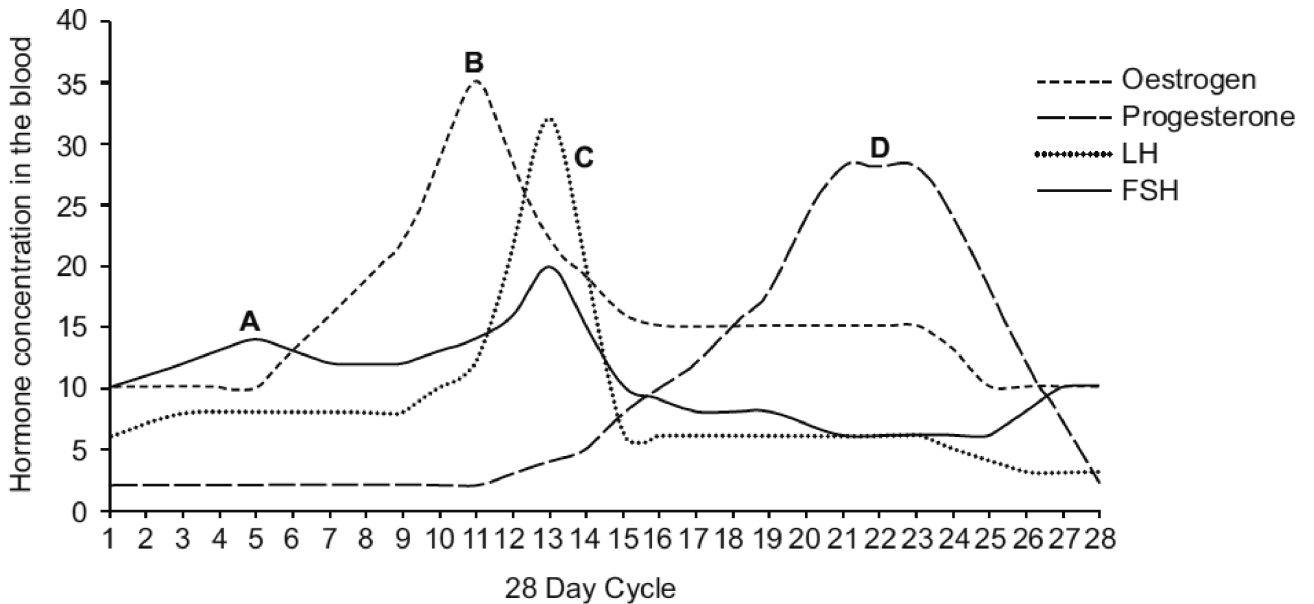
(b) Aseptic techniques must be used when culturing organisms.

Give an example of an aseptic technique and explain why it is used.

.....
.....
..... **[2]**

5 (a) The human menstrual cycle is controlled by hormones.

The diagram shows the concentration of the four hormones involved in the menstrual cycle.



Which letter, **A**, **B**, **C** or **D**, shows when ovulation occurs?

.....

[1]

(b) Some couples are unable to conceive a child naturally. In-vitro fertilisation (IVF) is a technique that can be used to help these couples.

In IVF, a woman's ovaries are stimulated to produce a greater number of eggs than during a normal menstrual cycle.

Which hormone could be used to achieve this?

Put a tick (✓) in the correct box.

- Oestrogen
- Progesterone
- LH
- FSH

[1]

(c) To confirm that a female is pregnant, a pregnancy test will be done. This test uses monoclonal antibodies.

(i) Describe how monoclonal antibodies are produced.

.....
.....
.....
.....
.....
..... [3]

(ii) Antibodies are proteins.

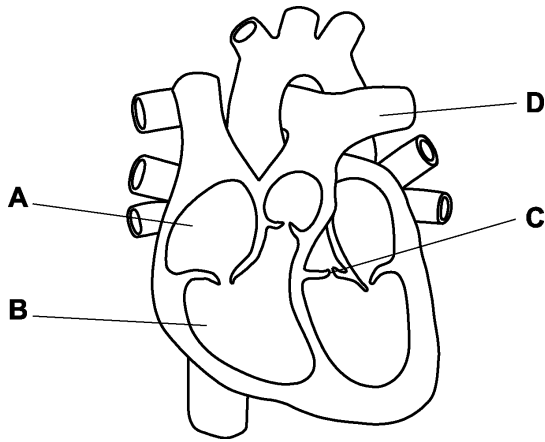
The statements below describe protein synthesis.

- A A copy of the gene is made from messenger RNA.
- B The gene that codes for the protein is found in the DNA.
- C The mRNA travels to a ribosome in the cytoplasm.
- D The ribosome joins the amino acids together in the correct order.

