Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level BIOLOGY

Paper 2

Friday 14 June 2024 Morning Time allowed: 2 hours

Materials

For this paper you must have:
- a ruler with millimetre measurements
- 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.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- 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).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 91.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

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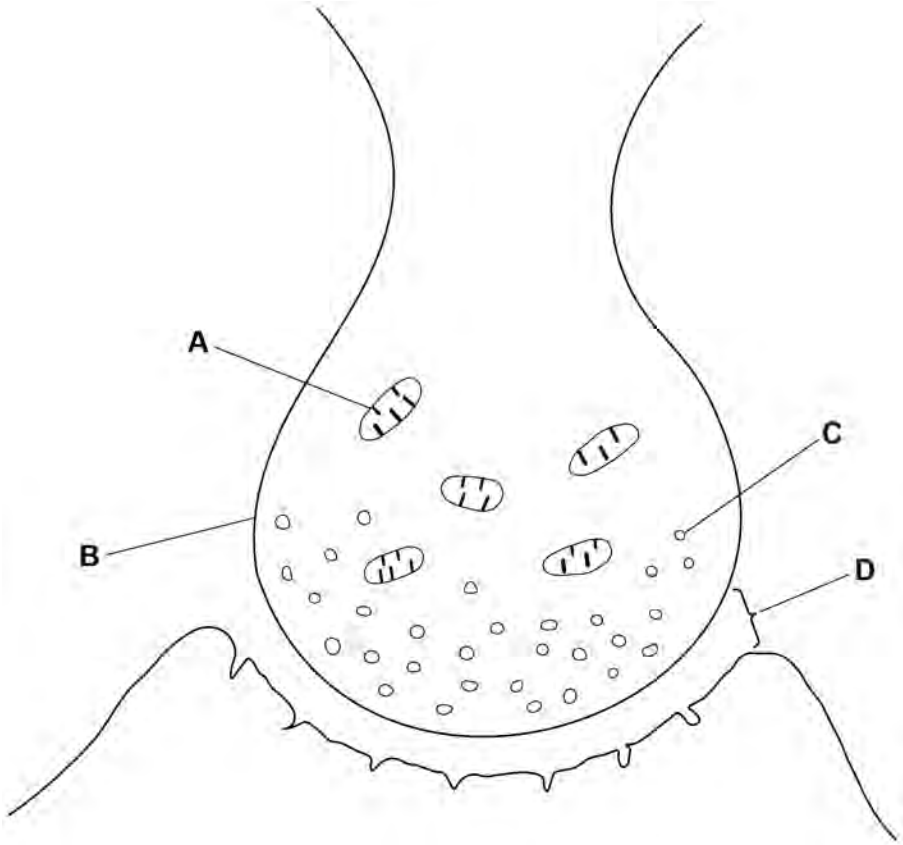
Answer **all** questions in the spaces provided.

0 1 **Figure 1** shows a drawing of a neuromuscular junction.

Figure 1



0 1 . 1 Name the parts labelled **A** to **D**.

[2 marks]

A _____

B _____

C _____

D _____

Do not write outside the box

0 1 . 2 Following the release of acetylcholine into a neuromuscular junction, a muscle contraction occurs.

Describe the sequence of events, following the release of acetylcholine, that leads to stimulation of this contraction.

Do **not** include in your answer the events following the release of calcium ions in the myofibril.

[4 marks]

0 1 . 3 Inhibitory synapses cause hyperpolarisation in postsynaptic neurones.

Explain how this inhibits synaptic transmission.

