2024

Name_____

Triple Science

Higher

Biology: Paper 2

AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

GCSE BIOLOGY

H

Higher Tier Paper 2H

Friday 7 June 2019 Afternoon 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.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- 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.

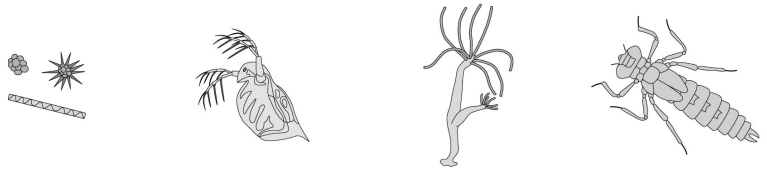
For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

Do not write outside the box

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

0 1 **Figure 1** shows a food chain in a pond.

Figure 1



0 1 . 1 Which term describes the Daphnia in this food chain?

[1 mark]

Tick (✓) **one** box.

- Apex predator ☐
- Primary consumer ☐
- Producer ☐
- Secondary consumer ☐

Do not write outside the box

0 1 . 2 Draw a pyramid of biomass for the food chain.

Label each trophic level.

[2 marks]

0 1 . 3 Give **one** reason why the total biomass of the Daphnia in the pond is different from the total biomass of the algae.

[1 mark]

Question 1 continues on the next page

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Students investigated the size of the population of Daphnia in the pond.

This is the method used.

1. Collect 1 dm^3 of pond water from near the edge of the pond.
2. Pour the water through a fine net.
3. Count the number of Daphnia caught in the net.
4. Repeat steps 1–3 four more times.

Table 1 shows the results.

Table 1

Sample number	Number of Daphnia in 1 dm^3 water
1	5
2	21
3	0
4	16
5	28

0 1 . 4 Calculate the mean number of Daphnia in 1 m^3 of pond water.

1 m^3 = 1000 dm^3

[2 marks]

Mean number of Daphnia in 1 m^3 of pond water = _____

Do not write outside the box

0 1 . 5 The pond was a rectangular shape, measuring:

- length = 2.5 metres
- width = 1.5 metres
- depth = 0.5 metres.

Calculate the estimated number of Daphnia in the pond.

Use your answer from Question **01.4**.

Give your answer in standard form.

[4 marks]

Number of Daphnia in the pond = _____

Question 1 continues on the next page

Do not write outside the box

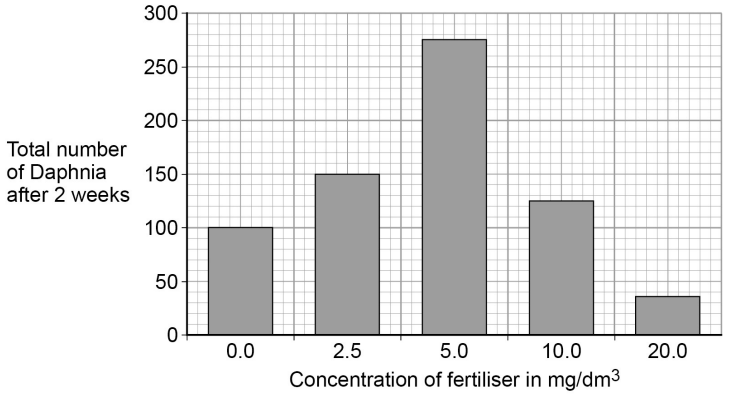
Rainfall can cause fertiliser to be washed from farmland into a pond.

The students investigated the effect of fertiliser on the population of Daphnia in water from the pond.

- The students put 20 Daphnia in each of five different concentrations of fertiliser.
- The students counted the total number of Daphnia in each concentration of fertiliser after 2 weeks.

Figure 2 shows the results.

Figure 2



0 1 . 6 A concentration of 5.0 mg/dm^3 of fertiliser caused a large increase in the population of Daphnia.

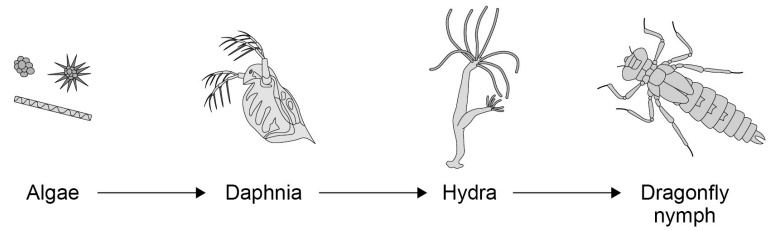
Explain why.

[2 marks]

Do not write outside the box

0 1 . 7 **Figure 1** is repeated below.

Figure 1



The population of **Hydra** will decrease when 20 mg/dm^3 of fertiliser is added to the pond.

Explain why.

[2 marks]

14

Turn over for the next question

Do not write outside the box

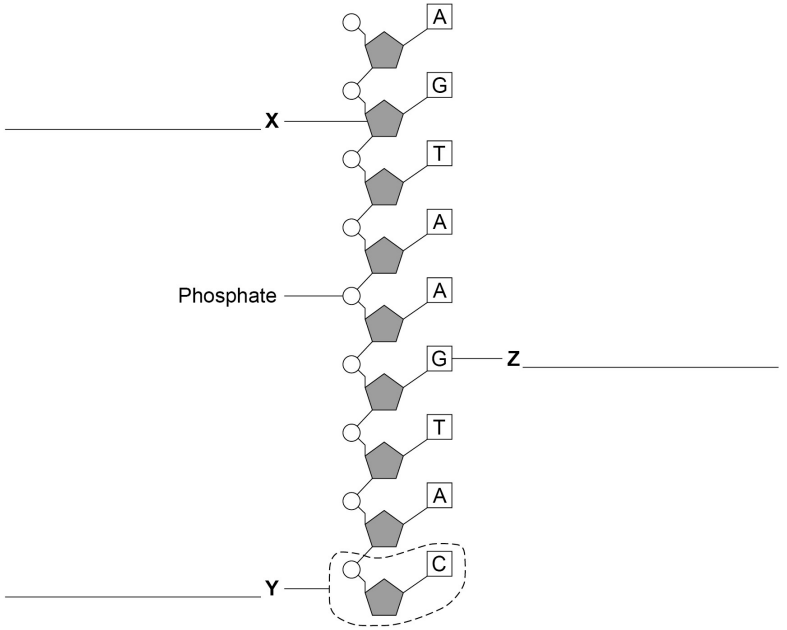
0 2 Genetic material is made of DNA.

0 2 . 1 Which structures in the nucleus of a human cell contain DNA?

[1 mark]

Figure 3 shows part of one strand of a DNA molecule.

Figure 3



0 2 . 2 Label parts **X**, **Y** and **Z** on **Figure 3**.

[3 marks]

Choose answers from the box.

Base	**Fatty acid**	**Nucleotide**	**Sugar**	**Glycerol**

Do not write outside the box

0 2 . 3 A complete DNA molecule is made of two strands twisted around each other.

What scientific term describes this structure?

[1 mark]

_____

0 2 . 4 DNA codes for the production of proteins.

A protein molecule is a long chain of amino acids.

How many amino acids could be coded for by the piece of DNA shown in **Figure 3**?

[1 mark]

Tick (✓) **one** box.

2 ☐ 3 ☐ 9 ☐ 18 ☐

0 2 . 5 Scientists have now studied the whole human genome.

Give **two** benefits of understanding the human genome.

[2 marks]

1 _____

_____

2 _____

_____

8

Turn over for the next question

Do not write outside the box

0 3 Phototropism is a growth response by part of a plant to light.

0 3 . 1 Name **one** other tropism.

Give the stimulus the plant responds to in the tropism you have named.

[2 marks]

Tropism _____

Stimulus _____

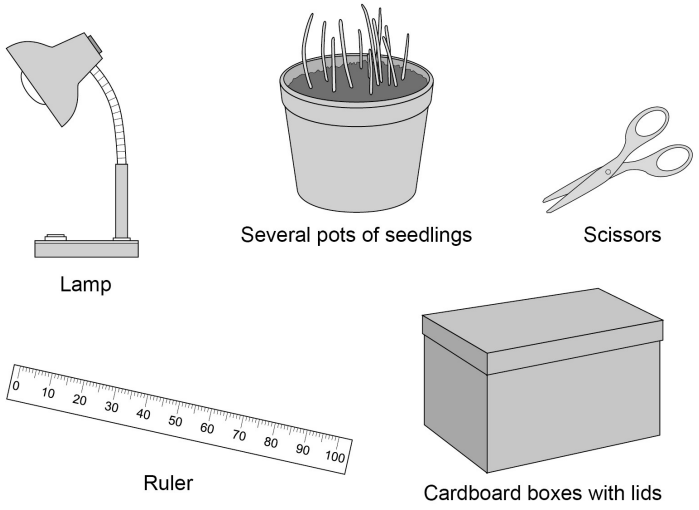
0 3 . 2 Plan an investigation to show the effect of light from one direction on the growth of plant seedlings.

Include details of any controls needed.

You may use some of the equipment shown in **Figure 4** and any other laboratory apparatus.

[6 marks]

Figure 4



Do not write outside the box

0 3 . 3 Explain how phototropism in a plant shoot helps the plant to survive.

[3 marks]

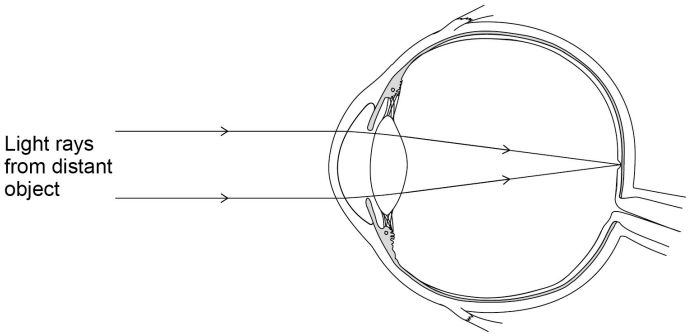
11

Do not write outside the box

0 4 The human eye can focus on objects at different distances.

Figure 5 shows how a clear image of a **distant** object is formed in a person's eye.

Figure 5



0 4 . 1 Explain how the person's eye could adjust to form a clear image of a **nearer** object.

[6 marks]

Do not write outside the box

0 4 . 2 Explain why a long-sighted person has difficulty seeing near objects clearly.

[2 marks]

0 4 . 3 Long-sightedness can be corrected by wearing spectacles.

Describe how spectacle lenses can correct long-sightedness.

[3 marks]

11

Do not write outside the box

0 5 **Table 2** gives the classification of four plant species.

Table 2

Group	Species 1	Species 2	Species 3	Species 4
Kingdom	*Plantae*	*Plantae*	*Plantae*	*Plantae*
Phylum	*Spermatophyta*	*Spermatophyta*	*Spermatophyta*	*Spermatophyta*
Class	*Monocotyledonae*	*Dicotyledonae*	*Monocotyledonae*	*Dicotyledonae*
Order	*Poales*	*Fabales*	*Poales*	*Scrophulariales*
Family	*Cyperaceae*	*Fabaceae*	*Poaceae*	*Scrophulariaceae*
Genus	*Eriophorum*	*Pisum*	*Poa*	*Antirrhinum*
Species	*angustifolium*	*sativum*	*annua*	*majus*

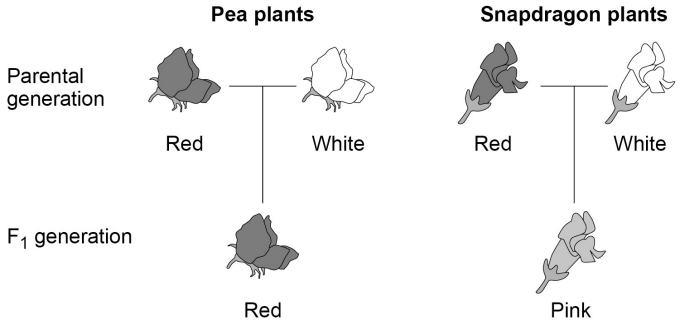
0 5 . 1 Species **1** and **3** are the most closely related.