Put the statements in the correct order.

..... [1]

6 Look at the diagram of the heart.



(a) (i) Which letter on the diagram, **A**, **B**, **C** or **D**, shows how the backflow of blood is prevented?

Place a tick (✓) in the correct box.

A

B

C

D

[1]

(ii) The blood vessels in the circulatory system are adapted to their function.

The table shows features of the three different blood vessels, **X**, **Y** and **Z**.

Vessel	Smooth inner lining	Valves	Muscular tissue	Elastic tissue
X	Yes	Yes	Yes	Yes
Y	Yes	No	Yes	Yes
Z	Yes	No	No	No

Using the table, identify the **type** of blood vessel for **X**, **Y** and **Z**.

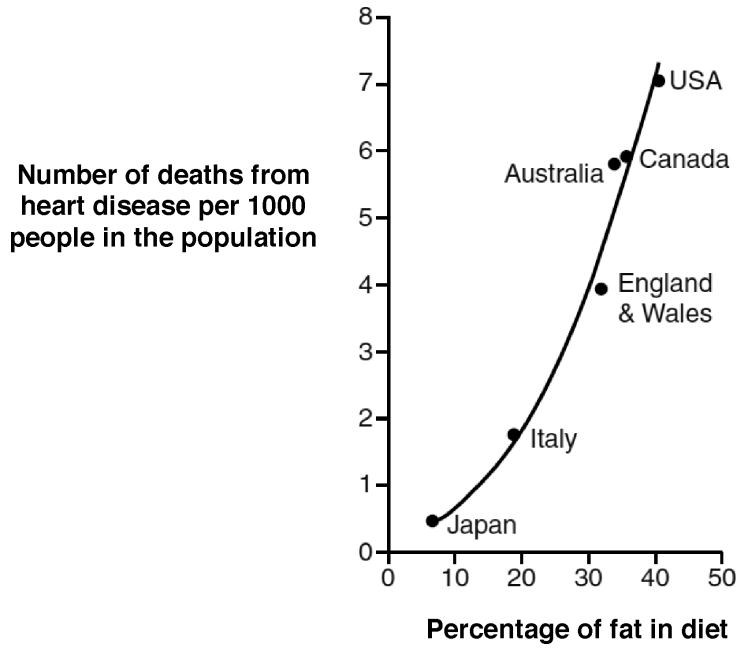
Blood vessel **X**

Blood vessel **Y**

Blood vessel **Z** [3]

- (b) A scientist collected information about the percentage of fat in people's diet and the number of deaths from heart disease in various countries.

The information was plotted in the graph below.



- (i) What can you conclude about the percentage of fat in the diet and the chance of dying from heart disease?

.....
..... [1]

- (ii) What **two** lifestyle changes might you suggest to a person to decrease their chance of dying from heart disease?

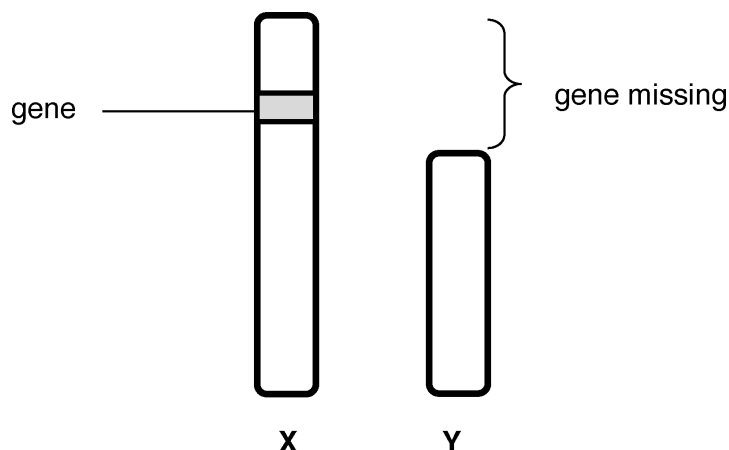
1

2 [2]

(c) Some diseases are inherited.

Haemophilia is an example of an inherited disease, caused by a **recessive allele**. The gene for haemophilia is located on the sex chromosomes.

Due to the location of the gene for haemophilia, females inherit two copies of the gene, but males only inherit one. For a male, this is shown on the diagram below.



Males **cannot** be carriers for haemophilia. They either have the disease or they do not.

(i) A female carrier has the genotype $X^H X^h$ and a healthy male has the genotype $X^H Y$.

Complete the Punnet square to show the probability of this couple having a son with haemophilia.

	X^H	X^h
X^H		
Y		

Probability = [2]

(ii) Which of the following genotypes would a female with haemophilia have?