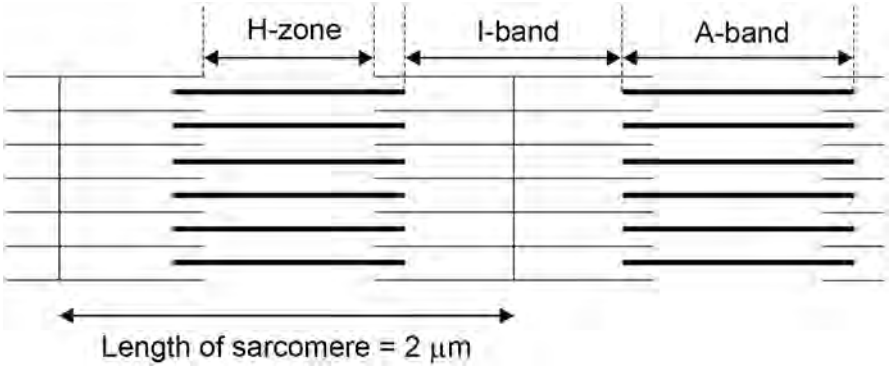
[2 marks]

8

Do not write outside the box

0 2 . 1 **Figure 2** shows part of a relaxed myofibril.

Figure 2



The myofibril represented in **Figure 2** has 34 sarcomeres.
The length of every sarcomere is 2 μm
After contraction of this myofibril, the length of each sarcomere changed by 20%.

Use the information provided to calculate the length of the myofibril after contraction.

Give your answer in mm and in standard form.

Show your working.

[2 marks]

Answer _____ mm

Do not write outside the box

0 2 . 2 Which statement correctly describes the changes in length in a sarcomere when a myofibril contracts?

Tick (✓) **one** box.

[1 mark]

H-zone decreases, I-band increases, A-band decreases ☐

H-zone increases, I-band decreases, A-band decreases ☐

H-zone decreases, I-band decreases, A-band no change ☐

H-zone increases, I-band increases, A-band no change ☐

0 2 . 3 Fast muscle fibres have a higher concentration of glycogen than slow muscle fibres.

Explain how the difference in glycogen concentration is related to the different properties of these muscle fibres.

[4 marks]