What information in **Table 2** gives evidence for this?

[1 mark]

Figure 6 shows the inheritance of flower colour in two species of plant.

Figure 6



- In pea plants and in snapdragon plants, flower colour is controlled by one pair of alleles.
- In **Figure 6** the parental generation plants are homozygous for flower colour.
- In heterozygous **pea** plants, the allele for red flower colour is dominant.
- In heterozygous **snapdragon** plants, the alleles for flower colour are both expressed.

Do not write outside the box

Use the following symbols for alleles in your answers to Questions **05.2** to **05.4**:

Pea plants	**Snapdragon plants**
R = allele for red flowers	$\mathbf{C^R}$ = allele for red flowers
r = allele for white flowers	$\mathbf{C^W}$ = allele for white flowers

0 5 . 2 What is the genotype of the red-flowered pea plants in the F_1 generation?

[1 mark]

_____

0 5 . 3 What is the genotype of a white-flowered snapdragon plant?

[1 mark]

_____

A gardener crossed two pink-flowered snapdragon plants.

0 5 . 4 Draw a Punnett square diagram to show why only some of the next generation plants had pink flowers.

Identify the phenotypes of all the offspring plants.

[3 marks]

0 5 . 5 What percentage of the offspring would you expect to have pink flowers?

[1 mark]

Percentage = _____ %

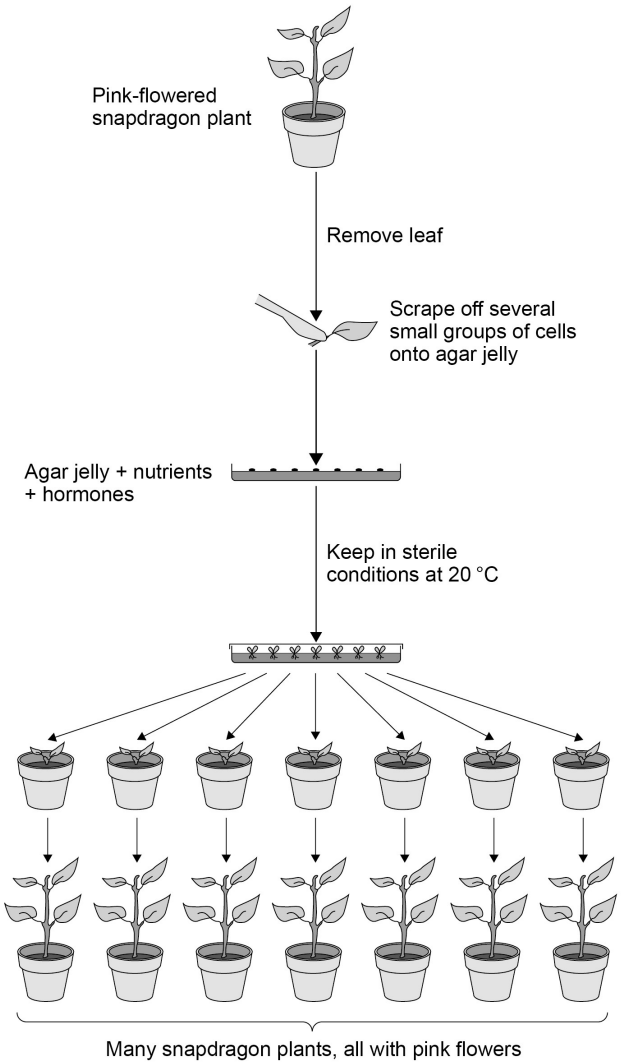
Turn over ►

Do not write outside the box

Commercially, hundreds of pink-flowered snapdragon plants can be produced from one pink-flowered plant.

Figure 7 shows a tissue culture technique used for producing many plants from one plant.

Figure 7



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0 5 . 6 Give a reason for each of the following steps shown in **Figure 7**.

[5 marks]

Several groups of cells are scraped off the leaf: _____

_____

_____

Nutrients are added to the agar jelly: _____

_____

_____

Hormones are added to the agar jelly: _____

_____

_____

The plant cells are kept in **sterile** conditions: _____

_____

_____

The plant cells are kept at **20 °C**: _____

_____

_____

0 5 . 7 Explain why the method shown in **Figure 7** produces **only** pink-flowered plants.

[2 marks]

_____

_____

_____

_____

_____

_____

14

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0 6 Water conservation is important to the human body.

0 6 . 1 Which gland releases the hormone that controls water loss from the body?

[1 mark]

Tick (✓) **one** box.

- Adrenal ☐
- Pancreas ☐
- Pituitary ☐
- Thyroid ☐

0 6 . 2 Which hormone helps the kidneys to control water loss from the body?

[1 mark]

Tick (✓) **one** box.

- ADH ☐
- Adrenaline ☐
- LH ☐
- Thyroxine ☐

Do not write outside the box

0 6 . 3 A man is walking across a desert.

The man has used up his supply of drinking water.

Explain how the gland you named in Question **06.1** and the kidneys reduce water loss.

[3 marks]

Question 6 continues on the next page

Do not write outside the box

0 6 . 4 Some people have kidney failure.

Doctors may treat patients with kidney failure by either:

- dialysis
- a kidney transplant.

Explain **two** biological reasons why most doctors think that a kidney transplant is a better method of treatment than dialysis.

Do **not** refer to cost or convenience.

[4 marks]

Reason 1

Reason 2

9

Do not write outside the box

0 7 Ragwort is a weed that grows on farmland.

Ragwort is poisonous to horses.

0 7 . 1 Plan an investigation to estimate the size of a population of ragwort growing in a rectangular field on a farm.

[4 marks]

Question 7 continues on the next page

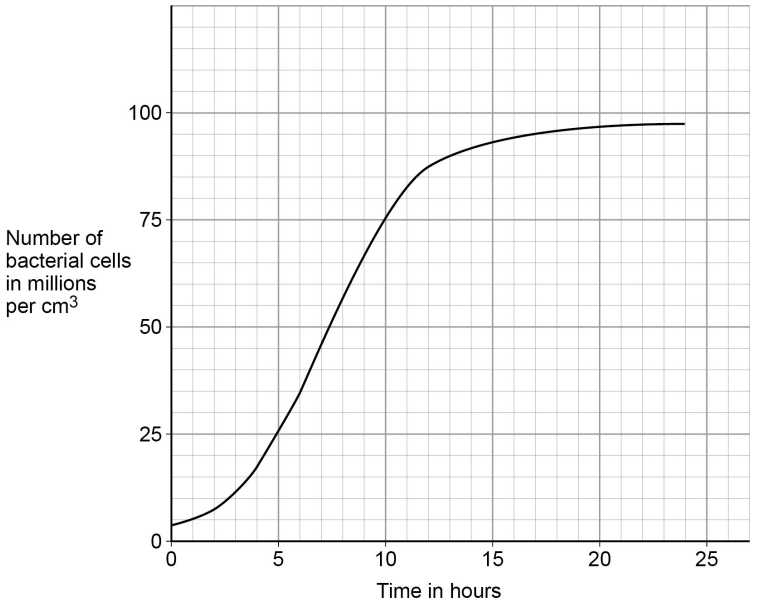
Do not write outside the box

The herbicide glyphosate will kill ragwort and other weeds.

Scientists use bacteria for the genetic engineering of crop plants to make the crops resistant to glyphosate.

Figure 8 shows the growth of a culture of the bacteria in a solution of nutrients at 25 °C

Figure 8



0 7 . 2 Why did the rate of reproduction increase between 2 hours and 7 hours?

[1 mark]

Do not write outside the box

0 7 . 3 After 12 hours, the rate of reproduction decreased.

Suggest **three** ways the scientists could maintain a high rate of reproduction in the bacterial culture.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 7 . 4 The rate of reproduction of the bacteria is fastest at 7 hours.

How many times faster is the rate of reproduction at 7 hours than the rate at 12 hours?

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

Rate at 7 hours is _____ times faster.

Question 7 continues on the next page

Do not write outside the box

0 7 . 5 Scientists transferred a gene for resistance to the herbicide glyphosate into the bacteria.

The genetically-modified (GM) bacteria can then transfer the glyphosate-resistance gene to a crop plant.

Explain the advantage of making crop plants resistant to glyphosate.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

_____

15

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0 8 It is important to keep the blood glucose concentration within narrow limits.

0 8 . 1 A person eats a meal containing a lot of carbohydrate. This causes an increase in the person's blood glucose concentration.

Explain how the hormones insulin **and** glucagon control the person's blood glucose concentration after the meal.

[5 marks]

0 8 . 2 The body cells of a person with Type 2 diabetes do **not** respond to **insulin**.

A person with Type 2 diabetes often has a higher blood **insulin** concentration than a non-diabetic person.

Explain why.

[3 marks]

Do not write outside the box

Metformin is a drug used for treating people who have Type 2 diabetes.

Scientists investigated the effects of metformin and two other drugs, **A** and **B**.

The scientists wanted to see how the drugs affected the blood glucose concentrations of 220 people with Type 2 diabetes.

This is the method used.

1. Put the 220 people into five groups.
2. Treat each group with a different drug or combination of drugs for several weeks.
3. Give each person a meal high in carbohydrate.
4. Measure the blood glucose concentration of each person 30 minutes after the meal and again 3 hours after the meal.

0 8 . 3 Suggest **three** variables that the scientists should have controlled in the investigation.

[3 marks]

1

2

3

Do not write outside the box

The scientists recorded their results as a mean value for each group.

The scientists calculated the 'standard deviation' for each group's result.

Standard deviation is a measure of the spread of the individual results above or below (±) the mean value.

The scientists gave each group's result as:

mean ± standard deviation

The larger the standard deviation, the greater is the spread of results around the mean.

0 8 . 4 Which of the results is the most precise?

[1 mark]

Tick (✓) **one** box.

Mean = 171.6 ± 16.3 ☐

Mean = 177.2 ± 15.4 ☐

Mean = 182.5 ± 18.2 ☐

Mean = 205.2 ± 19.4 ☐

Question 8 continues on the next page

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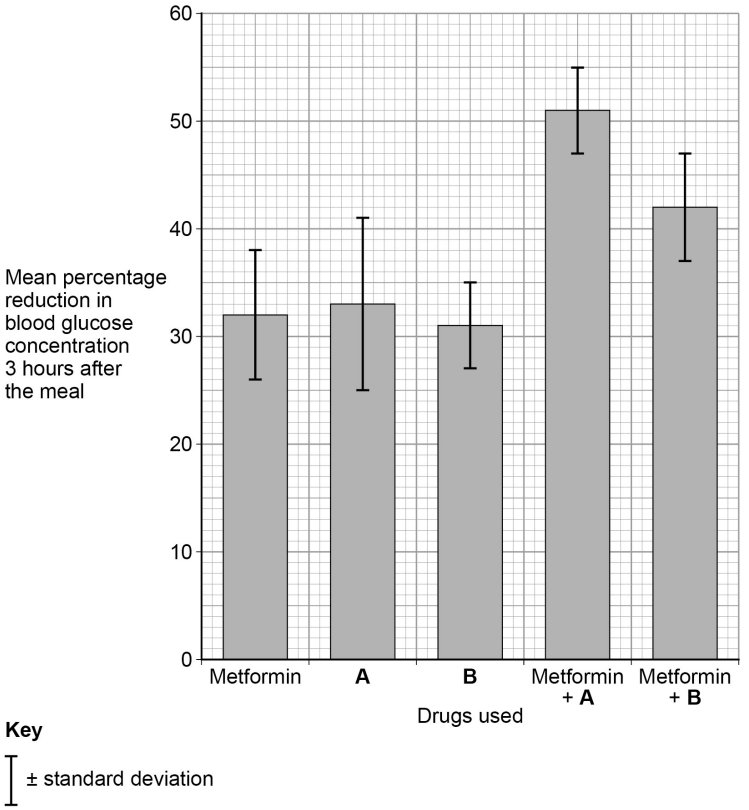
Table 3 and **Figure 9** show the scientists' results.