Put a tick (✓) in the correct box.

- $X^H X^H$
- $X^H X^h$
- $X^h X^h$
- $X^H X$

[1]

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TURN OVER FOR THE NEXT QUESTION

- 7 (a) (i) Mia has an eye disease that weakens the fibres that hold her cornea in place.

Her cornea has become damaged, causing its shape to change.

What is the role of the cornea and how will damage to the shape affect Mia's sight?

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.....
.....
..... [2]

- (ii) Scientists are now using stem cells to repair damage to corneas.

What is a stem cell?

.....
..... [1]

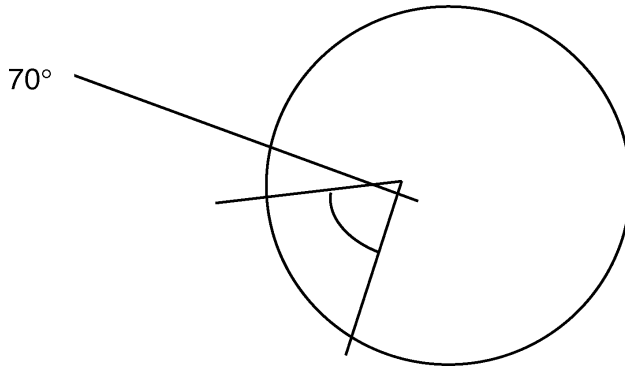
- (iii) Stem cells can be obtained from embryos.

Why are some people against using embryos as a source of stem cells?

.....
..... [1]

(b) New body cells are created as part of the cell cycle.

This is represented in the diagram.



In this example, the whole cell cycle, takes 141 minutes.

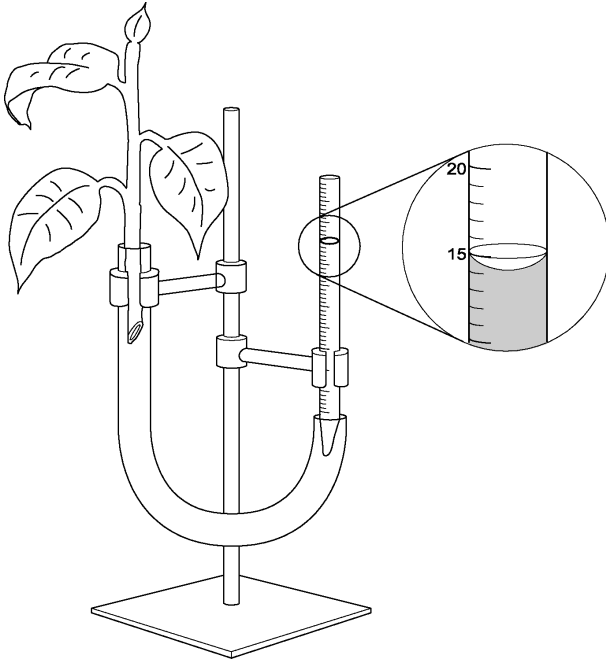
Calculate the time spent in mitosis.

Give your answer to **two** decimal places.

Time spent in mitosis = minutes [2]

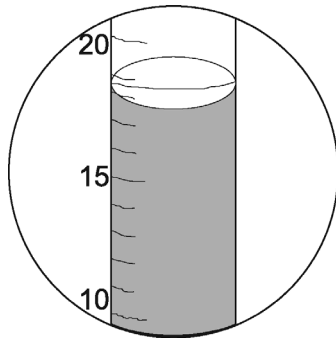
- 8 A student investigates the effect of temperature on the rate of water uptake by a plant.

- (a) She places a plant in the apparatus shown below. The temperature of the room is 35°C.

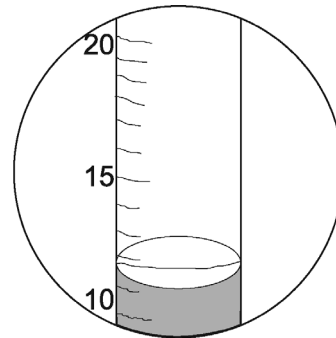


- (i) The student measured the distance moved by the water level over a period of 30 minutes.

The diagrams show her results.



Water level before



Water level after

Calculate the rate of water uptake.

Show your working.

Give your answer to **two** significant figures.

Rate of water uptake = cm³/min [2]

(ii) How could the student use this apparatus to investigate the rate of water uptake in windy conditions?

Other apparatus is available.

.....
..... [1]

(iii) The volume of water taken up may **not** be an accurate measurement of the water lost in transpiration.

