AQA

Please write clearly in block capitals.

Centre number | | | | | |

Candidate number | | | | |

Surname ______________________

Forename(s) ______________________

Candidate signature ______________________

A-level BIOLOGY

Paper 2

Thursday 13 June 2019 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.
- 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 . 1 Succession occurs in natural ecosystems. Describe and explain how succession occurs.

[4 marks]

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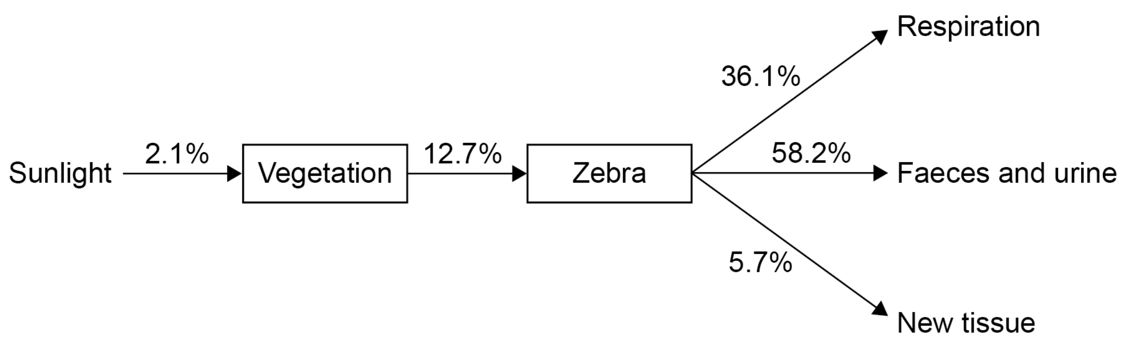
Figure 1 shows percentages of energy transferred from sunlight to a zebra in a grassland ecosystem.

Figure 1



0 1 . 2 Use **Figure 1** to calculate the percentage of sunlight energy that would be transferred into the faeces and urine of a zebra. Give your answer to 3 significant figures.

[1 mark]

Answer = ____________________ %

0 1 . 3 In this ecosystem the net productivity of the vegetation is 24 525 kJ m^{-2} $year^{-1}$

Use this information and **Figure 1** to calculate the energy stored in new tissues of the zebra in kJ m^{-2} $year^{-1}$

[2 marks]

Answer = ____________________ kJ m^{-2} $year^{-1}$

7

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0 2 Sickle cell disease (SCD) is a group of inherited disorders. People with SCD have sickle-shaped red blood cells. A single base substitution mutation can cause one type of SCD. This mutation causes a change in the structure of the beta polypeptide chains in haemoglobin.

0 2 . 1 Explain how a single base substitution causes a change in the structure of this polypeptide.

Do **not** include details of transcription and translation in your answer.

[3 marks]

Haematopoietic stem cell transplantation (HSCT) is a long-term treatment for SCD. In HSCT, the patient receives stem cells from the bone marrow of a person who does not have SCD. The donor is often the patient's brother or sister. Before the treatment starts, the patient's faulty bone marrow cells have to be destroyed.

0 2 . 2 Use this information to explain how HSCT is an effective long-term treatment for SCD.

