AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
BIOLOGY

H

Higher Tier Paper 2H

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator.

Instructions
- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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Answer **all** questions in the spaces provided.

0 1 There are two types of reproduction:

- sexual reproduction
- asexual reproduction.

0 1 . 1 Complete **Table 1** to compare sexual reproduction with asexual reproduction.

Write a tick (✓) in the box if the statement is true.

The first row has been completed for you.

[2 marks]

Table 1

	Sexual reproduction	Asexual reproduction
Cell division occurs	✓	✓
Fertilisation occurs		
Genes are passed on from parent to offspring		
Offspring are genetically identical to each other		

0 1 . 2 Gametes are formed in sexual reproduction.

Name the male gamete formed in flowering plants.

[1 mark]

_____

Question 1 continues on the next page

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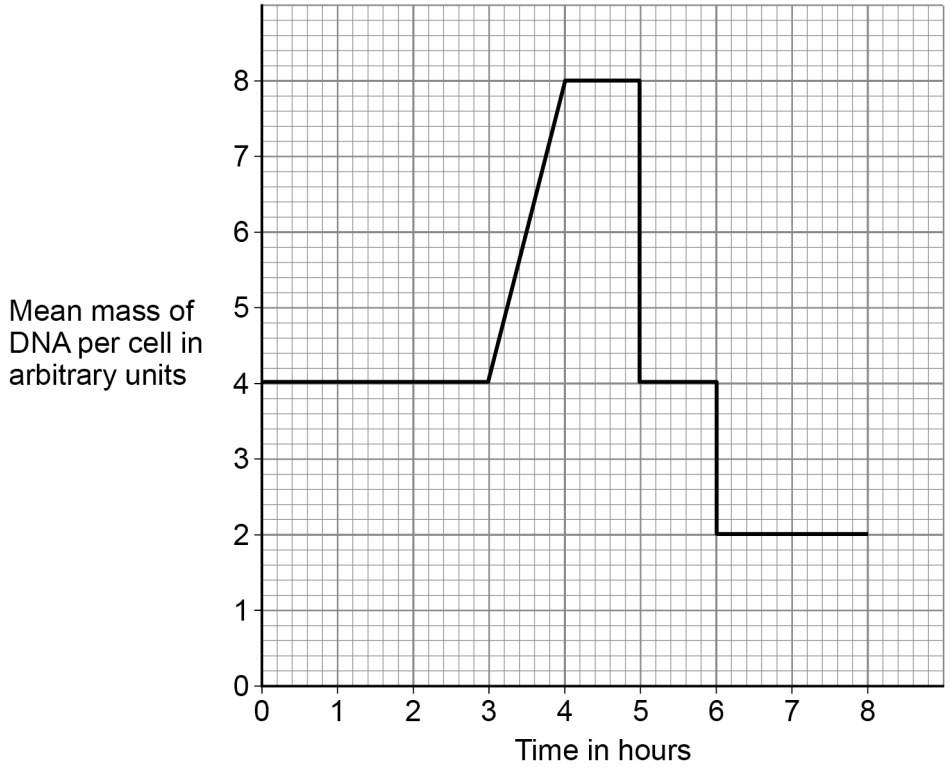
Cell division by meiosis forms gametes.

Figure 1 shows the mean mass of DNA per cell before, during and after meiosis.

Figure 1



Use information from **Figure 1** to answer questions **01.3** to **01.6**.

0 1 . 3 When is the DNA in the chromosomes being copied?

[1 mark]

Tick (✓) **one** box.

Between 0 and 3 hours ☐

Between 3 and 4 hours ☐

Between 4 and 5 hours ☐

Between 5 and 6 hours ☐

Do not write outside the box

0 1 . 4 Cells divide twice during meiosis.

Which **two** times in **Figure 1** show one cell dividing into two cells?

[2 marks]

Tick (✓) **two** boxes.

3 hours ☐

4 hours ☐

5 hours ☐

6 hours ☐

8 hours ☐

0 1 . 5 What is the mean mass of DNA in arbitrary units in a sperm cell?

[1 mark]

Tick (✓) **one** box.

2 ☐ 4 ☐ 8 ☐ 16 ☐

0 1 . 6 What is the mean mass of DNA in arbitrary units in each cell in an embryo?

[1 mark]

Tick (✓) **one** box.

2 ☐ 4 ☐ 8 ☐ 16 ☐

8

Turn over for the next question

Do not write outside the box

0 2 Earthworms:

- live in soil
- feed on dead and decaying plant matter
- have soft, moist skin
- exchange gases through their skin.

0 2 . 1 Give **two** abiotic factors and **two** biotic factors that could affect the size of an earthworm population.

[4 marks]

Abiotic factors

1 _____

_____

2 _____

_____

Biotic factors

1 _____

_____

2 _____

_____

Do not write outside the box

0 2 . 2 Students investigated the populations of earthworms in the soil in two different areas:

- Area **A**: a grass lawn
- Area **B**: a farmer's field.

Chemical **X** can be mixed with water and poured onto the soil.

The mixture brings earthworms to the surface of the soil but does **not** harm the earthworms.

Plan an investigation using chemical **X** to compare the number of earthworms per m^2 in areas **A** and **B**.

[6 marks]

10

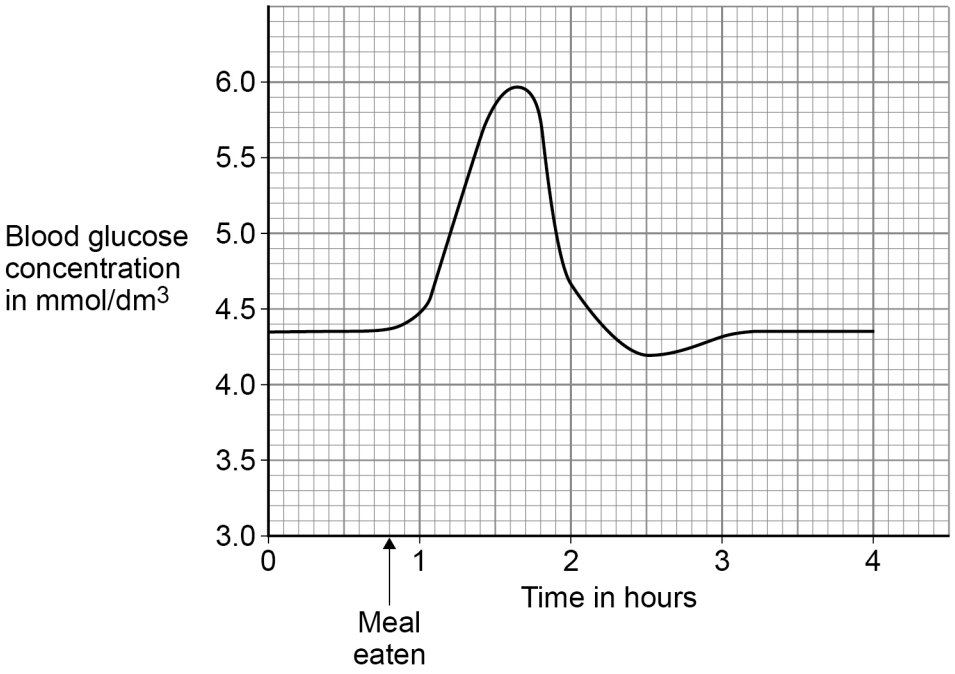
Turn over for the next question

Do not write outside the box

0 3 It is important to control the concentration of glucose in the blood.