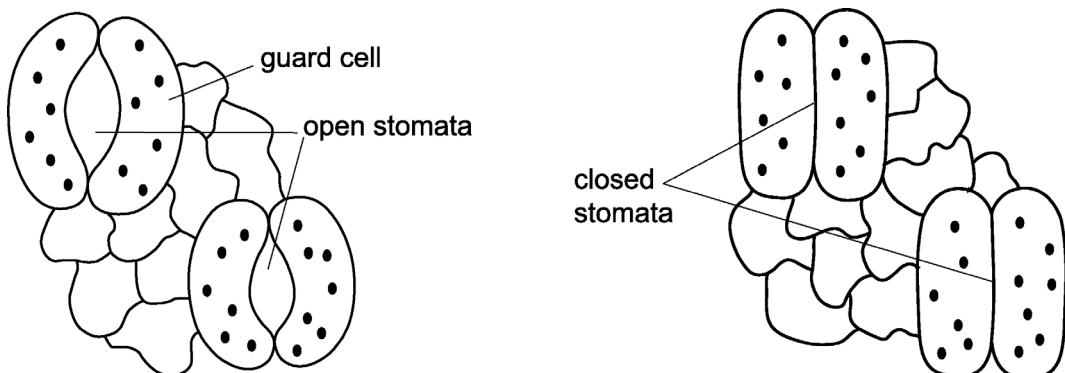
Suggest why.

.....
.....
..... [2]

(b) Stomata are small holes found mostly on the underside of leaves.

They can open and close. The opening and closing of the stomata is controlled by guard cells.

The diagram shows the stomata and the guard cells.



Potassium ions from neighbouring cells enter the guard cells. This causes the stomata to open.

Explain how this mechanism works.

.....
.....
.....
..... [2]

9 (a) In 1991 a type of genetically modified tomato was being developed.

This tomato contained a gene from a fish called an arctic flounder. Arctic flounder live in very cold conditions.

How would the tomato with the arctic flounder gene be useful to modern agriculture?

.....
..... [1]

(b) Genetic modification has many wider applications.

Children who lack human growth hormone can be injected with a genetically engineered version so that they grow as normally as possible.

The bacterium *Escherichia coli* is used as part of the genetic engineering process.

Use this information to describe how human growth hormone is made.

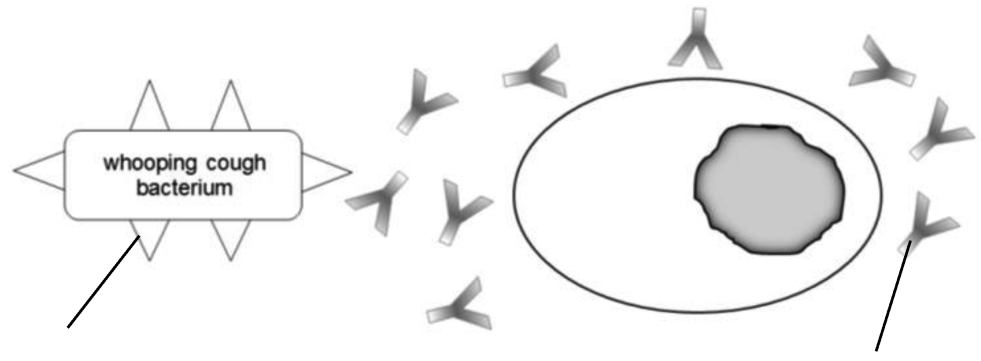
.....
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.....
.....
..... [3]

23
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TURN OVER FOR THE NEXT QUESTION

10 (a) Whooping cough is a non-communicable bacterial infection.

The diagram below shows the blood of a person infected with whooping cough. Label the two structures in the diagram.



(i)

(ii)

[2]

(iii) People can be vaccinated against whooping cough.

There are two types of vaccine:

- Type 1 uses whole bacterial cells
- Type 2 uses parts of bacterial cells.

Some people are concerned about using the Type 1 vaccine with whole bacterial cells.

Suggest why.

.....
..... [1]

- (b) New medicines, including vaccines, have to be tested before being made widely available.

Preclinical and clinical tests are used to assess the safety and effectiveness of new medicines.

For each test, complete the table by putting a tick (✓), in **one** box to indicate if it assesses **safety**, **effectiveness** or **both**.

For each test, one example has been done for you.

Preclinical tests	Safety	Effectiveness	Both
Cultured human cells			✓
Whole animals			

Clinical tests	Safety	Effectiveness	Both
Healthy volunteers			
Humans with the disease			✓

[2]

- 11 (a) James Watson and Francis Crick are famous for identifying the structure of DNA. They wrote a scientific paper about DNA in 1953.