Table 3

Drugs used	**Metformin**	**A**	**B**	**Metformin + A**	**Metformin + B**
Number of people	60	40	25	65	30
Mean blood glucose concentration 30 minutes after the meal in mg/100 cm^3 ± standard deviation	177.2 ± 15.4	182.5 ± 18.2	171.6 ± 16.3	205.2 ± 19.4	206.5 ± 19.6

Figure 9



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0 8 . 5 In **Table 3** and **Figure 9** some standard deviations of results overlap.

- An overlap of standard deviations shows the difference between the means is **not** significant.
- **No** overlap of standard deviations shows a significant difference between the means.

A student looked at the scientists' method and the results in **Table 3** and **Figure 9.**

The student stated:

'Metformin works better when used with other drugs.'

Evaluate the student's statement.

[6 marks]

END OF QUESTIONS

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Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	primary consumer		1	AO2 4.7.2.1 4.7.4.1
01.2	correct shape: 4 tiers with largest at bottom and smallest at top correctly labelled: dragonfly / nymph + hydra + daphnia + algae	 in this order **or** allow: 3rd-order **or** tertiary consumer **or** apex / top predator **or** (trophic level) 4 2nd-order **or** secondary consumer **or** (trophic level) 3 1st-order **or** primary consumer **or** herbivore **or** (trophic level) 2 producer **or** (trophic level) 1 allow for **2** marks inverted pyramid if correctly labelled	1 1	AO2 4.7.4.2
01.3	any **one** from: (Daphnia biomass smaller because) • non-digestible parts (of algae) or lost in faeces • not all absorbed • lost in urine / urea • used in respiration **or** lost as carbon dioxide / CO_2 • algae not all eaten **or** eaten by other organisms • some algae decompose	 ignore waste allow excretion allow (to supply energy) for movement / warmth allow used to supply energy	1	AO1 4.7.4.3
01.4	 14 14 000	an answer of 14 000 scores **2** marks allow evidence of an incorrectly calculated mean × 1000 allow 1.4×10^4	 1 1	AO2 4.7.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	 (volume of pond =) 1.875 **or** 2.5 × 1.5 × 0.5 14 000 × 1.875 26250 2.625×10^4	an answer of 2.625×10^4 **or** 2.63×10^4 **or** 2.6×10^4 scores **4** marks an answer of 26250 scores **3** marks allow ecf from Question **01.4** an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps allow ecf from Question **01.4** allow 2.63×10^4 **or** 2.6×10^4	 1 1 1 1	AO2 4.7.2.1
01.6	increased (growth / reproduction of) algae (more algae so) more food for Daphnia	 allow fertiliser toxic to Hydra (1) (so) fewer Daphnia eaten (1)	1 1	AO2 4.7.2.1 4.7.3.2 4.7.4.1
01.7	(Hydra have) less food because (graph shows) fewer Daphnia (with more fertiliser)	 allow other valid suggestions, eg fertiliser toxic to Hydra (1) **or** fertiliser causes growth of algae (on surface) which block light and so die and decay **or** eutrophication (1) (decay / eutrophication) uses up oxygen (so lack of oxygen for Hydra) (1)	1 1	AO3 4.7.2.1 4.7.3.2
Total			**14**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	chromosome(s)	allow gene(s) / allele(s)	1	AO1 4.6.1.4 4.1.2.1
02.2	X = sugar Y = nucleotide Z = base		1 1 1	AO1 4.6.1.5
02.3	double helix		1	AO1 4.6.1.4
02.4	3		1	AO2 4.6.1.5
02.5	any **two** from: • diagnosis of inherited / genetic disorder • gene therapy **or** treatment of inherited disorders • understanding (human) evolution **or** understanding ethnic origins (of a person) **or** understanding ancestry • tracing human migration patterns	allow descriptions or named examples allow research / understand genetic disorders allow other examples – eg identification of criminals (1) paternity determination (1)	2	AO1 4.6.1.4
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec.
03.1	named example of tropism – eg geotropism / gravitropism correct corresponding stimulus – eg gravity	allow hydrotropism **or** chemotropism **or** thermotropism allow water **or** chemical **or** 'heat'	1 1	AO1 4.5.4.1
03.2	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		5–6	AO1 AO2 4.5.4.1
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.		3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	
	No relevant content		0	
	Indicative content • several seedlings in each batch **or** one pot of seedlings in each batch • measure heights of shoots • leave some in dark with light from one side / direction in box with hole • control(s) with all-round light **or** rotating on clinostat **or** in dark • control variable(s) eg same temperature / water / soil type • after suitable time (at least several hours) • record appearance of seedlings re. light direction • re-measure heights of shoots • detail of how bent shoots were measured – eg use thread or straighten them out • calculate mean height increase for each group • use ruler / protractor to estimate angle of bending for level 3 a reference to comparing the growth of plants with light from one direction with plants either in darkness or in full light along with a control variable is required			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	leaves / plant receive(s) / absorb(s) more light		1	AO2 4.5.4.1 4.7.2.1
	(so) more photosynthesis		1	4.4 4.4.1.2
	(so plant) produces more glucose	allow starch / carbohydrate / sugar / organic material / other named organic substance if no other mark awarded allow **1** mark for any **two** of the mark points with no reference to 'more'	1	AO1
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	ciliary muscles contract		1	AO1 4.5.2.3
	(so ciliary muscles have a) smaller diameter		1	
	(so) suspensory ligaments loosen / slacken	do **not** accept 'relax'	1	
	(so) lens thickens **or** lens becomes more curved / rounded	allow lens becomes fatter ignore lens becomes bigger	1	
	(thicker) lens is more convergent	allow light rays bent (inwards) more **or** light refracted more	1	
	light rays / image focused on retina	allow light rays meet on retina	1	
04.2	eye(-ball) is (too) short **or** lens cannot be thickened enough	allow ciliary muscles (too) weak **or** lens not (sufficiently) elastic	1	AO1 4.5.2.3
	(so) light 'focuses' behind retina	allow (so) image forms behind retina	1	
04.3	convex / converging lens	allow shape described eg thicker in middle	1	AO1 4.5.2.3
	light rays bent / refracted (inwards) more	allow changes direction of light rays further inwards	1	
	light rays focused on retina	allow light rays brought to a point on retina **or** light rays converge on retina **or** focused /clear image forms on retina	1	
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	same kingdom + phylum + class + order **or** same order **or** they have the top four groups the same	allow both Poales	1	AO3 4.6.4
05.2	**Rr / rR**	do **not** accept **RR** or **rr** ignore heterozygous do not accept homozygous	1	AO3 4.6.1.6 4.6.3.3
05.3	C^WC^W		1	AO3 4.6.1.6
05.4	parental genotypes / gametes correct for both parents: C^R C^W C^R C^W / C^R and C^W genotypes of offspring correctly derived in a Punnett square: C^RC^R C^RC^W C^WC^W correct identification of phenotypes from their cross: C^RC^R = red C^RC^W = pink C^WC^W = white	allow **R** and **W** throughout allow own symbols if defined allow correctly derived genotypes from incorrect gametes allow colours correctly identified from different offspring, only if pink and other colour(s) are given	1 1 1	AO2 4.6.1.6
05.5	answer correctly derived from Question **05.4** to match stated phenotypes	allow 50(%) if no offspring given in Question **05.4** allow to match genotypes if no phenotypes given	1	AO2 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	*(several groups)* so many / several plants can be produced *(nutrients)* for making protein / amino acids **or** for making chlorophyll **or for providing** energy **or for respiration** *(add hormones)* so differentiation occurs **or** so roots / shoots develop *(sterile conditions)* to prevent growth / entry of microorganisms / named type **or** prevent decay / disease *(temperature = 20 °C)* so optimum / good growth	allow each (group) will give a new plant allow other examples do **not** accept making energy ignore for growth allow for the formation of different tissues / organs / named allow to stimulate cell division ignore to kill microorganisms ignore contamination unqualified allow reference to enzymes working well ignore enzymes not denatured ignore reference to pathogens / microorganisms	1 1 1 1 1	AO1 4.1.2.3 4.6.1.3 4.6.2.5
05.7	(all new plants have been) produced by asexual reproduction / mitosis **or** produced without (fusion of) gametes (so) all are genetically identical / clones **or** all are C^RC^W **/** heterozygous	ignore produced from one parent allow all are the same genotype / alleles / genes / DNA	1 1	AO2 4.1 4.1.2.2 4.6.1.1 4.6.2.5
Total			**14**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	pituitary		1	AO1 4.5.3.3
06.2	ADH		1	AO1 4.5.3.3
06.3		allow ecf for name of hormone from Question **06.2** ignore name of gland		4.5.3.3
	high(er) concentration of blood **causes** (more) ADH / hormone release	allow low(er) water potential of blood causes (more) ADH / hormone release allow alternative descriptions in terms of – eg low(er) water concentration / level **or** high(er) osmotic pressure **or** high(er) solute concentration / level	1	AO2
	(and hormone / ADH causes) increased permeability of kidney tubules (to water)	allow increased permeability of collecting duct / distal convoluted tubule	1	AO1
	(so) increased water reabsorption	allow more water taken back into blood ignore reference to urine	1	AO1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4		allow converse if clearly describing dialysis explanation must match reason		AO3 4.5.3.3
	changes in concentrations / levels of substances / urea are minimised	allow no change in concentration / level of substances / urea allow correctly named substances	1	
	(so) less / no chance of causing damage to body cells / tissues	allow eg less / no osmotic stress **or** not poisoned by urea	1	
	not repeatedly puncturing skin **or** blood not in contact with machine	allow blood does not leave the body	1	
	(so) less / no chance of infection **or** less / no chance of blood clots **or** no need to take anti-clotting drugs	allow less / no chance of microorganisms entering body allow only one operation so less chance of infection for **2** marks allow dialysis requires anti-clotting drugs and so may lose more blood if cut for **2** marks	1	
Total			**9**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	**Level 2:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		3–4	AO1 AO2
	Level 1: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.		1–2	
	No relevant content		0	
	Indicative content • use of quadrat • (quadrat) of given area / dimensions – eg 0.25 m^2 or 1 m × 1 m • quadrats are placed randomly • method of obtaining randomness – eg random coordinates from a calculator **or** throw over shoulder **or** throw with eyes closed • suitable number of quadrats (10 or more **or** a large number) • count number of plants (in each quadrat) • calculation of mean per quadrat or per unit area • determination of area of field (length × width) • population = mean per m^2 × area of field			4.7.2.1
07.2	more bacteria so more divisions / reproduction (per unit time)		1	AO2 4.1.1.6
07.3	any **three** from: • add (more) sugar • add (more) amino acids / protein • add (more) oxygen • increase temperature • remove toxins / waste **or** maintain pH • stir the culture	if neither point given, allow add (more) nutrients allow in range 26 °C to 40 °C allow maintain optimum temperature if no other mark awarded allow **1** mark for add more food	3	AO3 4.1.1.6 4.4.2.3 4.7.2.3 4.7.4.3 4.7.5.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4		an answer in the range of 2.9 to 3.4 scores **4** marks an answer in the range of 2.08 to 3.77 scores **3** marks		AO2 4.1.1.6 4.6.2.4
	tangent drawn to the curve at 12 hours	do **not** accept if there is an incorrect tangent at 7 hours	1	
	calculation of rate at 7 hours $\frac{\Delta y}{\Delta x}$	allow an answer that correctly rounds to a value in range 10.0 to 11.7	1	
	calculation of rate at 12 hours $\frac{\Delta y}{\Delta x}$	allow an answer that correctly rounds to a value in range 3.1 to 4.8	1	
	3.3	allow in range 2.9 to 3.4 if both rates are in the correct ranges	1	
07.5	can use the glyphosate / weed killer to kill weeds but not kill / affect crop	allow **only** kills weeds	1	AO1 4.6.2.4 4.7.1.3 4.7.5.4
	(so) less competition for light / water / minerals / ions	allow less competition for nutrients ignore food / carbon dioxide / space	1	AO2
	(so) crops have high(er) yield	allow crops grow better / well	1	AO1
Total			**15**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1		ignore incorrect organ secreting insulin / glucagon		4.5.1 4.5.3.2
	(blood glucose increases after meal causing) insulin secretion	allow (blood glucose increases after meal causing) insulin increase	1	AO2
	insulin causes glucose to enter cells / liver / muscles	allow glucose converted to glycogen in cells / liver / muscles for **2** marks	1	AO1
	(insulin causes) glucose conversion to glycogen		1	AO1
	(so) blood glucose decreases causing glucagon secretion	allow increase in glucagon when blood glucose is low	1	AO2
	glucagon causes glycogen to be converted to glucose		1	AO1
08.2	cells / liver / muscles absorb less glucose	allow cells / liver / muscles convert less glucose to glycogen do **not** accept no absorption / conversion of glucose	1	AO2 4.5.3.2
	(so) glucose concentration in blood remains high	allow (so) glucose concentration in blood does not decrease	1	
	(high blood glucose stimulates / causes) pancreas to release more insulin	allow more insulin is released from pancreas to 'try' to reduce blood glucose	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	any **three** from: • age • height **and** mass • proportion of males and females **or** group size • (same) severity of diabetes • (same) activity (during investigation) • (same) type of meal • dose of drug • (similar) blood glucose concentrations at start • other health conditions **or** other drugs being taken	allow BMI allow sex of the participants allow how much / type of food / drink consumed before allow may not have followed drug-taking regime beforehand	3	AO3 4.5.3.2
08.4	Mean = 177.2 ± 15.4		1	AO2 4.5.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.		5–6	AO3
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.		3–4	
	Level 1: Relevant points are made. They are not logically linked.		1–2	
	No relevant content		0	
	Indicative content **Pro:** • Met + A gives larger (%) reduction (in blood glucose) than Met alone • so statement is supported • Met + B gives larger (%) reduction (in blood glucose) than Met alone • so statement is supported • Met + A SD does not overlap with Met SD • so difference is significant **Con:** • Met + B SD overlaps with Met SD • so difference is not significant • difference in results could be due to chance --- • number of people used is not very large • number of people in each group is different • so may not be representative **or** may not be repeatable / reproducible • so anomalies will have a bigger impact on smaller groups • 30 minute / starting levels of blood glucose are different • all 30 minute / starting levels are higher in the 2-drug trial • so may cause different % reductions • no information about control variables **or** named eg • concentration of drugs not given / may differ • so results may not be valid for level 3 an inclusion of a discussion of significance is required			4.5.3.2
Total			**18**	