7

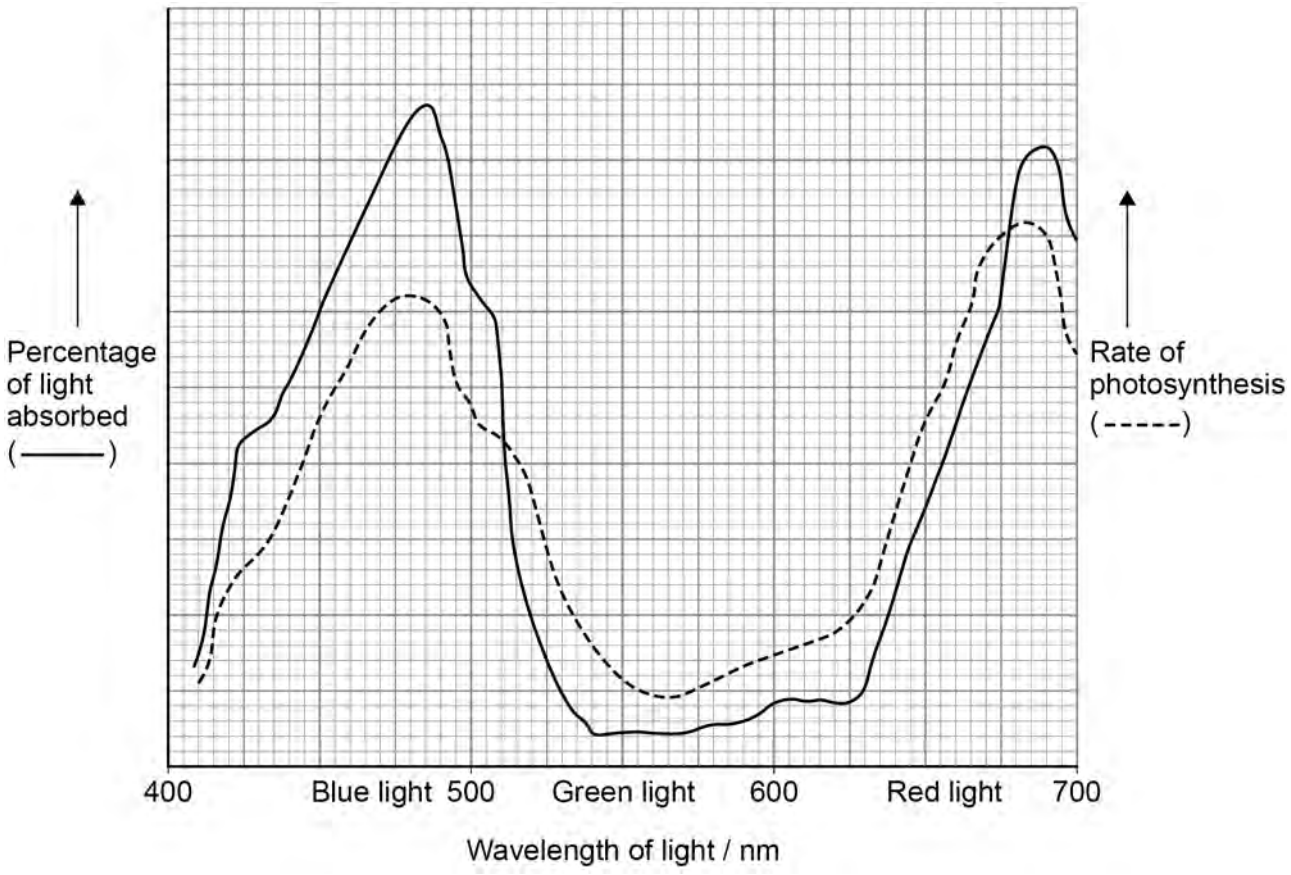
Do not write outside the box

0 3 . 1 A biologist investigated photosynthesis. They:

- measured the percentage of light absorbed by a plant when it was exposed to different wavelengths
- measured the rate of photosynthesis at each wavelength of light.

Figure 3 shows the results they obtained.

Figure 3



Using **Figure 3**, what can you conclude about the relationship between:

[2 marks]

the percentage of light absorbed and the rate of photosynthesis _____

_____

_____

the colour of light and the rate of photosynthesis _____

_____

_____

Do not write outside the box

0 3 . 2 Give **three** environmental factors that should be controlled when measuring the rate of photosynthesis in this investigation.

Do **not** include features of the plant in your answer.

[2 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 3 . 3 Describe how the products of the light-dependent reaction are used in the light-independent reaction to produce triose phosphate.

Do **not** include the role of ribulose bisphosphate (RuBP) in your answer.

[3 marks]

_____

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7

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0 4 . 1 In fruit flies, a gene for body colour has a dominant allele for grey body, **G**, and a recessive allele for black body, **g**.

Explain how you would determine if the genotype of a grey fly is homozygous or heterozygous for body colour.

[2 marks]

0 4 . 2 In fruit flies, males are **XY** and females are **XX**.

A cross between a grey-bodied male fly and a black-bodied female fly produced some black-bodied females. Explain how this shows that the gene for body colour is **not** sex-linked.

[1 mark]

Do not write outside the box

0 4 . 3 A population of fruit flies contained 19% grey-bodied flies.

Use the Hardy–Weinberg equation to calculate the percentage of flies heterozygous for gene **G**.

Show your working.

[2 marks]

Answer _____ %

0 4 . 4 In fruit flies, a gene for wing shape has a dominant allele for curly wings, **R**, and a recessive allele for normal wings, **r**. The alleles for this gene are on a different pair of chromosomes from the gene for body colour.

Fruit flies that are homozygous dominant for curly wings do not survive beyond the embryo stage.

A curly-winged fly, homozygous for grey body colour was crossed with a curly-winged, black-bodied fly.

Complete the genetic diagram to show all the possible genotypes and the ratio of phenotypes expected to develop into adults from this cross.

[3 marks]

Phenotypes of parents Curly-winged, grey-bodied, × Curly-winged, black-bodied

Genotypes of parents _____ × _____

Genotypes of offspring _____

_____

Phenotypes of offspring _____

_____

Ratio of offspring _____

8

Do not write outside the box

0 5 . 1 A weed is a plant growing where it is not wanted. Fat hen is a weed which grows in some crop fields.