Before this, scientists had clues about the parts of the DNA molecule. One of these clues was the relative amounts of the bases: A, T, C and G.

Chemical analysis of DNA from a wide variety of cells showed that

Total number of A bases and G bases = Total number of T bases and C bases.

What conclusion could early scientists have made from this analysis?

.....
.....
..... [2]

- (b) DNA structure is important in the production of proteins. DNA analysis allows scientists to group organisms based on similarities in their DNA.

Complete the sentences below.

A of bases is required to code for an amino acid.

The properties of the protein made depend on the.....of the amino acids.

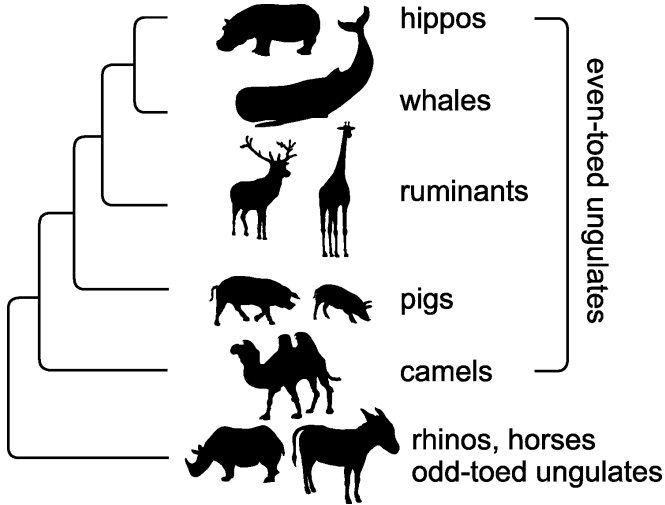
Grouping organisms according to similarities in their DNA or physical characteristics is called [3]

- (c) Knowledge of genetics and DNA analysis has allowed scientists to group organisms based on similarities in their DNA.

Scientists can then draw conclusions about the evolutionary relationships between organisms.

An evolutionary tree can be drawn to highlight these relationships.

An example is shown below.



Are hippos more closely related to whales or to pigs?

Justify your answer using evidence from the evolutionary tree in your answer.

.....

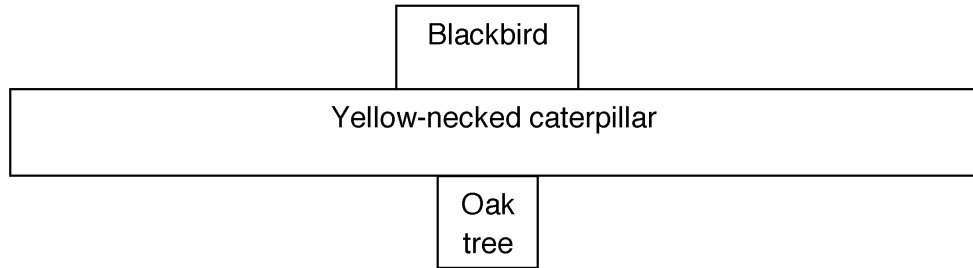
.....

..... [2]

- 12 (a) Sundip considers different options for displaying data about the organisms found in a woodland ecosystem.

One option is a pyramid of numbers for the simple food chain, as in the example below.

Oak tree → Yellow-necked caterpillar → Blackbird

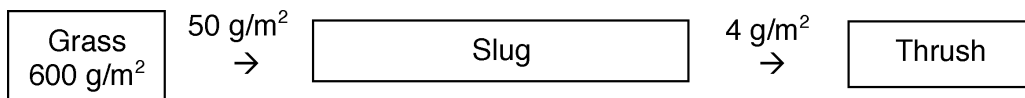


Draw a pyramid of biomass for this food chain in the space below.

[1]

- (b) Biomass in an ecosystem can be measured in g/m^2 .

Values for a different food chain in the same woodland ecosystem as in (a) are shown below.



- (i) Calculate the percentage of the biomass from the grass that is passed on to the thrush.

Show your working.

Give your answer to **two** decimal places.

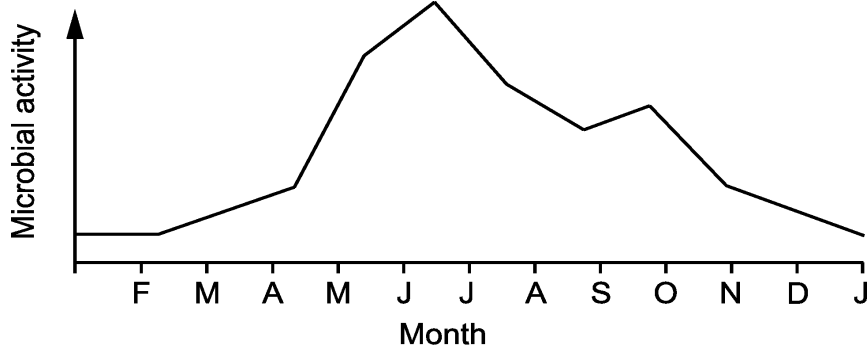
Biomass =% [1]

(ii) Give **one** reason why so little biomass from the grass is passed on to the thrush.