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	

Do not write outside the box

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

0 1 The nucleus of a cell contains DNA.

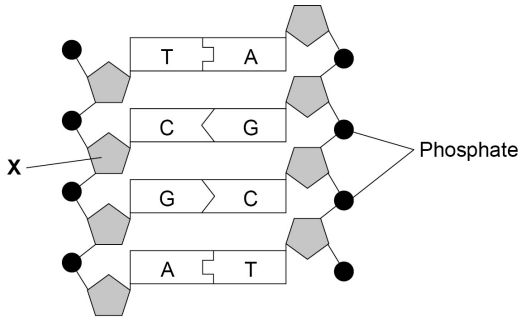
0 1 . 1 Name the structures inside the cell nucleus that contain DNA.

[1 mark]

_____

Figure 1 shows part of a DNA molecule.

Figure 1



0 1 . 2 Name the part of the DNA molecule labelled **X**.

[1 mark]

_____

0 1 . 3 What type of substances are labelled **A**, **C**, **G** and **T** in **Figure 1**?

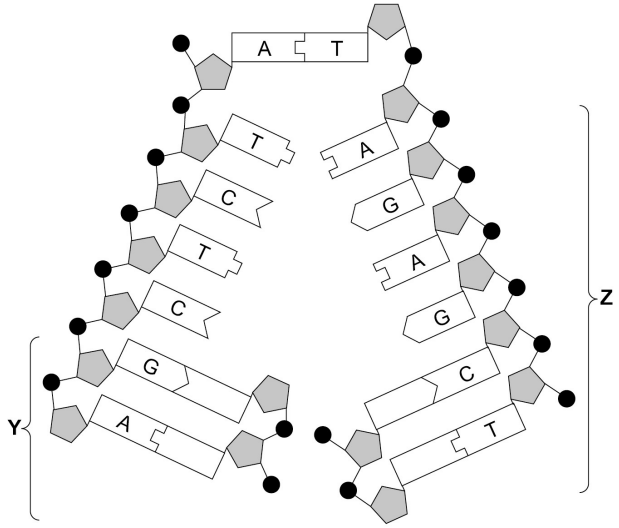
[1 mark]

_____

Do not write outside the box

Figure 2 shows another section of a DNA molecule.

Figure 2



0 1 . 4 Four of the substances you named in Question **01.3** are **not** labelled in part **Y** of **Figure 2.**

Label each of these substances with the correct letter, **A**, **C**, **G** or **T.**

Use information from other parts of **Figure 2** to help you.

[1 mark]

0 1 . 5 What is happening to the DNA in part **Z** of **Figure 2**?

[1 mark]

Tick (✓) **one** box.

- Differentiation ☐
- Evolution ☐
- Fertilisation ☐
- Replication ☐

Turn over ►

Do not write outside the box

0 1 . 6 A gene is a length of DNA.

What type of substance does a gene code for?

[1 mark]

0 1 . 7 Most human body cells contain 6×10^{-12} grams of DNA.

What mass of DNA will a human sperm cell contain?

[1 mark]

Tick (✓) **one** box.

- 6×10^{-6} grams ☐
- 6×10^{-12} grams ☐
- 3×10^{-6} grams ☐
- 3×10^{-12} grams ☐

0 1 . 8 What is the name of the type of cell division that produces sperm cells?

[1 mark]

Tick (✓) **one** box.

- Binary fission ☐
- Differentiation ☐
- Meiosis ☐
- Mitosis ☐

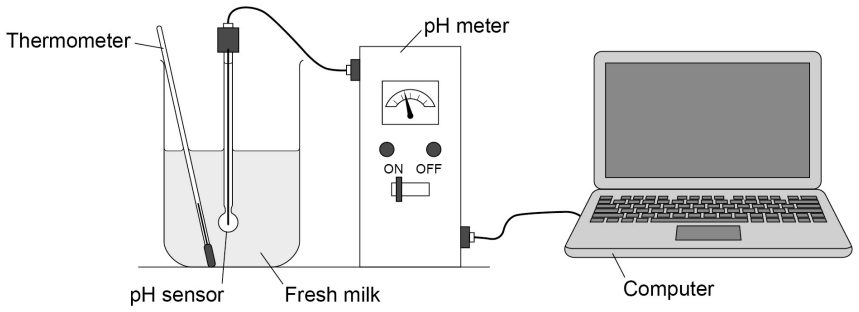
8

Do not write outside the box

0 2 A student investigated the effect of temperature on the decay of milk.

Figure 3 shows the apparatus the student used.

Figure 3



This is the method used.

1. Set up the apparatus as shown in **Figure 3** with the milk at 20 °C.

2. Record the pH over 5 days using the computer.

3. Repeat with another batch of fresh milk at 25 °C.

0 2 . 1 How could the student keep the milk at a constant temperature for 5 days?

[1 mark]

0 2 . 2 Give **one** variable the student should keep constant.

Do **not** refer to temperature in your answer.

[1 mark]

Question 2 continues on the next page

Turn over ►

Do not write outside the box

Table 1 shows the student's results for the milk at 20 °C.

Table 1

Time in days	0	1	2	3	4	5
pH	6.7	6.7	6.3	5.3	4.6	4.4

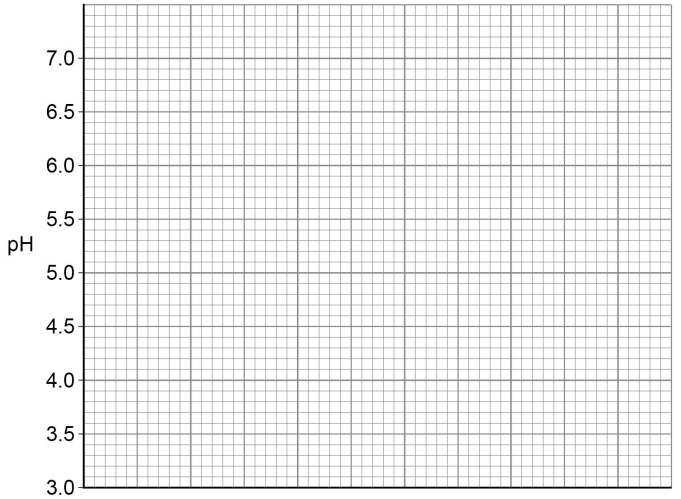
0 2 . 3 Complete **Figure 4**.

[4 marks]

You should:

- label the x-axis
- use a suitable scale for the x-axis
- plot the data from **Table 1**
- draw a line of best fit.

Figure 4



0 2 . 4 The data you plotted in Question **02.3** were obtained at 20 °C.

Sketch a line on **Figure 4** to show the results you would expect at 25 °C.

Label this line '25 °C'.

[2 marks]

8

Do not write outside the box

0 3 Human body temperature is controlled within very narrow limits.

Scientists investigated the effect of drinking ice-cold water on:

- internal body temperature
- the rate of sweating.

This is the method used.

1. Sit a person inside a room kept at a constant temperature of 25 °C.
2. Measure the person's internal body temperature near the brain.
3. Measure the person's rate of sweating.
4. After 20 minutes, give the person 500 cm^3 of ice-cold water to drink.
5. Continue to measure the person's internal body temperature and sweating rate for a further 50 minutes.

0 3 . 1 Give the reason why the person should **not** move during the investigation.

[1 mark]

Question 3 continues on the next page

Do not write outside the box

Figure 5 and **Figure 6** show the scientists' results.

Figure 5

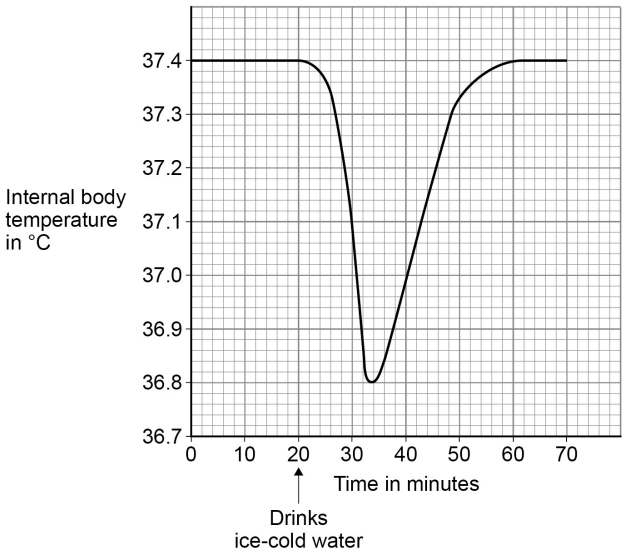
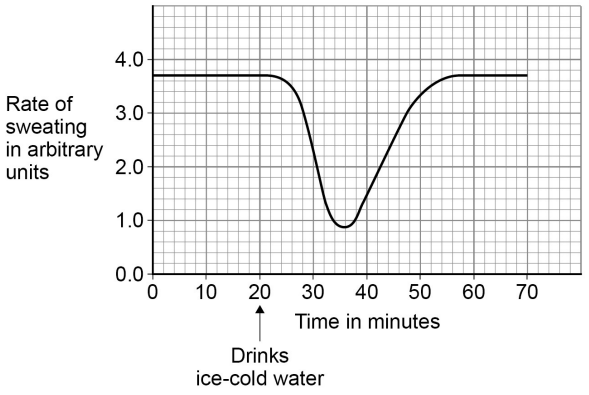


Figure 6



Do not write outside the box

0 3 . 2 What is this person's normal internal body temperature?