Describe how you could estimate the **number** of fat hen plants in a field.

[5 marks]

Do not write outside the box

0 5 . 2 In potato plant fields, fat hen plants can grow up to a height of 2 m and absorb large quantities of nutrients from the soil.

Fat hen has a negative effect on the growth of potato plants.

Use the information provided to explain why.

In your answer, name the type of competition occurring between fat hen plants and potato plants.

[3 marks]

Question 5 continues on the next page

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0 5 . 3 **Table 1** gives some features of fat hen seeds.

Table 1

Feature of seed	
Mean mass / mg	0.77
Maximum number produced per fat hen plant during a growing season	20 000
Percentage viable (able to develop) after a growing season	79

During a growing season, it was estimated that a total number of 550 fat hen plants grew on the fields of a farm.

Calculate the maximum mass, in kg, of viable fat hen seeds on this farm after a growing season.

Show your working.

Assume that all the seeds produced during the growing season remain on the farm.

[2 marks]

Answer _____ kg

10

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 6 . 1 Describe the myogenic stimulation of the heart and how the regular contraction of the atria and ventricles is coordinated.

Do **not** include the autonomic nervous system in your answer.

[5 marks]

Do not write outside the box

0 6 . 2 Atrial fibrillation (AF) is a condition that causes an irregular heart rate. Scientists used a statistical test to investigate the association between different factors and the risk of developing AF.

Table 2 shows some of the scientists' results, including the probability (P) values obtained using the statistical test.

Table 2

Factor	**Probability (P) value for association between factor and risk of AF**
Age	0.004
High blood pressure	0.001
High LDL (Low-density lipoprotein) concentration	0.222
Hyperthyroidism	0.018

What can you conclude from **Table 2**?

[3 marks]

8

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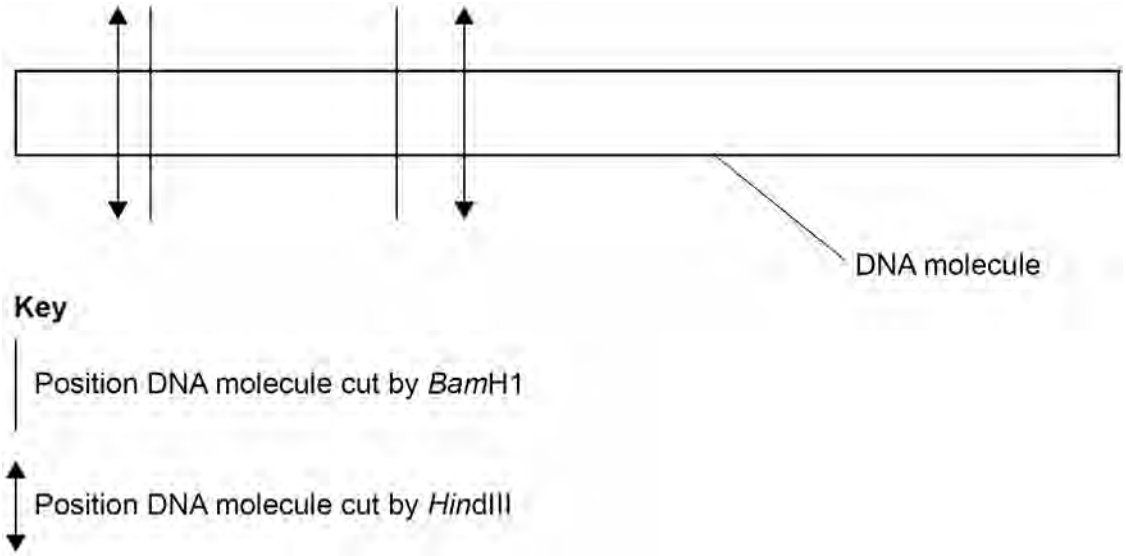
0 7 . 1 *Bam*H1 and *Hin*dIII are both restriction endonucleases.

Figure 4 shows the positions where these enzymes cut a linear molecule of DNA.