Figure 2 shows how the concentration of glucose in the blood of a person changed over 4 hours.

Figure 2



0 3 . 1 Give **one** time when the concentration of **insulin** in the person's blood would be high.

Use **Figure 2**.

[1 mark]

Time = _____ hours

Do not write outside the box

0 3 . 2 Explain the effect a high concentration of insulin has on blood glucose concentration.

[3 marks]

Effect _____

Explanation _____

_____

_____

_____

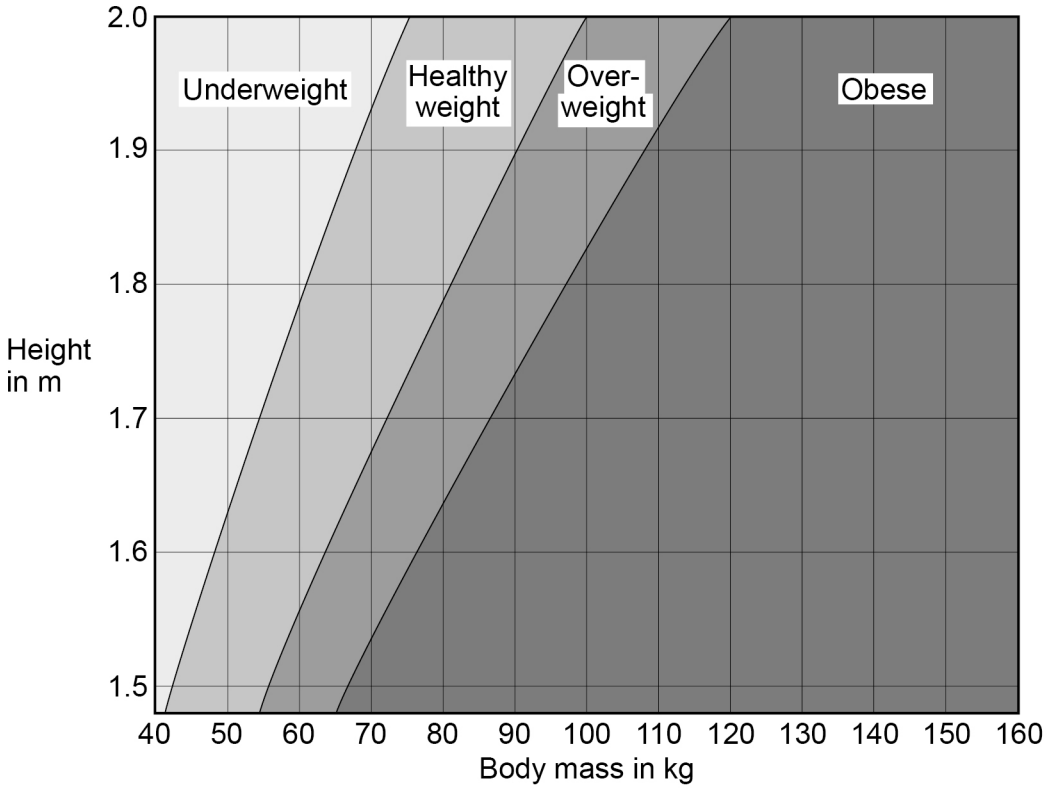
Question 3 continues on the next page

People with diabetes have difficulty controlling the concentration of glucose in their blood.

Type 2 diabetes is linked to obesity.

Figure 3 shows how to find if an adult's body mass is healthy for their height.

Figure 3



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0 3 . 3 Person **A**:

- is 1.75 m in height
- has a body mass of 52 kg.

What is person **A**'s weight category?

[1 mark]

Tick (✓) **one** box.

Underweight ☐

Healthy weight ☐

Overweight ☐

Obese ☐

0 3 . 4 Person **B** is 1.9 m in height.

Give the range of body masses that would put person **B** in the healthy weight category.

[1 mark]

Range from _____ kg to _____ kg

Question 3 continues on the next page

Do not write outside the box

0 3 . 5 Person **C** is obese.

A doctor thinks that person **C** has Type 2 diabetes.

The doctor tests a sample of blood from person **C**.

Table 2 shows:

- the results of the blood test
- the mean results for people who do **not** have diabetes.

Table 2

	Concentration in blood	
	Person C	**Mean for people who do not have diabetes**
Cholesterol in mmol/dm^3	6.21	5.20
Glucose in mmol/dm^3	9.56	4.51
Insulin in arbitrary units	24.32	14.83

Type 2 diabetes occurs when body cells have a reduced response to insulin.

Give **two** ways the results of the blood test show that person **C** might have Type 2 diabetes.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

0 3 . 6 Give **two** ways that a person can reduce the chance of developing Type 2 diabetes.

[2 marks]

1 _____

_____

2 _____

_____

10

Turn over for the next question

Do not write outside the box

0 4 The rapid growth in human population means that more waste substances are released into the environment.

The release of substances into the environment can cause pollution.

0 4 . 1 Name **one** harmful substance that could cause air pollution.

[1 mark]

_____

0 4 . 2 Name **three** harmful substances that could cause water pollution.

Do **not** refer to plastic or to litter in your answer.

[3 marks]

1 _____

2 _____

3 _____

Do not write outside the box

0 4 . 3 Describe how substances that pollute air and water could be harmful to humans and other living organisms.