[1 mark]

Tick (✓) **one** box.

36.8 °C ☐ 37.0 °C ☐ 37.4 °C ☐

The results show that when the ice-cold water was drunk, the temperature near the brain decreased.

0 3 . 3 Explain why the temperature near the brain decreased.

[2 marks]

0 3 . 4 The thermoregulatory centre in the brain responds to the decrease in temperature.

How does the thermoregulatory centre send information to sweat glands in the skin?

[1 mark]

0 3 . 5 The rate of sweating changes between 24 minutes and 36 minutes.

Explain how this change helps to maintain the person's normal body temperature.

[2 marks]

Question 3 continues on the next page

Do not write outside the box

0 3 . 6 During exercise, the skin appears red.

What causes the skin to appear red?

[1 mark]

Tick (✓) **one** box.

Blood vessels moving closer to the skin surface ☐

Constriction of blood vessels in the skin ☐

Decrease in heart rate ☐

Dilation of blood vessels in the skin ☐

8

Turn over for the next question

Do not write outside the box

Turn over for the next question

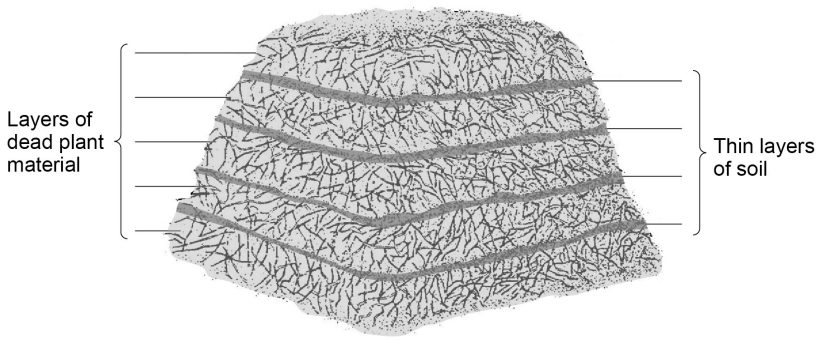
DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 4 Decay occurs in a compost heap.

Figure 7 shows a compost heap.

Figure 7



Describe:

- how microorganisms in the layers of soil help to recycle chemicals in the dead plants
- how the chemicals are used again by living plants.

[6 marks]

Do not write outside the box

6

Turn over for the next question

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 5 The growth of daisy plants on a lawn is affected by biotic factors and by abiotic factors.

0 5 . 1 **Table 2** shows six factors.

Tick (✓) **one** box in each row to show whether the factor is biotic or abiotic.

[3 marks]

Table 2

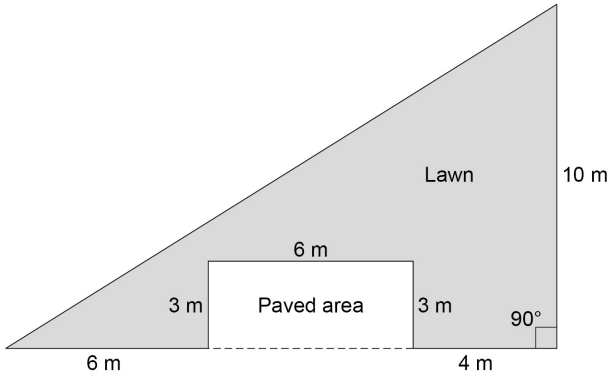
Factor	Biotic	Abiotic
Nitrates in the soil		
Rabbits eating the plants		
Shading by a building		
Soil pH		
Temperature		
Trampling by people		

Question 5 continues on the next page

Do not write outside the box

Figure 8 shows a plan of a garden.

Figure 8



A student estimates the number of daisy plants growing on the lawn.

The student places a quadrat at 10 different positions on the lawn.

The quadrat measures 50 cm × 50 cm.

The student counts the number of daisy plants in each quadrat.

0 5 . 2 How should the student decide where to place the quadrat?

Give the reason for your answer.

[2 marks]

Do not write outside the box

0 5 . 3 The mean number of daisy plants in each quadrat is 6.

Calculate the number of daisy plants on the lawn.

Give your answer to 3 significant figures.

[6 marks]

Number of daisy plants on the lawn = _____

0 5 . 4 Using the mean from this investigation to calculate the number of daisy plants on the lawn may **not** be accurate.

Give **two** reasons why.

[2 marks]

1 _____

2 _____

13

Turn over for the next question

Do not write outside the box

0 6 Reflex actions are coordinated by the nervous system.

0 6 . 1 What is meant by the term 'reflex action'?

[2 marks]

0 6 . 2 A woman's hand accidentally touches a hot object.

The woman moves her hand away rapidly.

Describe how the woman's nervous system coordinates the reflex action.

[6 marks]

Do not write outside the box

0 6 . 3 The endocrine system coordinates many internal functions of the body.

Give **three** ways coordination by the endocrine system is different from coordination by the nervous system.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 6 . 4 Describe how hormones control the menstrual cycle.

[5 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

16

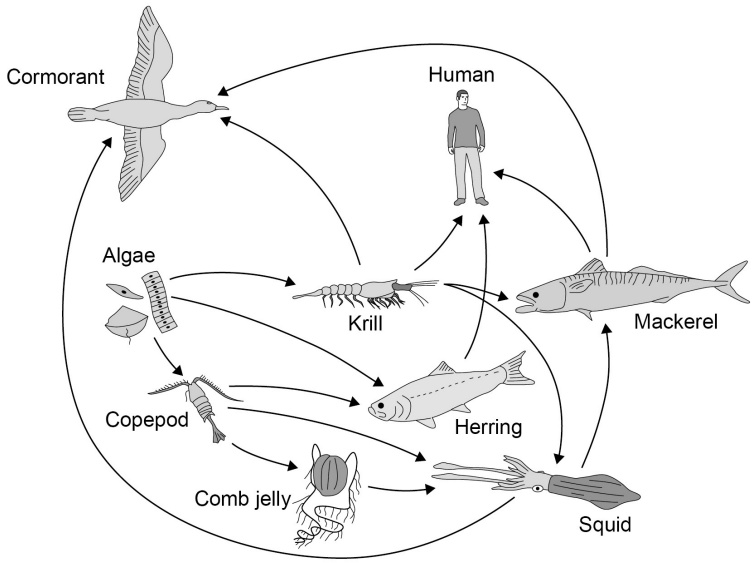
Turn over for the next question

Do not write outside the box

0 7 A food web contains several food chains.

Figure 9 shows a food web.

Figure 9



Not to scale

0 7 . 1 The animals in **Figure 9** get their energy by eating other organisms.

Describe how the algae get energy.

[2 marks]

_____

_____

_____

_____

0 7 . 2 Name **one** primary consumer in **Figure 9**.

[1 mark]

_____

Do not write outside the box

0 7 . 3 Name **one** producer in **Figure 9**.

[1 mark]

_____

0 7 . 4 The different food chains in **Figure 9** have different numbers of organisms.

Complete **Figure 10** to show a food chain in **Figure 9** with **five** organisms, including the human.

[1 mark]

Figure 10

1 _____

↓

2 _____

↓

3 _____

↓

4 _____

↓

5 Human

0 7 . 5 **Figure 9** shows that mackerel eat krill and squid.

The biomass of mackerel is much less than the combined biomass of krill and squid.

One reason for this is that the mackerel cannot digest all parts of the krill and squid.

Give **two** other reasons.

[2 marks]

1 _____

_____

2 _____

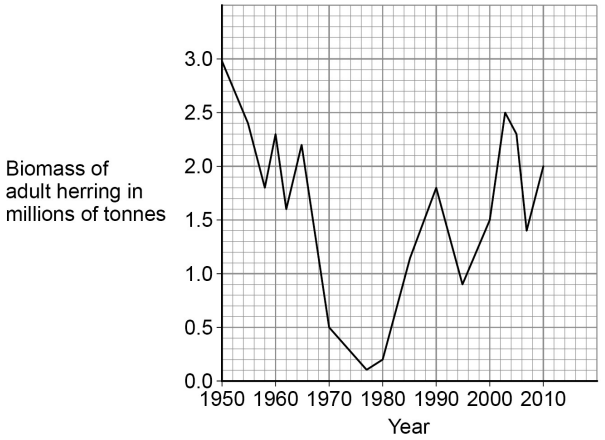
_____

Turn over ►

Do not write outside the box

Figure 11 shows how the biomass of adult herring in the North Sea has changed between 1950 and 2010.

Figure 11



0 7 . 6 Calculate the percentage decrease in the biomass of herring between 1960 and 1977.

Give your answer to the nearest whole number.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

Percentage decrease = _____ %

Do not write outside the box

Question 7 continues on the next page

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 7 . 7 Too many herring were caught by fishermen between 1960 and 1977.

Herring can live for up to 12 years and begin to reproduce when 3 to 4 years old.

Laws have been introduced to help conserve herring:

- 1977 to 1981 – herring fishing was banned in the North Sea
- 1984 to present day – control of mesh size of fishing nets
- 1997 to present day – fishing quotas were introduced
- 1998 to present day – herring fishing was banned in breeding grounds during the breeding season.

Figure 12 shows how a minimum mesh size helps to conserve herring.

Figure 12

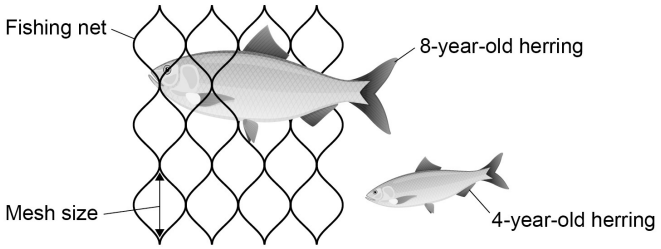
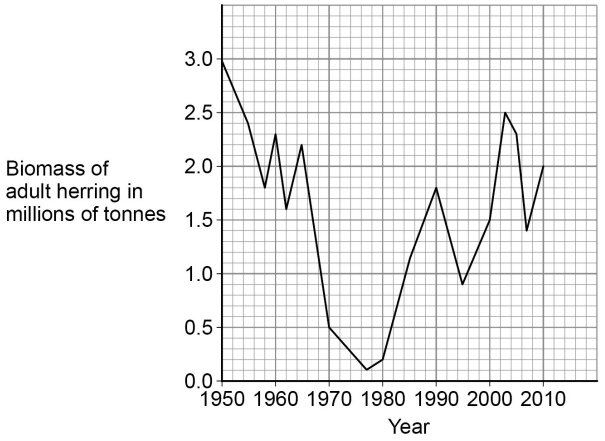


Figure 11 is repeated below.

Figure 11



Do not write outside the box

Evaluate the effect of these laws on the conservation of herring stocks.

Use data from **Figure 11** and information from **Figure 12** in your answer.

[6 marks]

17

Turn over for the next question

Do not write outside the box

0 8 Sickle cell anaemia is an inherited condition that affects red blood cells.

Sickle cell anaemia is caused by a mutation in the gene for haemoglobin. Haemoglobin is the red pigment found in red blood cells.

A person who is homozygous for the normal haemoglobin allele (H^A) produces normal red blood cells.

A person who is homozygous for the mutated allele (H^S):

- produces red blood cells with abnormal haemoglobin
- has red blood cells that can form an altered shape
- has sickle cell anaemia and becomes ill.

A person who is heterozygous:

- has both normal and abnormal haemoglobin in the red blood cells
- has sickle cell trait
- is generally healthy but can become ill in certain circumstances.

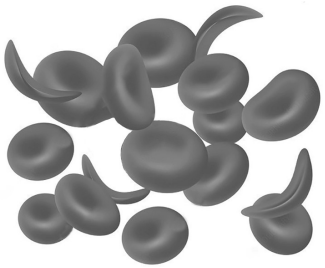
0 8 . 1 Give the reason why a mutation in the gene coding for haemoglobin could be harmful.