Figure 4



In two experiments, multiple copies of the DNA molecule shown in **Figure 4** were all completely cut into fragments using these restriction enzymes. The DNA fragments produced were then separated by electrophoresis.

Experiment 1 – DNA cut into fragments using *Bam*H1.

Experiment 2 – DNA cut into fragments using *Bam*H1 and *Hin*dIII.

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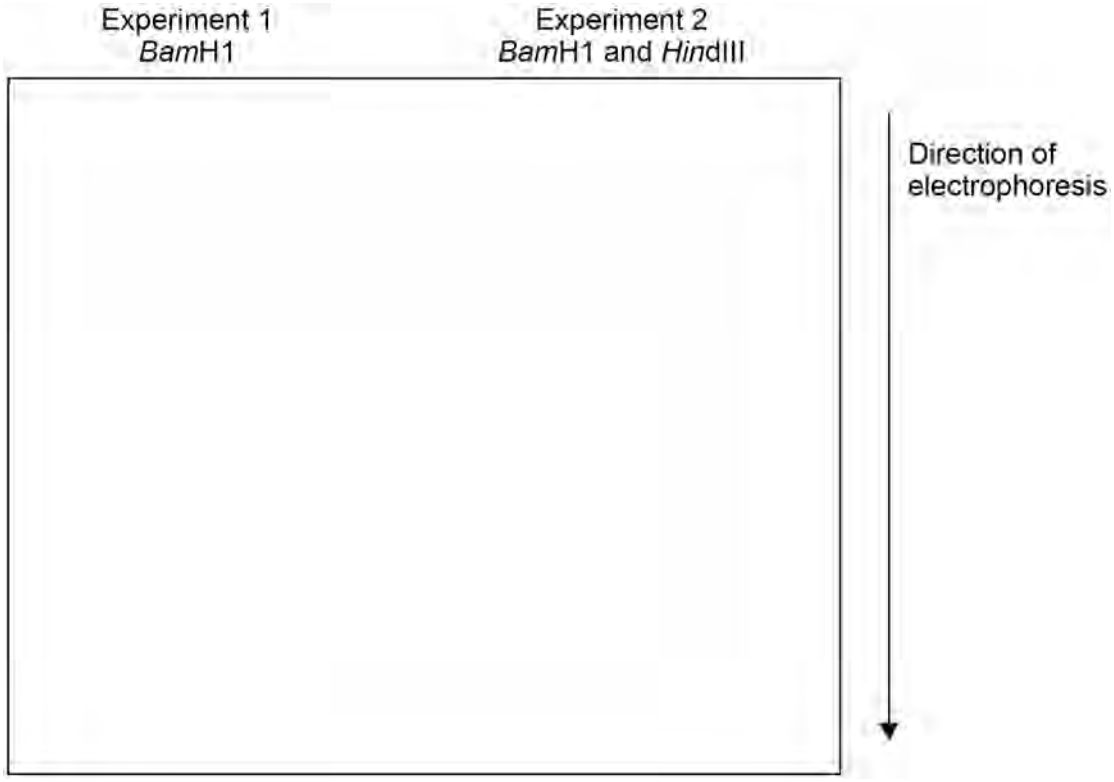
Complete **Figure 5** to show the relative positions of the bands following electrophoresis in experiments 1 and 2.

[2 marks]

Figure 5



0 7 . 2 Suggest how you could determine the size of the different DNA fragments produced in these experiments.

[2 marks]

Do not write outside the box

0 7 . 3 How many DNA fragments would be produced in experiment 2 if the original DNA molecule was a plasmid?

[1 mark]

0 7 . 4 Describe how restriction endonuclease and DNA ligase are used to insert a gene into a plasmid.