[6 marks]

10

Turn over for the next question

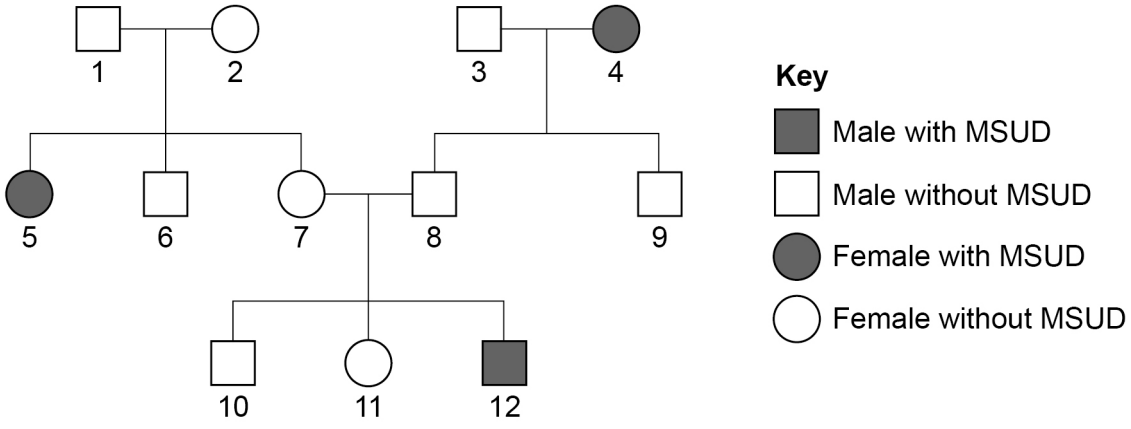
Do not write outside the box

0 5 Maple syrup urine disease (MSUD) is a rare inherited human condition.

MSUD is usually diagnosed early in childhood and can be controlled by having a low-protein diet.

Figure 4 shows the inheritance of MSUD in one family.

Figure 4



The allele for MSUD is recessive.

0 5 . 1 Give **one** piece of evidence from **Figure 4** which shows that MSUD is a recessive condition.

[1 mark]

Do not write outside the box

0 5 . 2 Persons **7** and **8** in **Figure 4** are expecting a fourth child.

Determine the probability that the child will have MSUD.

You should:

- draw a Punnett square diagram
- identify the phenotype of each offspring genotype
- use the symbols:

N = allele for **not** having MSUD
n = allele for MSUD.

[4 marks]

Probability = _____

Question 5 continues on the next page

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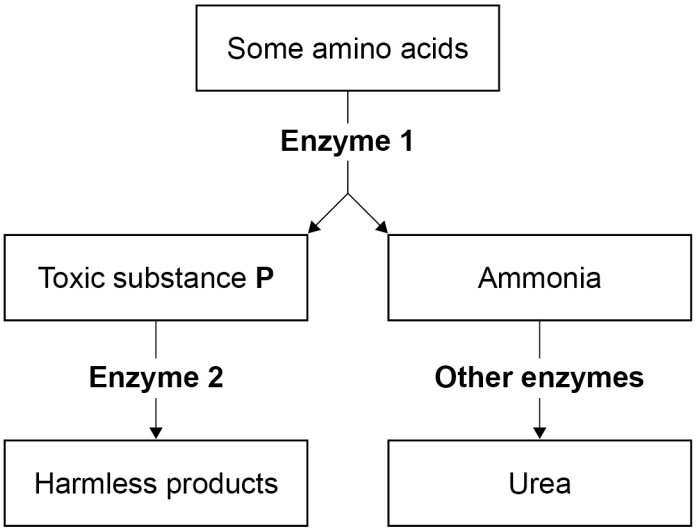
Figure 5 shows chemical reactions involved in the normal breakdown of some types of amino acid inside body cells.

Figure 5



A person with MSUD **cannot** make **Enzyme 2**.

0 5 . 3 One of the final products shown in **Figure 5** is urea.

Where in the human body are the reactions shown in **Figure 5** most likely to occur?

[1 mark]

Tick (✓) **one** box.

Kidney ☐

Liver ☐

Pancreas ☐

Small intestine ☐

Do not write outside the box

Scientists can analyse blood samples or urine samples to see if a person has MSUD.

The test identifies high concentrations of toxic substance **P**, shown in **Figure 5**.

0 5 . 4 Explain why the **blood** of a person with MSUD will have a high concentration of toxic substance **P**.

Use information from **Figure 5**.

[3 marks]

0 5 . 5 Explain why the **urine** of a person with MSUD will have a high concentration of toxic substance **P**.

[2 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 6 Explain why a person with MSUD must have a low-protein diet.

[3 marks]

14

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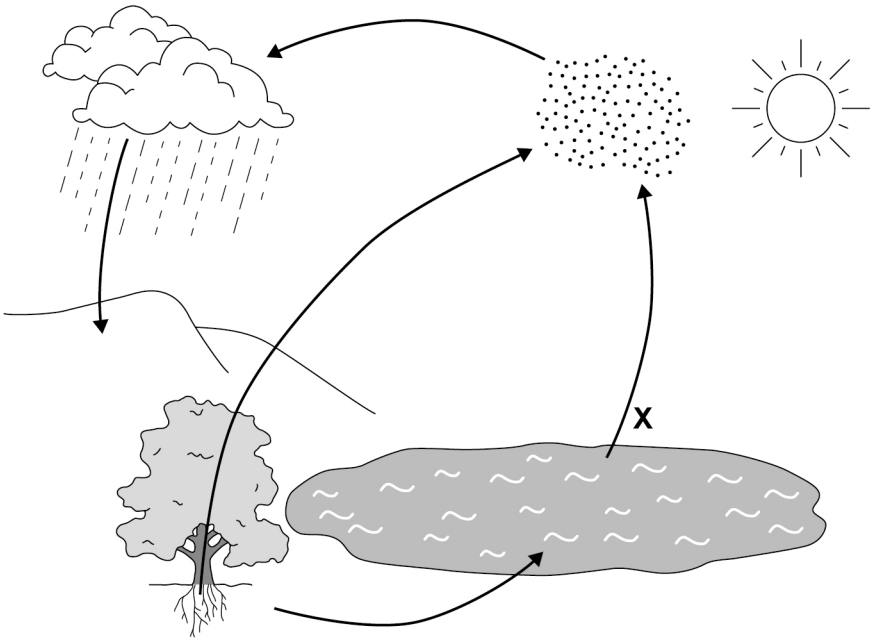
0 6 Energy flows through an ecosystem and materials are recycled.

Figure 6 shows the water cycle.

Figure 6



0 6 . 1 Name process **X**.

[1 mark]

0 6 . 2 Name the process by which water is absorbed into plant roots.

[1 mark]

0 6 . 3 Give **two** uses of water in plants.