[1 mark]

Do not write outside the box

0 8 . 2 **Figure 13** shows some red blood cells from the blood of a person with sickle cell trait.

Figure 13



Calculate the proportion of cells in **Figure 13** that have an altered shape.

[2 marks]

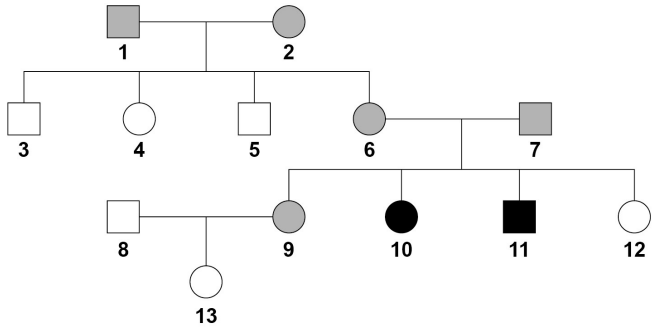
Proportion = _____

Question 8 continues on the next page

Do not write outside the box

Figure 14 shows the inheritance of sickle cell anaemia in one family.

Figure 14



Key

- Unaffected male
- Unaffected female
- Male with sickle cell anaemia
- Female with sickle cell anaemia
- Male with sickle cell trait
- Female with sickle cell trait

Do not write outside the box

0 8 . 3 Persons **8** and **9** in **Figure 14** are expecting a second child.

Determine the probability that the child will be a girl with sickle cell trait.

You should:

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

  H^A = normal haemoglobin allele

  H^S = mutated haemoglobin allele.

[5 marks]

Probability of a girl with sickle cell trait = _____

Question 8 continues on the next page

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0 8 . 4 Without medical treatment, people with sickle cell anaemia are frequently ill and have a reduced life expectancy.

The malarial parasite cannot live in the red blood cells of a person who has the H^S allele.

A scientist stated:

'It is an advantage for people to have the H^S allele in countries where malaria occurs.'

Evaluate the scientist's statement.

[3 marks]

11

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 9 The Galapagos Islands are located in the Pacific Ocean.

Several species of birds called finches live on the Galapagos Islands.

These finches are very similar to each other.

Figure 15 shows two modern species of Galapagos finch and their classification.

Figure 15

Medium ground finch **Small ground finch**

Classification group	**Medium ground finch**	**Small ground finch**
Kingdom	*Animalia*	*Animalia*
	Chordata	*Chordata*
Class	*Aves*	*Aves*
	Passeriformes	*Passeriformes*
	Thraupidae	*Thraupidae*
Genus	*Geospiza*	*Geospiza*
	fortis	*fuliginosa*

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0 9 . 1 Complete **Figure 15** to give the names of the missing classification groups.

[2 marks]

0 9 . 2 Give the binomial name of the medium ground finch.

Use information from **Figure 15**.

[1 mark]

Question 9 continues on the next page

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In each species of finch, there is a variation in beak depth.

Figure 16 shows how beak depth is measured.

Figure 16

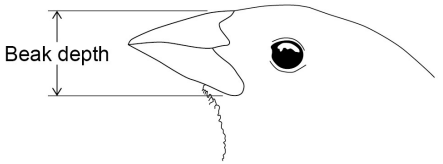
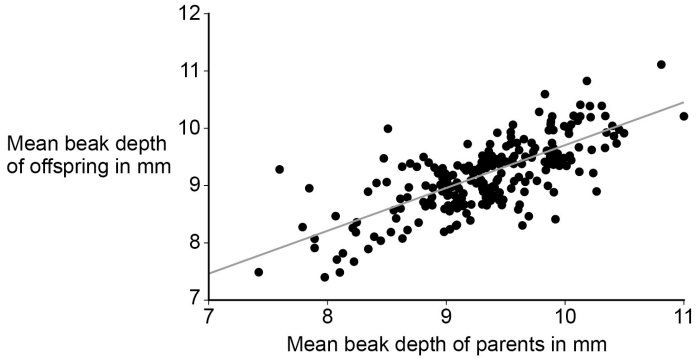


Figure 17 shows the relationship between the beak depth of parent birds and the beak depth of their offspring.

Figure 17



0 9 . 3 Give evidence from **Figure 17** that beak depth is an inherited characteristic.

[1 mark]

Do not write outside the box

0 9 . 4 Scientists suggested that more than one gene controls beak depth.

Give evidence from **Figure 17** to support the scientists' suggestion.

[1 mark]

Question 9 continues on the next page

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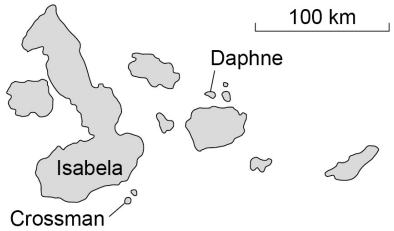
Figure 18 is a map of the Galapagos Islands.

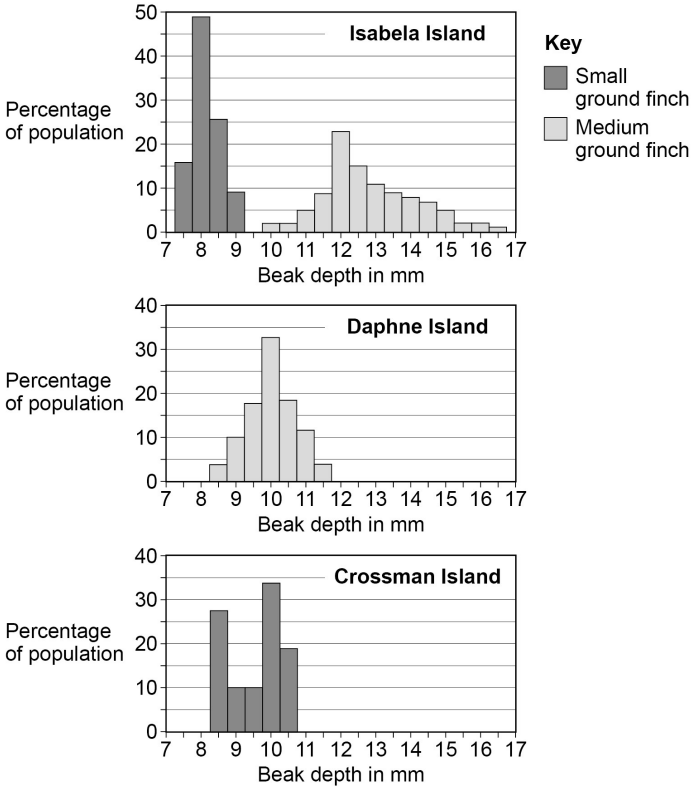
Figure 18



On Isabela Island, the medium ground finch **and** the small ground finch are found.
On Daphne Island, only the medium ground finch is found.
On Crossman Island, only the small ground finch is found.

Figure 19 shows how the beak depth of each species varies on each island.

Figure 19



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The medium ground finch and the small ground finch both feed on seeds.

The size of seeds eaten by each bird depends on the depth of the bird's beak.

0 9 . 5 The range of beak depth of **medium ground finches** on Isabela Island is different from the range on Daphne Island.

Explain what might have caused this difference.

[6 marks]

Question 9 continues on the next page

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0 9 . 6 **Figure 19** shows:

- the **two** species of finch live on Isabela Island
- only **one** of the species lives on Daphne Island
- only **one** of the species lives on Crossman Island.

Suggest why both species of finch are able to live on Isabela Island.

[2 marks]

13

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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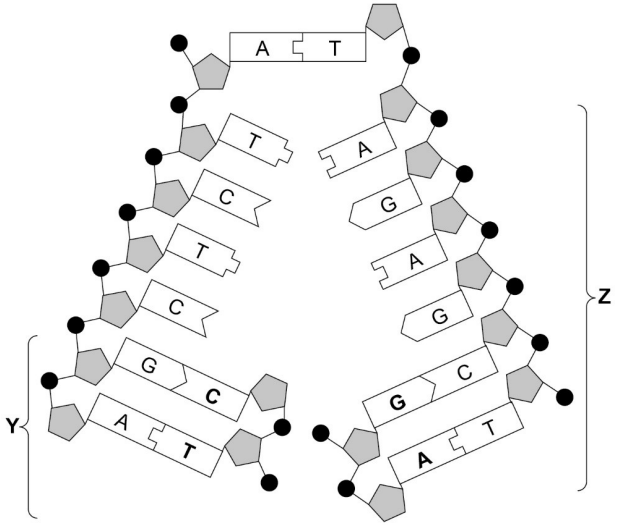
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	chromosome(s)	allow chromatid(s) / gene(s) / allele(s)	1	AO1 4.6.1.4
01.2	sugar	allow deoxyribose allow pentose do **not** accept ribose	1	AO1 4.6.1.5
01.3	base(s)	allow nitrogenous base(s) allow adenine **and** cytosine **and** guanine **and** thymine	1	AO1 4.6.1.5
01.4	 all four required for the mark		1	AO3 4.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	replication		1	AO3 4.6.1.5 4.1.2.2
01.6	protein	allow polypeptide	1	AO1 4.6.1.4
01.7	3×10^{-12} grams		1	AO2 4.6.1.2
01.8	meiosis		1	AO1 4.6.1.2
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(put beaker in a) water bath	allow (put beaker in an) incubator	1	AO1 4.7.2.3 RPA10
02.2	volume of the milk **or** type of milk	allow amount of milk allow named type of milk, eg cows' or semi-skimmed	1	AO1 4.7.2.3 RPA10
02.3	correct scale and axis labelled all points plotted correctly suitable curved line of best fit	scale must be at least 1 cm for 1 day allow a tolerance of ± ½ small square allow 4 or 5 correct plots for **1** mark ignore line joined point to point with straight lines	1 2 1	AO2 4.7.2.3 RPA10
02.4	similar shaped line drawn to left of 20 °C line on **Figure 4** same start pH	 allow a tolerance of ± ½ small square allow from student's line of best fit or student's plot for 0 days	1 1	AO2 4.7.2.3 RPA10
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3.1	any **one** from: • movement would release (extra) heat • movement would increase body temperature • movement would increase sweating		1	AO2 4.5.1 4.5.2.4
3.2	37.4 °C		1	AO2 4.5.1 4.5.2.4
3.3	blood is cooled at stomach / mouth (cooled) blood flows to the brain		1 1	AO2 4.5.1 4.5.2.4
3.4	via nerve(s) / neurones **or** via (nerve) impulse(s)	ignore type of neurone allow electrical signals allow via the nervous system	1	AO2 4.5.1 4.5.2.4
3.5	less sweating occurs so less heat is lost **or** less cooling	allow less sweat evaporates do **not** accept no sweating allow less heat used for evaporation of sweat / water	1 1	AO3 AO2 4.5.1 4.5.2.4
3.6	dilation of blood vessels in the skin		1	AO2 4.5.1 4.5.2.4
Total			**8**	

Question	Answers	Mark	AO / Spec. Ref.
4	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	4–6	AO1 4.7.2.1 4.7.2.2 4.7.2.3 4.2.2.1 4.2.3.1 4.2.3.2 4.4.1.1 4.4.1.3 4.4.2.1
	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 *in microorganisms* • digestion **or** large molecules to small molecules • enzymes **or** named example • respiration • production of carbon dioxide • release of mineral ions **or** named example such as nitrate / phosphate / magnesium *in plants* • carbon dioxide (from air) taken in by leaves • by diffusion • via stomata • carbon dioxide used in photosynthesis • making glucose / sugar / starch / cellulose **or** making other correctly named example • (named) ions taken in by roots • by active transport • nitrate ions for making amino acids / proteins / DNA / chlorophyll • phosphate for making DNA For **Level 2** processes in microorganisms and in plants should be considered		
Total		**6**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1			3	AO1 4.7.1.2 4.7.1.3 4.4.1.2