[2 marks]

7

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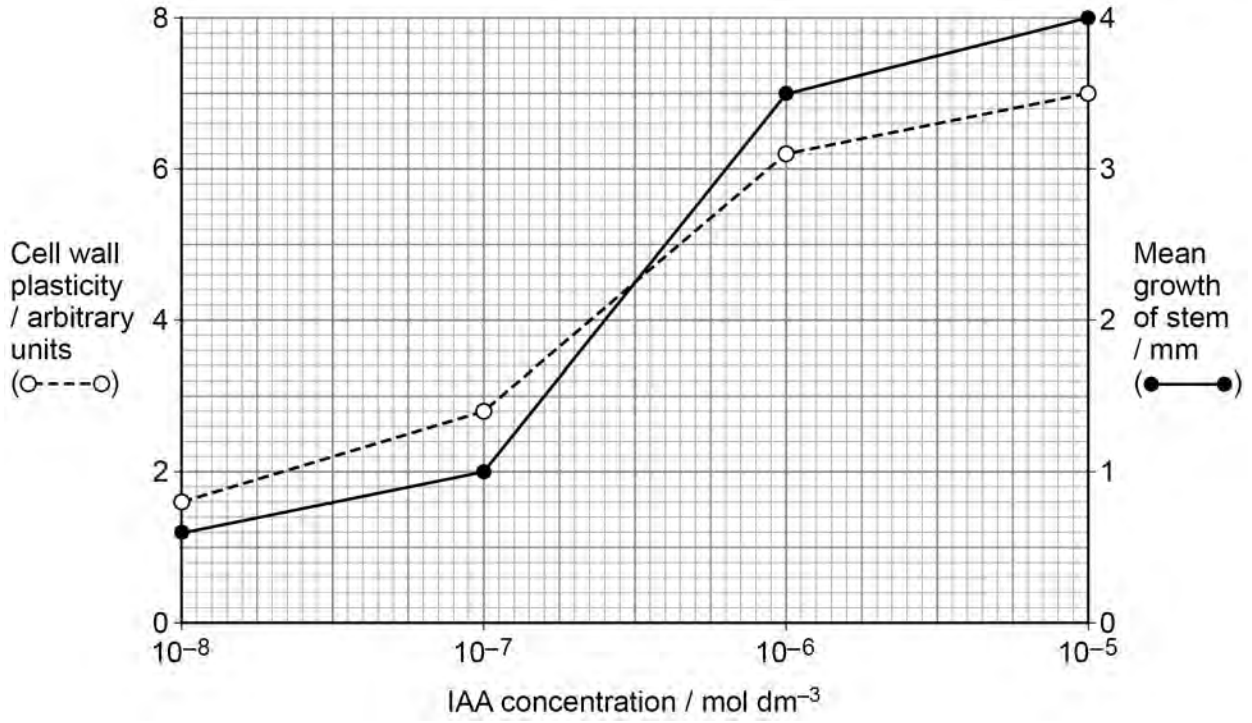
0 8 Plant cells are surrounded by a rigid cell wall. Cell wall plasticity refers to the ability of a cell wall to stretch permanently. IAA is a growth factor which can activate enzymes that loosen the cell wall.

Scientists investigated the effect of IAA concentration on cell wall plasticity and the growth of stem segments.

Figure 6 shows some of the scientists' results.

Figure 6



0 8 . 1 Use the information provided to explain the relationship between IAA concentration, cell wall plasticity and mean growth of the stem segments.

[2 marks]

Do not write outside the box

0 8 . 2 Use **Figure 6** to calculate the percentage increase in mean growth of the stem segments when the IAA concentration was increased from 10^{-8} mol dm^{-3} to 10^{-5} mol dm^{-3}

Give your answer to 2 significant figures.

Show your working.

[2 marks]

Answer _____ %

Question 8 continues on the next page

Do not write outside the box

Gibberellic acid (GA) is another plant growth factor. A student was asked to design and carry out an investigation into the effect of different concentrations of GA on the growth of stem segments.

The student was provided with:

- 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5} mol dm^{-3} concentrations of GA solution
- distilled water
- 6 Petri dishes and access to glassware
- 60 stem segments of different lengths.

0 8 . 3 A technician produced the different concentrations of GA solution from a stock 10^{-1} mol dm^{-3} concentration of GA.

Describe how the technician produced the 10^{-3} mol dm^{-3} solution.