[2 marks]

1

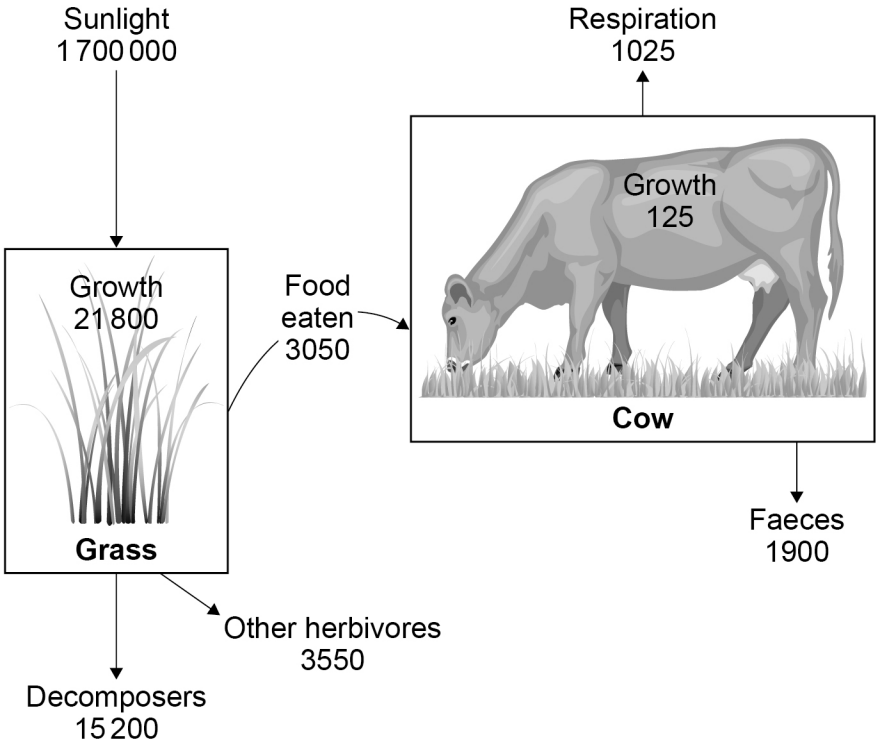
2

Do not write outside the box

Figure 7 shows the flow of energy through a food chain.

The numbers are in kilojoules/m^2/year.

Figure 7



Do not write outside the box

0 6 . 4 The cow is more efficient than the grass at converting energy.

The energy conversion efficiency of the cow is 4.098%.

Calculate how many times more efficient the cow is at converting energy than the grass.

The equation for energy conversion efficiency is:

$$\text{energy conversion efficiency} = \frac{\text{energy used for growth}}{\text{energy input}} \times 100$$

Give your answer to 3 significant figures.

[5 marks]

Number of times (3 significant figures) = _____

Question 6 continues on the next page

Do not write outside the box

0 6 . 5 It is more energy-efficient to rear cows indoors than to rear cows outdoors.

Give **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

0 6 . 6 Suggest **two** possible disadvantages of rearing cows indoors.

[2 marks]

1 _____

_____

2 _____

_____

13

Do not write outside the box

0 7 A scientist found a polluted pond which had a new type of blue algae in the water.

The blue colour of the algae was caused by a mutation.

0 7 . 1 What is a mutation?

[1 mark]

Question 7 continues on the next page

Do not write outside the box

The scientist measured the number of blue algal cells in a sample of the pond water.

The scientist used a special slide which has a counting grid.

This is the method used.

1. Dilute 2.5 cm^3 of pond water to a volume of 10 cm^3 with distilled water.
2. Place a drop of the diluted pond water on the special slide, as shown in **Figure 8**.
3. Place a thick coverslip over the diluted pond water to give a depth of 0.1 mm of pond water.
4. Use a microscope to count the number of algal cells in a 0.2 mm × 0.2 mm square on the counting grid.

Figure 8 shows a side view of the special slide.

Figure 8

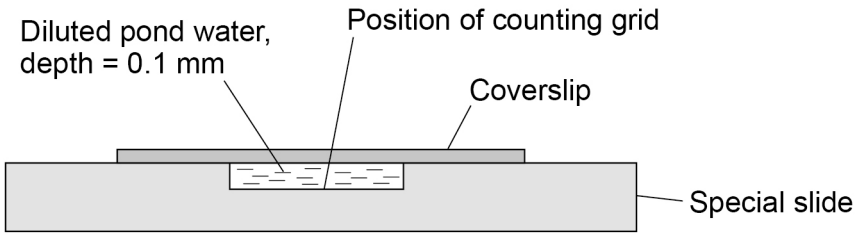
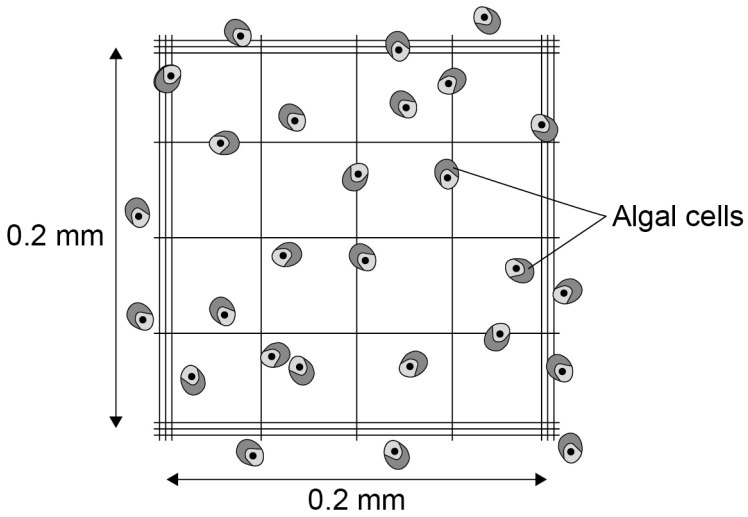


Figure 9 shows the view of the counting grid through a microscope.

Figure 9



Do not write outside the box

0 7 . 2 How many algal cells are in the 0.2 mm × 0.2 mm square in **Figure 9**?

Use the following procedure:

- Count all cells that are completely within the 0.2 mm × 0.2 mm square in the counting grid.
- Count cells that are touching the left side or the lower side of the square.
- Do **not** count cells that are touching the right side or the top side of the square.

[1 mark]

Number of algal cells in the 0.2 mm × 0.2 mm square = _____

0 7 . 3 One week later the scientist repeated the test and counted 14 cells on the 0.2 mm × 0.2 mm counting grid.

Calculate the number of algal cells in 1.0 mm^3 of **undiluted** pond water.

Use the scientist's second count of 14 cells.

[6 marks]

Number of algal cells in 1.0 mm^3 of undiluted pond water = _____

Question 7 continues on the next page

Do not write outside the box

0 7 . 4 Suggest why the scientist diluted the pond water before placing it on the special slide.

[1 mark]

0 7 . 5 A student repeated the scientist's method.

The student used a thin coverslip over the diluted pond water instead of the thick coverslip.

The liquid pulled the thin coverslip downwards slightly.

Explain how the use of the thin coverslip would affect the results for the cell count.

[2 marks]

11

Do not write outside the box

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 8 An echidna is a mammal that lives in Australia.

Figure 10 shows an echidna.

Figure 10

Figure 11 shows how the body temperature of the echidna varies in warm weather and in cold weather.