Factor	Biotic	Abiotic
Nitrates in the soil		✓
Rabbits eating the plants	✓	
Shading by a building		✓
Soil pH		✓
Temperature		✓
Trampling by people	✓	

all 6 correct = **3** marks
4 or 5 correct = **2** marks
2 or 3 correct = **1** mark
0 or 1 correct = **0** marks

05.2	(grid and) coordinates		1	AO1 4.7.2.1
	to achieve randomness	ignore throwing quadrat allow random coordinates for **2** marks if no other mark awarded allow random walk **or** description of random walk for **1** mark	1	RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	*(mean per m^2 =)* 24 **or** 6 × 4		1	AO2 4.7.2.1 RPA9
	(calculation of area of lawn =) (½ × 16 × 10) – (6 × 3) **or** 80 – 18		1	
	(area of lawn =) 62 m^2	allow correct calculation using total area (of triangle) – area of rectangle	1	
	(total number of daisies =) 24 × 62	allow correct calculation using an incorrectly calculated area of the lawn and / or mean	1	
	1488	allow answer based on incorrect area	1	
	(answer to 3 sig figs =) 1490	allow student's calculated answer rounded to 3 sig figs	1	
05.4	too few quadrats **or** quadrat too small	allow sample size too small	1	AO3 4.7.2.1 RPA9
	sample may not be representative of the lawn	allow quadrats may not have been placed randomly	1	
Total			**13**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1		ignore examples		AO1 4.5.2.1
	response / reaction	ignore action	1	
	automatic **or** no thinking **or** not conscious **or** involuntary	ignore reference to brain ignore quick	1	
06.2	receptor (in skin of finger / hand) detects stimulus / temperature change	allow receptor detects heat ignore pain	1	AO1 4.5.2.1
	(electrical) impulses pass along neurones	allow electrical signals pass along nerve cells ignore messages	1	
	(impulses pass from) sensory to relay to motor neurones		1	
	synapse between neurones where chemical crosses gap	allow neurotransmitter / acetylcholine for chemical allow by diffusion	1	
	(synapses) in spinal cord / CNS	ignore brain	1	
	muscle contraction (to pull hand away) **or** effector is a muscle		1	
06.3	coordination by endocrine system is:	allow converse points if clearly indicating nervous co-ordination answers must be comparative		
	slower		1	AO1
	longer-lasting		1	AO1
	(chemical / hormone) via blood instead of electrical / impulse / neurones		1	AO2 4.5.2.1 4.5.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4		ignore reference to days of menstrual cycle		
	FSH (release from pituitary) stimulates maturation of egg / ovum / follicle	allow FSH stimulates development / growth of egg	1	AO1 4.5.3.1 4.5.3.4
	oestrogen (release from ovary) inhibits FSH production **and** stimulates LH production		1	
	LH (release from pituitary) stimulates ovulation	allow LH stimulates release of egg	1	
	progesterone (release from ovary) inhibits FSH **and** LH production	allow (release from corpus luteum)	1	
	oestrogen **and** progesterone maintain the uterus lining	allow oestrogen **and** progesterone build up the uterus lining	1	
Total			**16**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	from light / sunlight	ignore sun unqualified	1	AO1 4.7.2.1
	absorbed by chlorophyll / chloroplasts	if no other mark awarded allow by photosynthesis for **1** mark	1	4.7.4.3 4.4.1.1
07.2	krill / herring / copepod		1	AO2 4.7.2.1 4.7.4.1
07.3	algae		1	AO2 4.7.2.1 4.7.4.1
07.4	1 algae 2 krill **or** copepod 3 squid 4 mackerel (5 Human)	all correct for **1** mark	1	AO2 4.7.2.1
07.5	any **two** from: (losses due to)		2	AO1 4.7.4.3
	• non-eaten parts (of squid / krill)	allow bones / shells allow eaten by other animals		
	• <u>respiration</u> **or** <u>respiring</u> (in mackerel)	do **not** accept respiration produces / makes / creates energy		
	• excretion (by mackerel)	allow loss of a named waste product such as CO_2 / urea ignore loss of waste unqualified ignore faeces		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	2.3 **and** 0.1 (million)	allow in the range 2.25 to 2.3 for 2.3 (million)	1	AO2 4.7.5.3
	$\frac{2.3 - 0.1}{2.3} \times 100$ **or** $\frac{220}{2.3}$		1	
	95.65217.....	allow answer from correct substitution of incorrect values from **Figure 11**	1	
	96	allow student's calculated answer correctly rounded to the nearest whole number	1	

Question	Answers	Mark	AO / Spec Ref.
07.7	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO3 4.7.5.3
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content figures may be given without units (million tonnes) throughout **points for:** • small fish are not caught so can live long enough to reproduce • biomass / stocks have generally increased after these laws introduced • '77-'81 law (total ban) resulted in increase in biomass, eg 0.1 to 0.48 **or** to 0.9 by '84 • '84 law (mesh size) resulted in increase in biomass, eg 0.9 to 1.8 (by '90) • '97 law (quotas) resulted in increase, eg 1.15 to 1.25 • '98 law (ban in breeding season) resulted in increase, eg 1.25 to 2.5 **points against:** • could be a cause other than the law **or** correlation does not necessarily indicate causal relationship **or** other factors • laws superimposed so can't necessarily tell the effect of each • each law results in an increase followed by a decrease • quotas lead to dead fish being thrown back into sea For **Level 3** points both for and against must be considered together with appropriate use of data		
Total		**17**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	mutation means less oxygen for (aerobic) respiration	allow haemoglobin **or** red blood cell carries oxygen for (aerobic) respiration do **not** accept no oxygen for respiration	1	AO2 4.6 4.6.1.5 4.2.2.3
08.2	4 ÷ 17 0.235(29...)	allow 4:13 allow 0.24 **or** 24% allow ratio 1 : 3.25	1 1	AO2 4.6.1.5 4.2.2.3
08.3	father / **8**'s gametes correct: $H^A + H^A$ mother / **9**'s gametes correct: $H^A + H^S$ correct derivation of offspring genotypes: H^AH^A H^AH^A H^AH^S H^AH^S correct phenotype for each derived genotype 0.25 / ¼ / 25% / 1 in 4 / 1:3	allow **1** mark for both sets of gametes if parents not identified allow correctly derived offspring genotypes from incorrect parental gametes allow **only** a probability consistent with student's derivations	1 1 1 1 1	AO2 AO2 AO2 AO2 AO3 4.6.1.6 4.6.1.7 4.6.1.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	any **three** from: *points for:* • H^AH^S do not get malaria • H^AH^S survive sickle cell anaemia *points against:* • H^AH^A may die from malaria • H^SH^S may become (severely) ill with sickle cell anaemia • Judgement: if parents H^AH^S then some offspring survive both malaria and sickle cell anaemia **or** if parents H^AH^S then some offspring may become (severely) ill with malaria and some become (severely) ill with sickle cell anaemia	to gain full marks both point(s) for and point(s) against must be given	3	AO3 4.6.2.1
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	**Classification group** Kingdom Phylum Class Order Family Genus Species	all 4 correct = **2** marks 2 or 3 correct = **1** mark 0 or 1 correct = **0** marks	2	AO1 4.6.4
09.2	Geospiza fortis	ignore underlining or attempted italics or upper and lower case letters	1	AO2 4.6.4
09.3	offspring have similar beak depths to parents	ignore same beak depths ignore positive correlation / described	1	AO3 4.6.2.1
09.4	parents of a given beak depth produce offspring with several beak depths	allow spread of results for a given parental beak depth about line of best fit allow range of phenotypes for a given parental beak depth	1	AO3 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	colonisers of Isabela have a range of beak depths	allow colonisers of Daphne have a range of beak depths	1	AO2
	due to different combinations of alleles of several genes **or** due to different alleles of one gene **or** due to mutation		1	AO1
	large range of (sizes / species of) seeds / food (on Isabela) **or** large(r) seeds (on Isabela)	allow small range of (sizes / species of) seeds / food on Daphne **or** allow small(er) seeds on Daphne	1	AO2
	more competition for seeds / food (on Isabela)	allow less competition for seeds / food on Daphne ignore competition unqualified	1	AO2
	birds with larger beaks get enough food to (survive and) reproduce (on Isabela)	allow birds with smaller / medium beak sizes get enough food to (survive and) reproduce on Daphne	1	AO2
	(survivors) pass on (beneficial) alleles to offspring	allow pass on genes / mutation ignore pass on chromosomes / characteristics	1	AO1 4.6.2.1 4.6.2.2 4.7.1.1 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	Isabela is a large island with more species of plants **or** Isabela is a large island with more variety in seed / food sizes **or** Isabela is a large island with more plants / seeds / food		1	AO3 4.7.1.1 4.7.1.3
	less competition for seeds / food **or** enough seeds / food for both bird species		1	
Total			**13**	

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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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]

_____

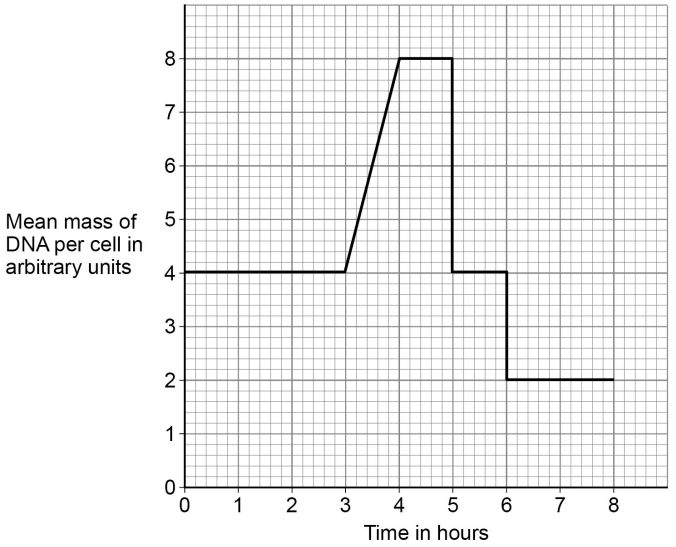
Question 1 continues on the next page

Do not write outside the box

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

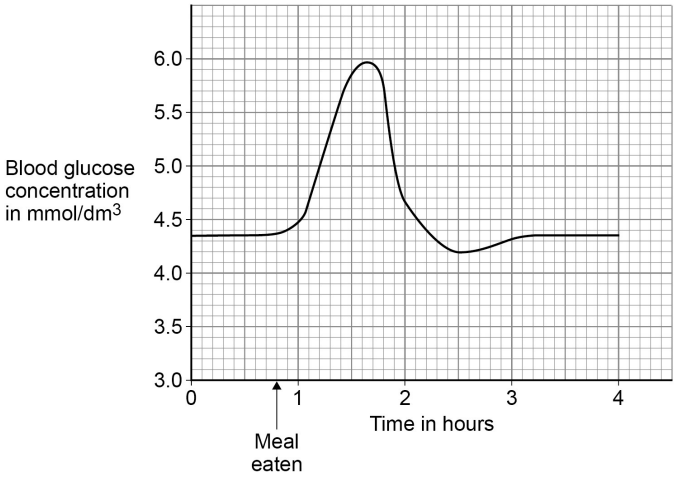
Turn over for the next question

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

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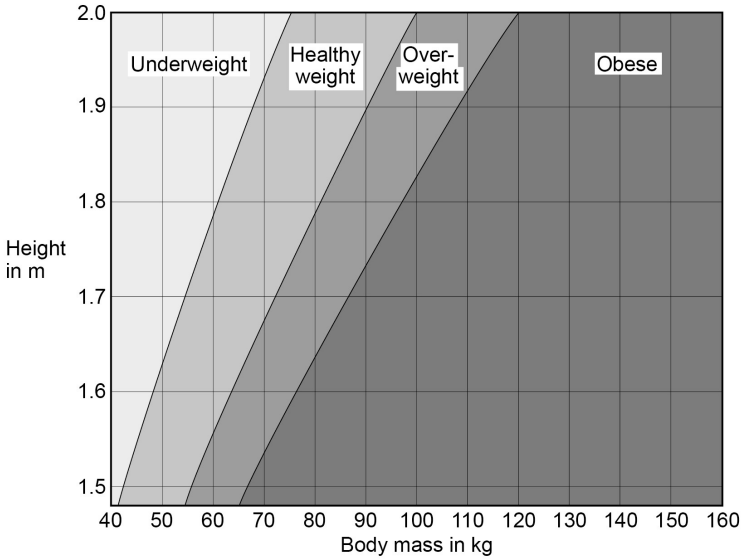
People with diabetes have difficulty controlling the concentration of glucose in their blood.