.....
..... [1]

(c) Decomposers are also an important part of ecosystems.

The graph shows the activity of decomposers in a woodland ecosystem during a year, from January to December.



(i) Describe the pattern of microbial activity shown in the graph above.

.....
.....
.....
..... [2]

(ii) Explain the pattern you have described in (c)(i).

.....
.....
.....
..... [2]

END OF QUESTION PAPER

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Oxford Cambridge and RSA

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...day June 20XX – Morning/Afternoon

GCSE (9–1) Biology B (Twenty First Century Science)

J257/03 Breadth in biology (Higher Tier)

SAMPLE MARK SCHEME

Duration: 1 hour 45 minutes

MAXIMUM MARK 90

This document consists of 20 pages

MARKING INSTRUCTIONS**PREPARATION FOR MARKING****SCORIS**

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal <http://www.rm.com/support/ca>
3. Log-in to scoris and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

5. Work crossed out:
 - a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
 - b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.
6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.
7. There is a NR (No Response) option. Award NR (No Response)
 - if there is nothing written at all in the answer space
 - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
 - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).
8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.** If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.
9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. Annotations

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

11. Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Biology B:

	Assessment Objective
AO1	Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

Question			Answer	Marks	AO element	Guidance
1	(a)	(i)	Transports oxygen ✓	1	1.1	ALLOW carries oxygen / carries carbon dioxide / transports carbon dioxide
		(ii)	Any three from 1. Sarah has fewer red blood cells than normal ✓ 2. Less oxygen transported ✓ 3. So less ATP produced ✓ 4. As less respiration ✓	3	2.1	MP3 DO NOT ALLOW less energy produced
		(iii)	136 / 90 = 1.5 : 1 ✓	1	2.2	
		(iv)	Increases rate of diffusion of oxygen into cell ✓	1	1.1	
		(v)	A (chemical) messenger ✓	1	1.1	
	(b)	(i)	Any one from <i>Descriptions</i> 1. Person B sugar level falls faster / person A sugar level falls more slowly ✓ 2. Person B sugar level falls back to starting level after just over 2 hours / Person A sugar level remains high ✓ Any one from <i>Reasons why</i> 3. Person A does not respond to the hormone / insulin produced to convert sugar to glycogen ✓ 4. Person B produces a hormone / insulin in response to the rise in blood sugar and this causes cells to convert the sugar to glycogen so the level falls ✓	2	3.1a 2.1	Max 1 for description and max 1 for the reason why MPs 3 and 4 DO NOT ALLOW a reference to hormone response or lack of response without reference to the role of insulin.

Question		Answer	Marks	AO element	Guidance
	(ii)	<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">Type 1 diabetes</div> <div style="display: flex; flex-direction: column; gap: 10px;"> <div style="border: 1px solid black; padding: 5px;">body no longer responds to the insulin produced</div> <div style="border: 1px solid black; padding: 5px;">should eat a diet high in complex carbohydrates and exercise</div> <div style="border: 1px solid black; padding: 5px;">will need to inject insulin</div> <div style="border: 1px solid black; padding: 5px;">pancreas stops producing insulin</div> </div> </div>	2	1.1	If more than 2 lines are drawn, delete one mark for each incorrect line

Question		Answer	Marks	AO element	Guidance	
2	(a)	<p>Any three from Use a line transect AND quadrat ✓ Running from the sea up the shore ✓ To take many samples ✓ Repeat at different parts of the shore ✓</p>	3	2.2		
	(b)	(i)	8 ✓	1	3.1a	
		(ii)	<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 47 award 2 marks</p> <p>$(45 + 47 + 49) / 3$ ✓ 47 ✓</p>	2	2.2	
	(c)	<p>limpets will decrease in numbers ✓ as more are eaten ✓ OR crabs will increase ✓ as more food ✓</p>	2	3.1a 2.1 3.1a 2.1	ALLOW any correct species with correct explanation	
	(d)	<p>Any two from idea of interdependence ✓ example of interdependence e.g. food / shelter / reproduction ✓ maintaining genetic diversity ✓ may be required in the future for medicines ✓ maintains the stability of the food web ✓</p>	2	1.1		
	(e)	<p>Advantage: (can be) fast / no need to find a mate ✓ Disadvantage: lack of genetic diversity / are all genetically identical ✓</p>	2	1.1	MP2 ALLOW are clones DO NOT ALLOW are all identical	
	(f)	(i)	✓ Enzymes will become denatured	1	2.1	If more than one box is ticked, do not award the mark even if the correct box is also ticked
		(ii)	✓ Some cells may burst	1	2.1	If more than one box is ticked, do not award the mark even if the correct box is also ticked