Figure 11

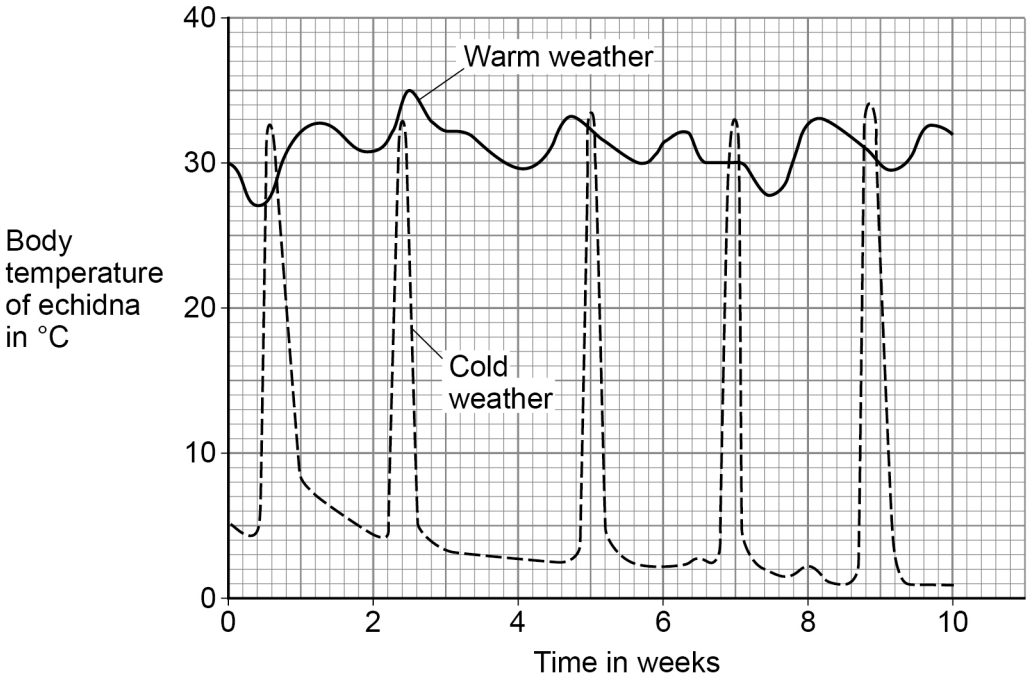
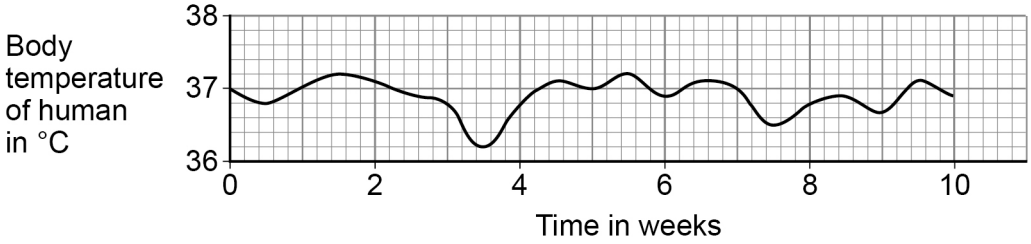


Figure 12 shows how human body temperature varies.

Figure 12



Do not write outside the box

0 8 . 1 Compare the variation in body temperature of the echidna in warm weather with the variation in body temperature of the human.

Use data from **Figure 11** and **Figure 12**.

[2 marks]

In the cold winter months, the echidna hibernates.

During hibernation:

- the echidna's body temperature decreases to below 5 °C
- the echidna sleeps for up to 17 days at a time
- the echidna's rate of metabolism slows down.

0 8 . 2 Explain why the decrease in body temperature is an advantage to the echidna during hibernation.

[2 marks]

Question 8 continues on the next page

Do not write outside the box

0 8 . 3 During hibernation the echidna wakes up several times.

Each time the echidna wakes up it becomes active and its body temperature increases to over 30 °C.

Explain why the echidna has a higher body temperature when it is active.

[2 marks]

0 8 . 4 An echidna can dilate and constrict blood vessels in its skin.

Explain how the **dilation** of blood vessels in the skin can help to decrease body temperature.

[3 marks]

Do not write outside the box

An athlete trained in a hot climate.

The athlete lost a large volume of water each day in sweat.

0 8 . 5 The athlete's energy intake each day from food was 20 000 kJ.

Evaporation of 1 cm^3 of sweat requires 2.5 kJ of energy.

40% of the athlete's daily energy intake was used to evaporate sweat.

Calculate the volume of sweat the athlete lost each day.

Give your answer in dm^3

1 dm^3 = 1 000 cm^3

[3 marks]

Volume of sweat lost in one day = _____ dm^3

0 8 . 6 Suggest why the athlete was advised to take salt tablets each day.

[1 mark]

13

Turn over for the next question

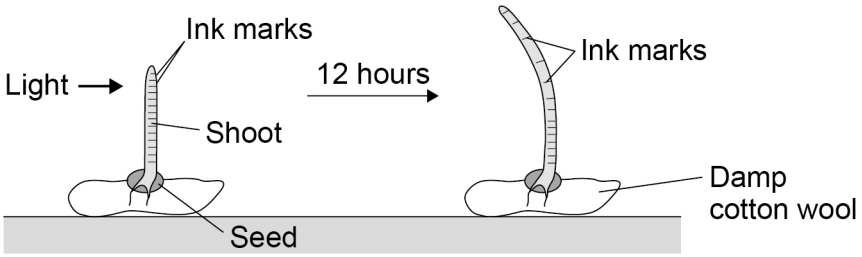
Do not write outside the box

0 9 Students investigated the response of plant shoots to one-sided light.

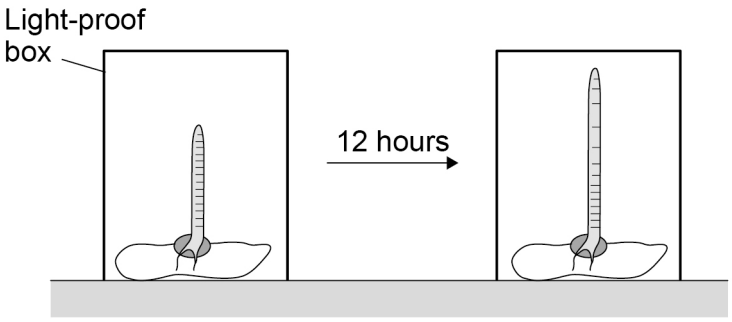
Figure 13 shows how the students set up three experiments.

Figure 13

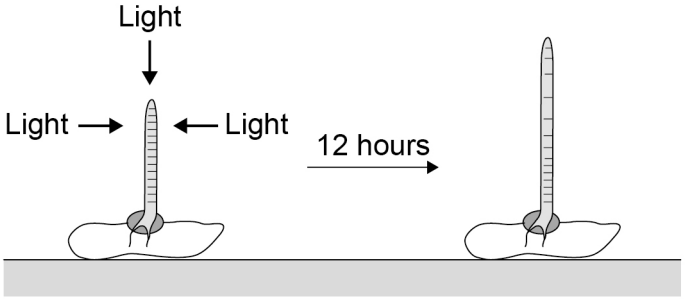
Experiment A



Experiment B



Experiment C



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0 9 . 1 Suggest **two** control variables the students should have used in their investigation.