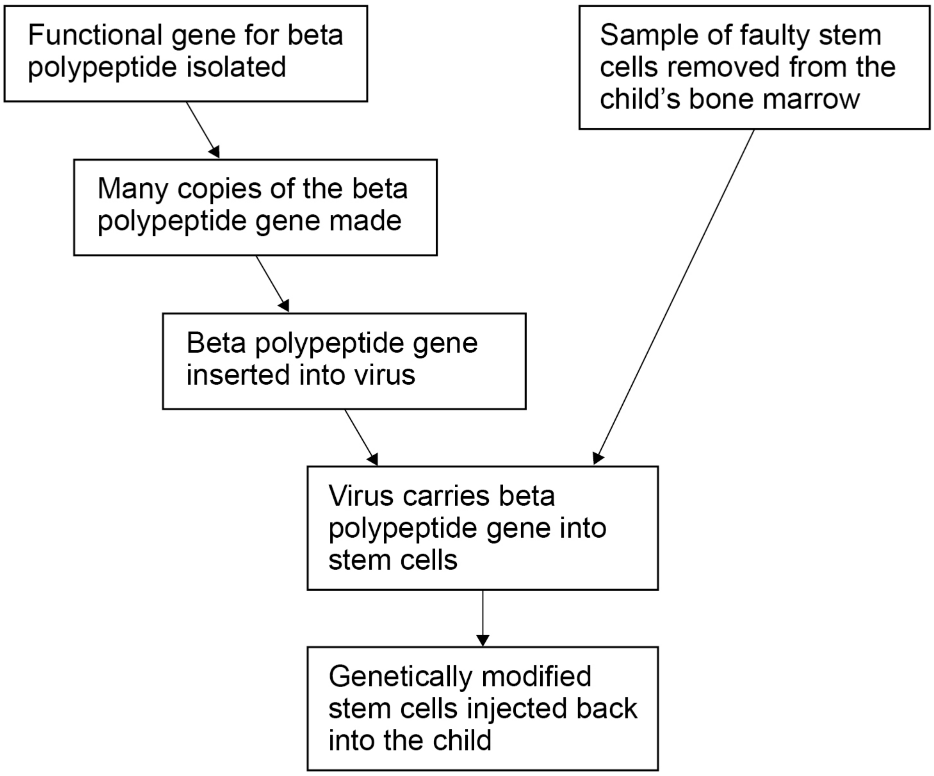
[3 marks]

Do not write outside the box

A new long-term treatment for SCD involves the use of gene therapy.

Figure 2 shows some of the stages involved in this treatment in a child with SCD.

Figure 2



0 2 . 3 Some scientists have concluded that this method of gene therapy will be a more effective long-term treatment for SCD than HSCT. Use all the information provided to evaluate this conclusion.

[3 marks]

9

Turn over ►

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0 3 A student investigated the effects of indoleacetic acid (IAA) on the growth of oat seedlings (young plants).

The student:

- removed the shoot tip from each seedling and cut out a 10 mm length of shoot
- placed 10 lengths of shoot into each of 5 Petri dishes
- added to each Petri dish an identical volume of 5% glucose solution
- added to each Petri dish 40 cm^3 of a different concentration of IAA solution
- left the Petri dishes at 20 °C in the dark with their lids on for 5 days
- removed the shoots after 5 days and measured them
- determined the mean change in length of shoot at each concentration of IAA.

Table 1 shows her results.

Table 1

IAA concentration added to Petri dish / parts per million	10^{-5}	10^{-3}	10^{-1}	1	10
Mean change in length of shoot / mm	0.0	0.1	1.3	2.4	3.1

0 3 . 1 Explain why the student removed the shoot tip from each seedling.

[2 marks]

[Extra space]

Do not write outside the box

0 3 . 2 Explain why the student added glucose solution to each Petri dish.

[2 marks]

0 3 . 3 Explain why the lids were kept on the Petri dishes.

[2 marks]

0 3 . 4 Describe and explain the results shown in **Table 1** and suggest how the results might have differed if lengths of **root** had been used.

[3 marks]

Do not write outside the box

0 3 . 5 The student produced the different concentrations of IAA using a stock 1 g dm^{-3} solution of IAA (1 g dm^{-3} = 1 part per thousand) and distilled water.

Complete **Table 2** with the volumes of stock IAA solution and distilled water required to produce 40 cm^3 of 10 ppm (parts per million) IAA solution.

[1 mark]

Table 2

Concentration of IAA solution / parts per million	Volume of stock IAA solution / cm^3	Volume of distilled water / cm^3
10		

10

Turn over for the next question

Turn over ►

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0 4 Scientists investigated the effect of a decrease in pH on muscle contraction. The scientists did the investigation with four different preparations of isolated muscle tissue: **A**, **B**, **C** and **D**.

A - mouse muscle fibres at typical pH of mouse muscle tissue (control 1).

B - mouse muscle fibres at 0.5 pH units below typical pH.