Question		Answer	Marks	AO element	Guidance
3	(a)	<ul style="list-style-type: none"> ✓ DNA is made from four different nucleotides ✓ DNA is a polymer 	2	1.1	If more than two boxes are ticked, do not award the mark even if the correct box is also ticked
	(b)	Correct sequence of amino acids – leu, glu, tyr, thr ✓	1	2.1	ALLOW leucine, glutamine, tyrosine, threonine
	(c)	<p>Any four from</p> <ul style="list-style-type: none"> Mutation is a substitution ✓ Result could be no change / new triplet might still code for same amino acid ✓ Result might be that the new triplet code for a different amino acid ✓ This might cause the protein not to function correctly / not to form ✓ Might affect a characteristic / the phenotype ✓ 	4	2.1	

Question			Answer	Marks	AO element	Guidance
4	(a)	(i)	<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 177.63 award 2 marks</p> <p>$\pi (7.5 \times 7.5) \checkmark$ 177.63 mm² \checkmark</p>	2	1.2	
		(ii)	\checkmark Antibiotic B has the least effect. Jack should not be given antibiotic B	1	3.2b	
		(iii)	<p>Any one from Used as a comparison \checkmark To show that it is the antibiotic that has the effect \checkmark</p>	1	3.3a	
	(b))	<p><i>Technique</i> Working under flame \checkmark Use of alcohol / flame \checkmark <i>For explanation</i> Prevents other bacteria colonising agar plate \checkmark Kills other microorganisms \checkmark</p>	2	1.2	<p>ALLOW any correct technique</p> <p>Technique and explanation required for 2 marks</p> <p>DO NOT ALLOW two techniques for 2 marks</p>

Question		Answer	Marks	AO element	Guidance
5	(a)	C ✓	1	2.1	
	(b)	✓ FSH	1	1.1	
	(c) (i)	Antigen is injected into the animal ✓ The antibody producing cells are taken from the animal ✓ The cells producing the correct antibody are then Selected and cultured ✓	3	1.1	All three stages needed for three marks
	(ii)	D B A C	1	1.1	

Question			Answer	Marks	AO element	Guidance									
6	(a)	(i)	✓ C	1	1.1										
		(ii)	Blood vessel X – vein ✓ Blood vessel Y – artery ✓ Blood vessel Z – capillary ✓	3	1.1										
	(b)	(i)	As the percentage of fat in the diet increases, the greater the risk of dying from heart disease ✓	1	3.2b										
		(ii)	Any two from Reduce amount of fat in diet ✓ Reduce stress ✓ Stop smoking ✓ Take (regular) exercise ✓	2	3.1b	ALLOW reduce cholesterol/salt									
	(c)	(i)	Correct Punnet square ✓ <table border="1" style="margin: 10px auto; width: 200px; height: 150px;"> <tr> <td></td> <td>X^H</td> <td>X^h</td> </tr> <tr> <td>X^H</td> <td>X^HX^H</td> <td>X^HX^h</td> </tr> <tr> <td>Y</td> <td>X^HY</td> <td>X^hY</td> </tr> </table> Probability 25% / ¼ / 1 in 4 ✓		X ^H	X ^h	X ^H	X ^H X ^H	X ^H X ^h	Y	X ^H Y	X ^h Y	2	1.2	3.1a ECF correct probability if Punnet square incorrect
	X ^H	X ^h													
X ^H	X ^H X ^H	X ^H X ^h													
Y	X ^H Y	X ^h Y													
		(ii)	X ^h X ^h ✓	1	2.1										

Question			Answer	Marks	AO element	Guidance
7	(a)	(i)	Cornea – responsible for bending the light ✓ Light rays will no longer meet on the retina so sight will be poor ✓	2	1.1 2.1	ALLOW reference to blindness
		(ii)	An unspecialised cell ✓	1	1.1	
		(iii)	Any one from Embryos killed in the process ✓ Embryos could be a life ✓	1	2.1	
	(b)		FIRST CHECK THE ANSWER ON THE ANSWER LINE IF Answer = 27.42 award 2 marks (141 ÷ 360) × 70 ✓ 27.42 (minutes) ✓	2	2.2	