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

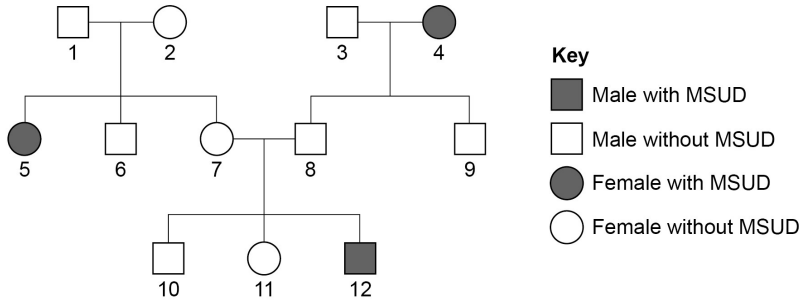
Do not write outside the box

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]

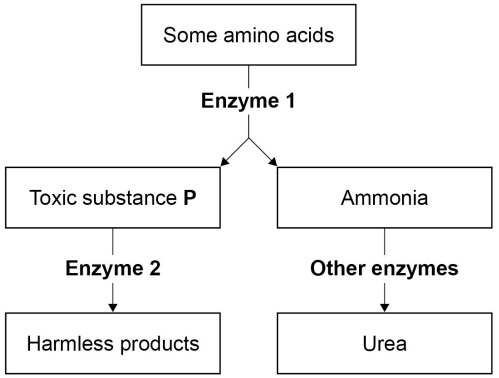
Probability = _____

Question 5 continues on the next page

Do not write outside the box

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]

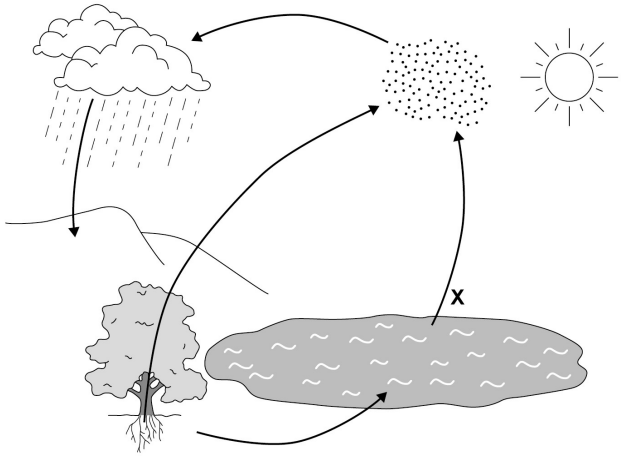
14

Do not write outside the box

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 _____

_____

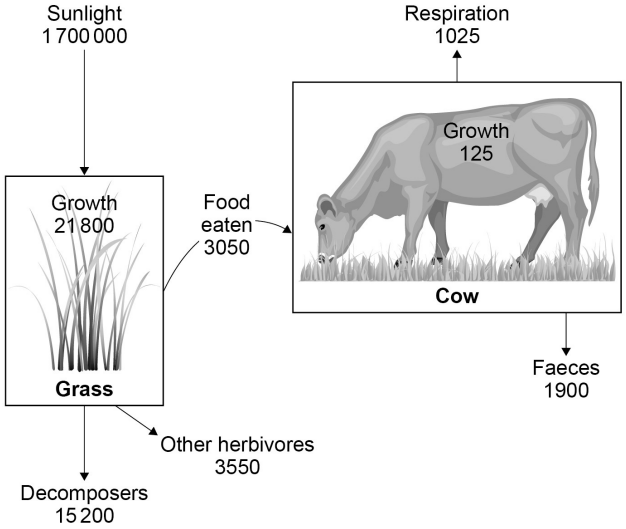
Turn over ►

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

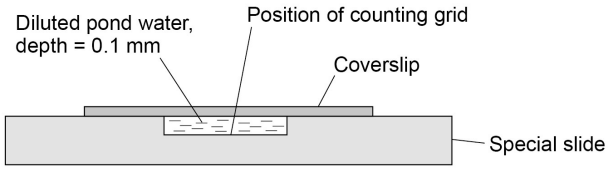
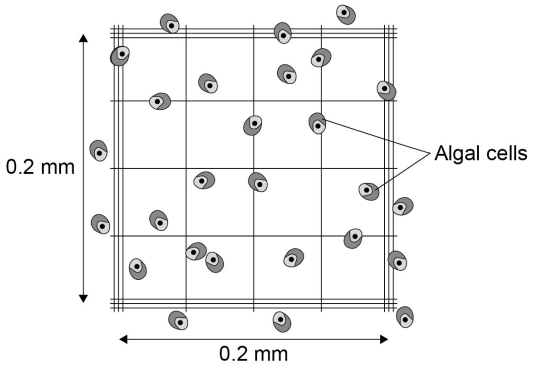


Figure 9 shows the view of the counting grid through a microscope.

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

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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

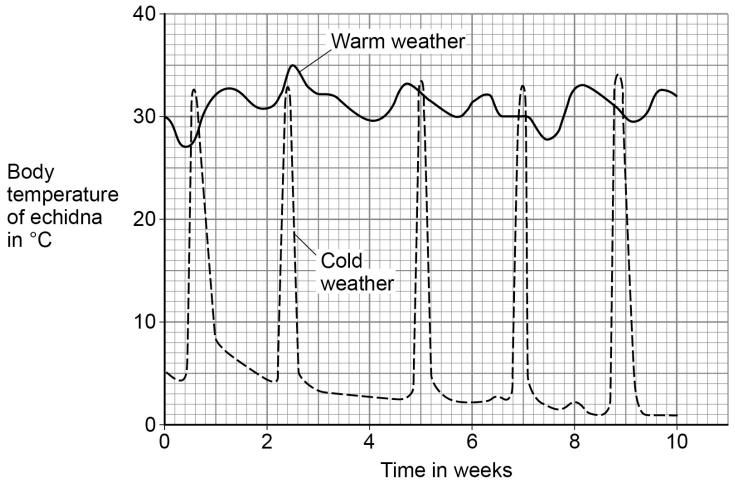
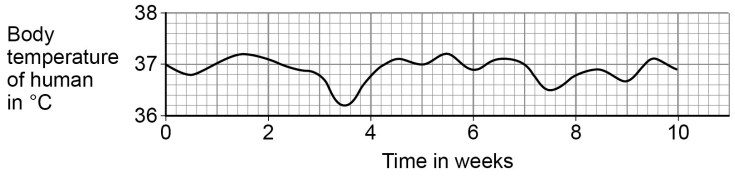


Figure 12 shows how human body temperature varies.

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

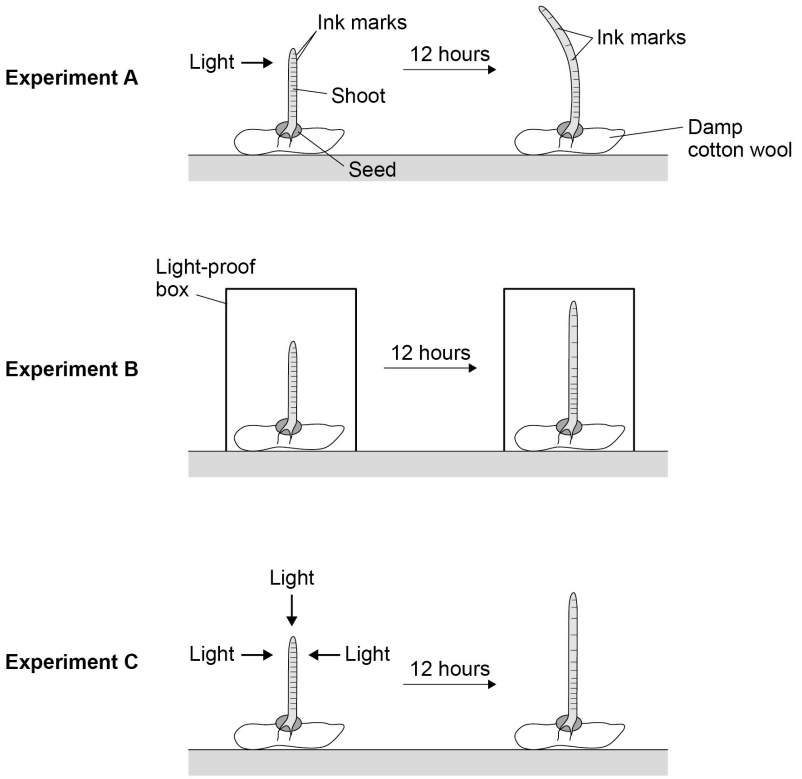
Turn over for the next question

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



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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

Do not write outside the box

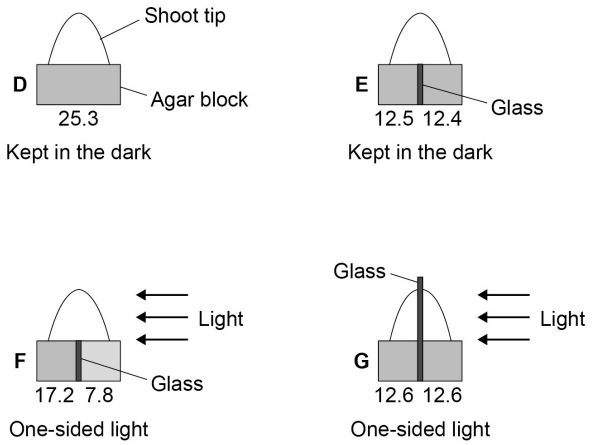
Auxin is a plant hormone. Auxin is made in the shoot tip.

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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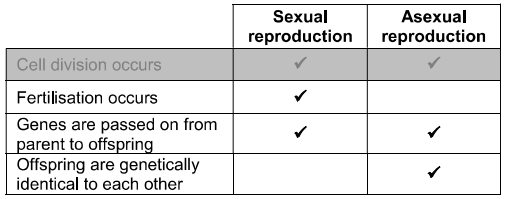
MARK SCHEME – GCSE BIOLOGY – 8461/2H – JUNE 2022

Question 1

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

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	1	
		do **not** accept (person **C** has) higher cholesterol		
		ignore unprocessed data		

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	1	
		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		

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 **or** 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 AO2
	(so) toxic substance **or P** does not build up in the body **and** cause damage to cells / tissues / organs		1	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		1	AO2 4.7.2.1 RPA9
	number of cells in 1 mm^3 ***diluted*** *pond water* 14 ÷ 0.004	allow 14 ÷ (0.2 × 0.2 × 0.1) allow use of an incorrectly calculated volume of 0.04	1	
	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 × 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) (so) more energy available for processes vital for life (1)	allow less energy transferred for keeping warm 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 heat (which increases body temperature) **OR** respiration / metabolism releases heat (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** $\frac{8000}{2.5}$ 3 200 (cm^3) 3.2 (dm^3)	 allow an incorrectly calculated value correctly divided by 1000	1 1 1	AO2 4.5.2.4

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 **l**ight (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 auxin	allow examples such as mass of auxin in **D** / **E** is (about) the same as in **F** / **G** **or** those in light have same mass of auxin as those in dark	1	AO3 4.5.4.1

Total Question 9		**11**