[1 mark]

Do not write outside the box

0 8 . 4 Describe a suitable procedure the student could follow to investigate the effect of different concentrations of GA on the growth of stem segments.

In your answer, you should include the variables that should be controlled in this investigation.

[5 marks]

10

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ANSWER IN THE SPACES PROVIDED

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0 9 A person with diabetes is in diabetes remission if their blood glucose concentration is below the diabetes threshold concentration for at least 3 months. This diabetes remission is achieved without taking medication.

Scientists investigated whether a weight-loss programme would result in type II diabetes remission.

The scientists:

- used a computer-generated list to select 380 volunteers from a large number of health centres
- selected volunteers aged 25 to 60 years, each with less than 5 years duration of type II diabetes
- divided the volunteers in the ratio 1 : 1 between experimental group **P** and control group **Q**
- placed group **P** on a weight-loss programme for the 2-year duration of this investigation
- recorded loss of mass and percentage of volunteers in each group in type II diabetes remission after 2 years.

0 9 . 1 Give **two** reasons why a weight-loss programme could be used to treat type II diabetes but **not** type I diabetes.

[2 marks]

1 _____

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_____

2 _____

_____

_____

Question 9 continues on the next page

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0 9 . 2 The design of this investigation helps to support the validity of any conclusions obtained.

Suggest and explain **three** features of this investigation that justify this statement.

[3 marks]

1 _____

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2 _____

_____

_____

3 _____

_____

_____

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0 9 . 3 **Table 3** shows some of the scientists' results.

Table 3

	Group P	Group Q
Percentage achieving diabetes remission	42.1	4.7
Percentage achieving weight loss ≥15 kg	15.8	2.1
Percentage with weight loss ≥15 kg achieving diabetes remission	70.0	75.0
Percentage with weight gain achieving diabetes remission	1.9	1.9

Use the information provided to calculate the difference in number of volunteers between the two groups who achieved diabetes remission.

Show your working.

[2 marks]

Answer _____

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 Use all the information to evaluate whether a weight-loss programme is an effective treatment for type II diabetes.

[4 marks]

11

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1 0 Read the following passage.

The wall gecko is a medium-sized lizard. In an isolated habitat of southern Italy, the wall gecko shows phenotypic diversity. Scientists investigated whether disruptive selection was leading to sympatric speciation in the wall gecko.

Pale geckos live only on walls and are nocturnal (active at night). Dark geckos live mainly on the dark trunks of olive trees and are diurnal (active during the day). These diurnal geckos can change skin colour when occupying different surfaces during the day.

Comparison of mitochondrial genes indicated that the diurnal geckos formed a distinct genetic group. This comparison also confirmed that all the geckos in the habitat were of the same species.

The scientists used the mark-release-recapture method to estimate the size of the population of geckos in the habitat.

Use the information in the passage and your own knowledge to answer the following questions.

1 0 . 1 The wall gecko shows phenotypic diversity (lines 1–2).

Suggest **two** factors that have resulted in this phenotypic diversity.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

Question 10 continues on the next page

Do not write outside the box

1 0 . 2 The ability of diurnal geckos to change skin colour (lines 7–8) is advantageous.

Explain why.

[2 marks]

1 0 . 3 The scientists concluded that it was probable that disruptive selection was leading to sympatric speciation in the wall gecko.

Use the information in the passage to evaluate this conclusion.

[5 marks]

Do not write outside the box

1 0 . 4 Explain how comparison of mitochondrial genes could indicate that the nocturnal geckos formed a distinct genetic group (lines 9–10).

In your answer, explain how new techniques enable the comparison of genes to be completed rapidly.

[3 marks]

Question 10 continues on the next page

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1 0 . 5 Describe and explain **two** precautions required to ensure that the estimate of the size of the population of geckos was valid (lines 12–13).

Do **not** include sample size as one of the required precautions.

In your answer, include the formula to estimate the size of the population using the mark-release-recapture method.

[3 marks]

Precaution 1 _____

_____

_____

Precaution 2 _____

_____

_____

Formula _____

_____

_____

15

END OF QUESTIONS

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