Question			Answer	Marks	AO element	Guidance
8	(a)	(i)	<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 0.23 award 2 marks</p> <p>7 / 30 ✓ 0.23 ✓</p>	2	1.2	ALLOW 1 mark for 7 / 30
		(ii)	Measure the rate of water uptake with a fan running on the shoot ✓	1	3.3a	DO NOT ALLOW 'place plant/apparatus outside'
		(iii)	<p>Any two from</p> <p>1. Water may be lost from parts of the equipment that are not sealed ✓</p> <p>2. Some water is used for photosynthesis ✓</p> <p>3. If the plant is wilting, the plant will use water to restore turgidity ✓</p>	2	1.2 1.1	DO NOT ALLOW incorrect use of water e.g. respiration
	(b)		<p>Any two from</p> <p>Potassium ions (reduce the water potential) increase the concentration in the guard cells ✓</p> <p>So water moves into the cell ✓</p> <p>By osmosis ✓</p> <p>Guard cells become turgid ✓</p>	2	1.1	

Question			Answer	Marks	AO element	Guidance
9	(a)		Able to grow in colder conditions / less likely to be damaged by cold conditions ✓	1	2.1	DO NOT ALLOW reference to freezing tomatoes
	(b)	(i)	Any three from: Isolate the gene for human growth hormone ✓ Put the gene into a vector / plasmid ✓ Use the vector to put the (human growth hormone) gene into <i>E.coli</i> bacteria ✓ Grow bacteria / separate the hormone ✓	3	2.1	

Question			Answer	Marks	AO element	Guidance																								
10	(a)	(i)	Antigen ✓	1	1.1																									
		(ii)	Antibody ✓	1	1.1																									
		(iii)	Whole cell could cause disease ✓	1	2.1																									
	(b)		<table border="1"> <thead> <tr> <th>Preclinical tests</th> <th>Safety</th> <th>Effectiveness</th> <th>Both</th> </tr> </thead> <tbody> <tr> <td>Cultured human cells</td> <td></td> <td></td> <td>✓</td> </tr> <tr> <td>Whole animals</td> <td></td> <td></td> <td>✓</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Clinical tests</th> <th>Safety</th> <th>Effectiveness</th> <th>Both</th> </tr> </thead> <tbody> <tr> <td>Healthy volunteers</td> <td>✓</td> <td></td> <td></td> </tr> <tr> <td>Humans with the disease</td> <td></td> <td></td> <td>✓</td> </tr> </tbody> </table>	Preclinical tests	Safety	Effectiveness	Both	Cultured human cells			✓	Whole animals			✓	Clinical tests	Safety	Effectiveness	Both	Healthy volunteers	✓			Humans with the disease			✓	2	1.1	Tick in correct box for mark If more than one box is ticked in each empty row, do not award the mark even if the correct box is also ticked
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Question		Answer	Marks	AO element	Guidance
11	(a)	A pairs with T or A pairs with C ✓ G pairs with T or G pairs with C ✓	2	3.2b	DO NOT ALLOW A pairs with T or G pairs with C alone
	(b)	Triplet ✓ Order / sequence ✓ Classification ✓	3	1.1	
	(c)	Whales ✓ As they are closer to them on the tree ✓	2	2.1	

Question		Answer	Marks	AO element	Guidance	
12	(a)	Would have biggest bar at bottom, then next biggest with smallest at top ✓	1	2.1	DO NOT ALLOW if bars are not labelled	
	(b)	(i)	(4 / 600) x 100 = 0.67% ✓	1	2.2	
		(ii)	Any one from Not all of the biomass is eaten e.g. roots ✓ Biomass is used in respiration (by other organisms) ✓ Biomass is egested (by slugs/ thrush) ✓	1	2.1	DO NOT ALLOW biomass egested by grass
	(c)	(i)	Any two from Activity starts to rise in spring ✓ Activity is at its peak in the summer months ✓ Activity falls in autumn ✓ Activity is low in the winter ✓	2	3.1a	
		(ii)	Any two from (Rise in spring) as more water is available ✓ (peak in summer) as this is when it is warmer / when the temperature is higher ✓ (Fall / low in autumn / winter) as this is when it is colder / when the temperature is lower ✓ <i>Idea of a link between more enzyme activity and more decomposer activity</i> ✓	2	1.1	

Summary of updates

Date	Version	Change
May 2018	2	We've reviewed the look and feel of our papers through text, tone, language, images and formatting. For more information please see our assessment principles in our "Exploring our question papers" brochures on our website
October 2019	2.1	Question 1(b)(ii)- Mark Scheme correction from "body no longer responds to the insulin produced" to "pancreas stops producing insulin"