[2 marks]

1 _____

_____

2 _____

_____

0 9 . 2 Describe how experiment **B** and experiment **C** acted as controls for the investigation.

[2 marks]

Experiment **B** _____

_____

Experiment **C** _____

_____

0 9 . 3 Give **two** conclusions that the students could make from the **ink marks** on the shoot in experiment **A**.

[2 marks]

1 _____

_____

2 _____

_____

0 9 . 4 Name the type of response shown by the seedling in experiment **A**.

[1 mark]

_____

Question 9 continues on the next page

Auxin is a plant hormone. Auxin is made in the shoot tip.

Scientists investigated the role of auxin in the response of shoot tips to light.

This is the method used.

1. Grow four seedlings in the dark for a few days.

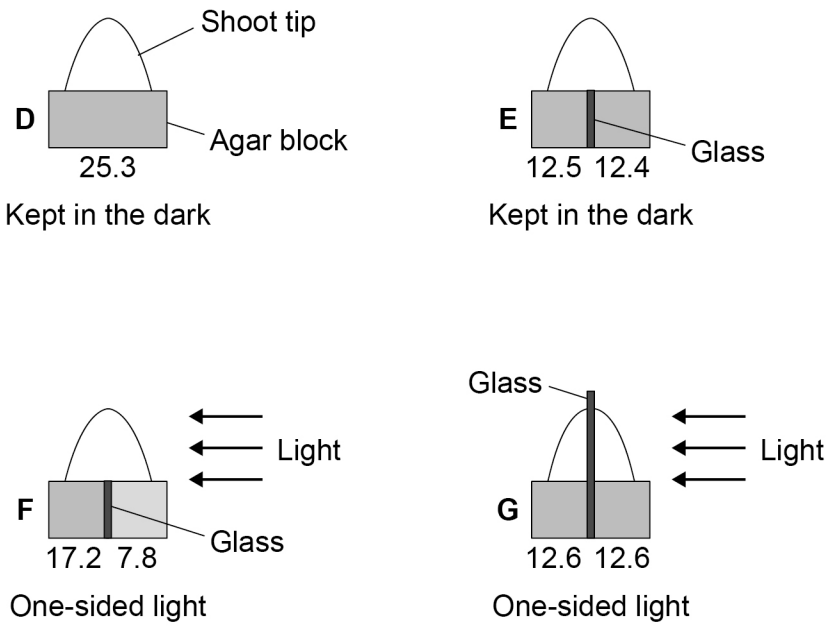
2. Cut the tip off the shoot of each seedling.

3. Place each shoot tip on a small block of agar jelly.

4. Place the shoot tips and agar in different conditions as shown in **Figure 14**.

5. After 24 hours, measure the mass of auxin in the agar blocks.

Figure 14



The numbers under each block show the mass of auxin that diffused into the blocks from the shoot tips.

The mass of auxin is given in arbitrary units.

Do not write outside the box

0 9 . 5 A scientist made a hypothesis:

'Light causes auxin to move from the side of the shoot nearest to the light to the side furthest from the light.'

Describe the evidence from **Figure 14** which supports the hypothesis.

[3 marks]

0 9 . 6 Another scientist made a different hypothesis:

'Light causes the breakdown of auxin.'

Give the evidence from **Figure 14** that shows that auxin is **not** broken down by light.

[1 mark]

11

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

GCSE
BIOLOGY
8461/2H

Paper 2 Higher Tier

Mark scheme

June 2022

Version: 1.0 Final Mark Scheme

226G84612H/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make their judgement
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent (for example, a scientifically correct answer that could not reasonably be expected from a student's knowledge of the specification).

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**.
Alternative words in the mark scheme are shown by a solidus eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name **two** magnetic materials.

[2 marks]

Student	Response	Marks awarded
1	iron, steel, tin	1
2	cobalt, nickel, nail*	2

3.2 Use of symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, or uses symbols to denote quantities in a physics equation, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. At any point in a calculation students may omit steps from their working. If a subsequent step is given correctly, the relevant marks may be awarded.

Full marks are **not** awarded for a correct final answer from incorrect working.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

An error can be carried forward from one question part to the next and is shown by the abbreviation 'ecf'.

Within an individual question part, an incorrect value in one step of a calculation does not prevent all of the subsequent marks being awarded.

3.6 Phonetic spelling

Marks should be awarded if spelling is not correct but the intention is clear, **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

3.11 Numbered answer lines

Numbered lines on the question paper are intended to support the student to give the correct number of responses. The answer should still be marked as a whole.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and, if necessary, annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level.

The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	<table><tr><th></th><th>Sexual reproduction</th><th>Asexual reproduction</th></tr><tr><td>Cell division occurs</td><td>✓</td><td>✓</td></tr><tr><td>Fertilisation occurs</td><td>✓</td><td></td></tr><tr><td>Genes are passed on from parent to offspring</td><td>✓</td><td>✓</td></tr><tr><td>Offspring are genetically identical to each other</td><td></td><td>✓</td></tr></table> allow **1** mark for 1 or 2 correct rows ignore 'x' in blank boxes		2	AO1 4.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	pollen (grain)	allow nucleus in pollen (grain)	1	AO1 4.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	between 3 and 4 hours		1	AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	5 hours 6 hours		1 1	AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	2		1	AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	4		1	AO2 4.6.1.2

Total Question 1		**8**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	**abiotic** any **two** from: • water • oxygen / air (in soil) • pH (of soil) • minerals / ions • temperature • size of soil particles **or** texture / type of soil **biotic** any **two** from: • food • predators / consumers / carnivores • disease / pathogens / bacteria / fungi	 allow moisture / humidity / rain(fall) allow dryness ignore carbon dioxide allow acidity / alkalinity (of soil) allow salts allow named example of an ion ignore nutrients allow named example of soil type ignore space / toxins / weather allow amount of dead / decaying matter (in soil) ignore nutrients allow example – such as birds allow microorganisms / microbes / parasites if **no** other marks awarded allow **2** marks for **four** factors in reverse categories	2 2	AO1 4.7.1.1 4.7.1.2 4.7.1.3

Question	Answers	Mark	AO / Spec. Ref.
02.2	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO2
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	AO2
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1
	No relevant content	0	
	Indicative content • same concentration of chemical / **X** applied to the soil • same volume / amount of chemical / **X** applied to the soil • same size of area sampled – eg 1 m^2 or 0.25 m^2 • use of a quadrat • same time between application and collecting worms • same time allowed for collecting worms after application • each sample area selected randomly • method of achieving randomness – eg random coordinates • (collect and) count worms in each of areas **A** and **B** • at least 5 repeats in each of areas **A** and **B** • calculate mean (per unit area) **or** total for each of areas **A** and **B** • compare means / totals for areas **A** and **B**		4.7.2.1 RPA9

Total Question 2		**10**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	an answer in the range 1.1 to 2(.0) (hours)		1	AO2 4.5.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	*effect* : lowered *explanation*: glucose taken in **or** glucose converted to glycogen **or** glucose used in respiration by cells / liver / muscles		1 1 1	AO1 4.5.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	underweight		1	AO3 4.5.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(from) 67.5 (kg to) 90 (kg)	allow in the range 67 to 68 (kg) for 67.5 (kg) allow in the range 90 to 90.5(kg) for 90 (kg) allow from 90 (kg to) 67.5 (kg)	1	AO2 4.5.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5		answers must be comparative		AO3 4.5.3.2
	(person **C** has) higher glucose (than mean)	allow comparison of higher glucose using numbers allow (person **C**'s) glucose is too high	1	
	(person **C** has) higher insulin (than mean)	allow comparison of higher insulin using numbers allow (person **C**'s) insulin is too high do **not** accept (person **C** has) higher cholesterol ignore unprocessed data	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	(more) exercise	allow example of (more) exercise	1	AO1 4.5.3.2
	eat less carbohydrate / sugar **or** eat a low carbohydrate diet	allow eat less fat allow eat a carbohydrate controlled diet if no other marks awarded allow **1** mark for lose weight **or** maintain healthy weight **or** eat less **or** eat fewer calories ignore references to healthy / balanced diet **or** diet unqualified	1	

Total Question 3		**10**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	carbon dioxide **or** acidic gas(es)	allow other named example of acidic gas such as sulfur dioxide allow chemical formula e.g. SO_2 allow carbon monoxide allow particulates / smoke / soot allow methane / CFCs	1	AO1 4.7.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	any **three** from: • fertiliser • sewage • toxic chemicals • herbicide • fungicide	 allow nitrate / phosphate allow organic matter / faeces / urine / urea allow a named toxic chemical such as mercury **or** sulfur dioxide **or** acid rain allow insecticide allow oil allow nuclear waste allow other examples of water pollutants if herbicide / fungicide / insecticide not given allow (named) pesticide for **1** mark	3	AO1 4.7.3.2

Question	Answers	Mark	AO / Spec. Ref.
04.3	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	4–6	AO1 4.4.1.1 4.2.2.6 4.4.2.1 4.7.3.2 4.7.3.5
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1–3	
	No relevant content	0	

	Indicative content
	
	air pollution:
	(carbon dioxide **or** methane **or** greenhouse gases)
	• global warming / climate change / traps heat
	  ○ floods / fire / drought **or** ice caps melt **or** rise in sea level **or** extreme weather
	  ○ loss of habitat / food
	  ○ migration
	
	(acidic gas / named – eg SO_2 / NO_x)
	• damage to leaves so less photosynthesis
	• damage to roots or alters ions in soil (/ e.g. phosphates / iron)
	  ○ (so) less protein manufacture
	• damage to lungs
	  ○ breathing difficulties / bronchitis / asthma
	
	(carbon monoxide)
	• combines with haemoglobin
	  ○ less oxygen carried (by haemoglobin / blood)
	
	(particulates / 'soot')
	• cover leaves **or** block light
	  ○ less photosynthesis so less glucose made
	• damage to lungs
	  ○ breathing difficulties / bronchitis / asthma
	
	water pollution:
	(sewage)
	• bacteria multiply
	  ○ use oxygen in respiration
	  ○ water animals cannot respire
	  ○ pathogens in water
	
	(fertiliser)
	• algae multiply
	  ○ (algae) block light so plants cannot photosynthesise
	  ○ lack of oxygen for respiration – fish die		

	(toxic substances)
	• damages / harms cells **o**r bioaccumulation
	  ○ interferes with metabolism – e.g. respiration / protein synthesis
	
	(plastics)
	• entrap animals or causing internal damage if swallowed
	
	(particles)
	• block light
	  ○ plants / algae cannot photosynthesise so less glucose made
	
	(oil)
	• damages birds' feathers
	  ○ cannot fly so cannot find food **or** escape predators
	
	(acid rain / acids)
	• lowers pH of water
	  ○ damages fish gills
	  ○ bleaches coral		

Total Question 4		**10**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	parents without MSUD have a child with MSUD	allow 1 and 2 (without MSUD) have child 5 (with MSUD) **or** 7 and 8 (without MSUD) have child 12 (with MSUD) ignore MSUD skips a generation	1	AO3 4.6.1.6 4.6.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	gametes correct: **N + n** and **N + n**		1	AO2
	correct derivation of offspring genotypes: **NN Nn Nn nn**	allow correct for gametes stated	1	AO2
	correct phenotype for each genotype	allow correct for offspring genotypes ignore carrier	1	AO2
	correct probability: 0.25 / ¼ / 25% / 1 in 4	allow correct answer only allow 1:3 do **not** accept 1 in 3 / 1:4	1	AO3 4.6.1.6 4.6.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	liver		1	AO2 4.5.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4		allow **P** for toxic substance throughout		AO2 4.2.2.1
	(no enzyme 2 made **so**) cannot break down the toxic substance	allow (no enzyme 2 made **so**) cannot change toxic substance into harmless products	1	4.1.3.1 4.6.1.5 4.6.1.6
	the toxic substance is still made (from the amino acids)	allow toxic substance builds up over time ignore concentration of toxic substance is high(er)	1	
	toxic substance diffuses / moves (from cells) into the blood	ignore incorrect name of organ	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	the toxic substance passes through filter in kidney **or** **P** passes through filter in kidney		1	AO1 4.5.3.3
	(some / all) not reabsorbed	allow (some / all) not absorbed **back** into the blood **or** (some / all) not taken **back** into the blood ignore (some / all) not absorbed into the blood **or** (some / all) not taken into the blood	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	proteins contain amino acids **or** proteins are made of amino acids	allow proteins are broken down into amino acids	1	AO1
	must keep (certain) amino acids in low amount	allow (so) (certain) amino acids do not build up allow (so) less of (certain) amino acids are produced	1	AO2
	(so) toxic substance **or P** does not build up in the body **and** cause damage to cells / tissues / organs		1	AO2 4.6.1.5 4.6.1.7 4.4.2.3

Total Question 5		**14**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	evaporation	allow vaporisation	1	AO1 4.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	osmosis	allow diffusion ignore absorption	1	AO1 4.7.2.2 4.2.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	any **two** from: • photosynthesis • support • (solvent for) transport **or** translocation **or** for the transpiration <u>stream</u>	 allow turgor allow to fill vacuole allow opening of stomata allow to prevent wilting allow (as a) solvent allow (as a) medium for chemical reactions allow hydrolysis / digestion / breakdown of stored food allow cooling allow making cytoplasm	2	AO1 4.7 4.7.2.2 4.1.1.2 4.2.3.2 4.4.1.1 4.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	*substitution* $\frac{21\,800}{1\,700\,000} \times 100$ 1.282(3529) *comparative efficiency* $\frac{4.098}{1.282}$ 3.196..... *significant figures* 3.20	 allow 1.28 **or** 1.3 allow an incorrectly calculated value for efficiency correctly substituted do **not** accept 3.2 do **not** accept if a unit is given	 1 1 1 1 1	AO2 4.7.2.1 4.7.4.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	less energy lost as heat less energy lost in movement	allow less heat lost allow less energy lost keeping warm **or** less energy for maintaining body temperature ignore less movement ignore less energy lost unqualified ignore controlling diet do **not** accept energy used for respiration do **not** accept energy produced / made / created	1 1	AO1 4.7.4.3 4.7.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	any **two** from: • increased spread of disease **or** increased use of drugs / antibiotics (to reduce disease) • more antibiotics in meat / milk • (extra) cost of heating / lighting / food / drugs • aggressive behaviour (causing harm) **or** 'emotional' stress reduces productivity	 allow diseases spread (more) easily allow (extra) energy used for heating / lighting ignore (extra) cost unqualified ignore cruelty / unethical ignore need to clean out barns / sheds ignore need to maintain / build barns	2	AO3 4.7.5.1 4.7.5.2

Total Question 6		**13**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	any **one** from: a change in • DNA • base code **or** nucleotide sequence • a base (in DNA) • a gene / allele • part of a chromosome • number of chromosomes • genetic code / material	ignore genetic information	1	AO1 4.6 4.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	16 / sixteen		1	AO3 4.7.2.1 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	*volume of sample in mm^3* 0.004 *number of cells in 1 mm^3* ***diluted*** *pond water* $14 \div 0.004$	 allow $14 \div (0.2 \times 0.2 \times 0.1)$ allow use of an incorrectly calculated volume of 0.04	 1 1	AO2 4.7.2.1 RPA9
	3 500	allow ecf from answer to q.07.2 for number of algal cells	1	
	correct dilution factor ¼	allow dilution = ×4 **or** 4 times	1	
	number of cells in 1 mm^3 ***undiluted*** *pond water* $3\,500 \times 4$	allow a calculation based on a dilution factor of 5	1	
	14 000 **or** 1.4×10^4		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	to make it easier to count	ignore easier to see **or** more spread out ignore quicker to count	1	AO3 4.7.2.1 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	smaller volume	allow (some) liquid / cells would leak out (from under the cover slip)	1	AO3 4.7.2.1 RPA9
	so fewer cells **or** lower cell count	allow this mark **only** if there is an attempt at an explanation	1	

Total Question 7		**11**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	echidna: 27 to 35 **or** by 8 (°C) **and** human: 36.2 to 37.2 **or** by 1 (°C)	allow a tolerance of ± 0.5 (°C) allow a tolerance of ± 0.1 (°C)	1	AO3 4.5.1 4.5.2.4
	echidna is more variable **or** human fluctuates less	allow echidna is 7 (°C) more variable for **2** marks allow echidna is 8 times more variable for **2** marks	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2		do **not** accept energy produced / made / created do **not** accept energy used for respiration		AO2 4.5.2.4 4.5.3.2 4.4.2.1
	loses less energy (from its body)	allow loses / wastes less heat	1	4.4.2.3
	(so) body energy store lasts longer	allow glycogen / fat lasts longer allow stored food lasts longer	1	
	OR			
	lower temperature gradient (between echidna and air) (1)			
	(so) loses less energy (1)	allow loses less heat		
	OR			
	less energy transferred maintaining (higher) body temperature (1)	allow less energy transferred for keeping warm		
	(so) more energy available for processes vital for life (1)	allow more energy for eg heart / brain function ignore metabolism		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	activity / movement requires energy from respiration (and) respiration / metabolism releases <u>heat</u> (which increases body temperature) **OR** respiration / metabolism releases <u>heat</u> (which increases body temperature) (1) (which) increases the rate of chemical reactions **or** increases enzyme activity (1)	do **not** accept energy produced / made / created **once** only	1 1	AO2 4.5.2.4 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	more blood flow near surface (of skin) **or** more blood flow to the skin (so) more heat / energy is lost (from the blood) cools blood which cools the body	do **not** accept blood vessels move nearer to surface of skin ignore cools blood / body unqualified	1 1 1	AO1 4.5.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	$\frac{20\,000 \times 40}{100 \times 2.5}$ **or** $\frac{8000}{2.5}$		1	AO2 4.5.2.4
	3 200 (cm^3)		1	
	3.2 (dm^3)	allow an incorrectly calculated value correctly divided by 1000	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	to replace ions / salt lost (in sweat)	allow named example such as Na^+ allow because ions / salt lost in sweat allow to prevent (muscle) cramp	1	AO2 4.5.2.4 4.5.3.3

Total Question 8		**13**

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	any **two** from: • (same volume of) water • (same) temperature • (same) species / type of plant • (same) age of shoot	allow (same amount of) water allow (amount of) minerals / ions / salts ignore (same) time ignore (same) height of shoot ignore carbon dioxide (concentration) do **not** accept light	2	AO3 4.5.4.1 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	**B** shows response (in **A**) is due to light (as **B** has no light)	allow **B** gives a comparison between no light and (one-sided) light ignore **B** shows the effect of no light	1	AO2 4.5.4.1 RPA8
	C shows response (in **A**) is due to one-sided light (as **C** has light from all sides)	allow **C** gives a comparison between all-round light and one-sided light ignore **C** shows the effect of light from all sides	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3		ignore reference to auxin ignore reference to left and right sides		AO3 4.5.4.1 RPA8
	growth / elongation occurs (just) behind / below / at the tip	allow no growth **or** very little growth at the base ignore shoot is taller	1	
	bending occurs (just) behind / below / at the tip **or** more growth on the side away from the light		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	phototropism / phototropic	allow positive phototropism ignore tropism do **not** accept negative phototropism do **not** accept phototrophic / phototrophism	1	AO1 4.5.4.1 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5		ignore references to **D** and **E** ignore references to left and right sides unless at least one is identified as side nearer to or further from the light		AO3 4.5.4.1
	in **F** there is more auxin in the side furthest from the light		1	
	in **G** there is the same mass of auxin in each side		1	
	in **F** auxin can move through the shoot but in **G** the glass prevents this		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	all four (blocks) have (approximately) the same mass of <u>auxin</u>	allow examples such as mass of <u>auxin</u> in **D** / **E** is (about) the same as in **F** / **G** **or** those in light have same mass of <u>auxin</u> as those in dark	1	AO3 4.5.4.1

Total Question 9		**11**