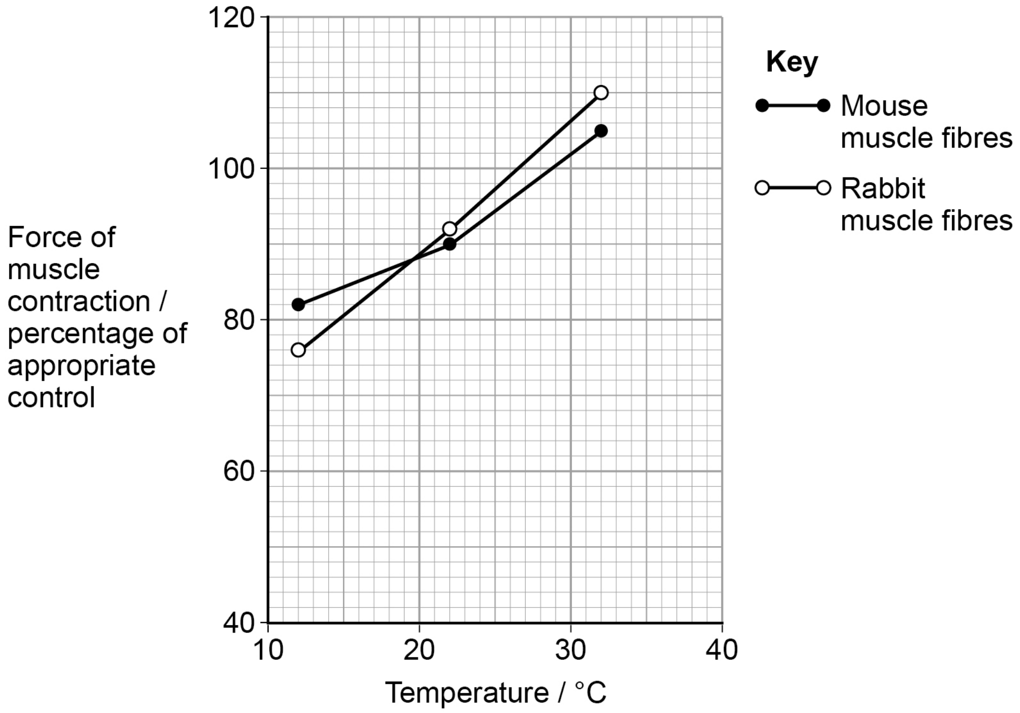
C - rabbit muscle fibres at typical pH of rabbit muscle tissue (control 2).

D - rabbit muscle fibres at 0.5 pH units below typical pH.

They measured the force of muscle contraction of the muscle fibres at 12 °C, 22 °C and 32 °C

Figure 3 shows the results the scientists obtained for **B** and **D** compared with the appropriate control.

Figure 3



Do not write outside the box

0 4 . 1 A student looked at the results and concluded that a decrease in pH does cause a decrease in the force of muscle contraction.

Use **Figure 3** to evaluate this conclusion.

[4 marks]

[Extra space]

Question 4 continues on the next page

0 4 . 2 Another group of scientists suggested that a decrease in the force of muscle contraction is caused by an increase in the concentration of inorganic phosphate, Pi, in muscle tissues.

Their hypothesis is that an increase in the concentration of Pi prevents the release of calcium ions within muscle tissues.

Explain how a decrease in the concentration of calcium ions within muscle tissues could cause a decrease in the force of muscle contraction.

[3 marks]

0 4 . 3 In muscles, pyruvate is converted to lactate during prolonged exercise.

Explain why converting pyruvate to lactate allows the continued production of ATP by anaerobic respiration.

[2 marks]

9

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Turn over for the next question

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**

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0 5 . 1 Describe the role of glucagon in gluconeogenesis.

Do **not** include in your answer details on the second messenger model of glucagon action.

[2 marks]

0 5 . 2 The gene that codes for glucagon is 9.531 kilobases in length. The DNA helix makes one complete turn every 10 base pairs. Every complete turn is 3.4 nm in length.

Use this information to calculate the length in micrometres (µm) of the gene for glucagon. Give your answer to 3 significant figures.

[2 marks]

Answer = ____________________ µm

Do not write outside the box

Metformin is a drug commonly used to treat type II diabetes. Metformin's ability to lower the blood glucose concentration involves a number of mechanisms including:

- increasing a cell's sensitivity to insulin
- inhibiting adenylate cyclase.

0 5 . 3 Explain how increasing a cell's sensitivity to insulin will lower the blood glucose concentration.

[2 marks]

0 5 . 4 Explain how inhibiting adenylate cyclase may help to lower the blood glucose concentration.

[3 marks]

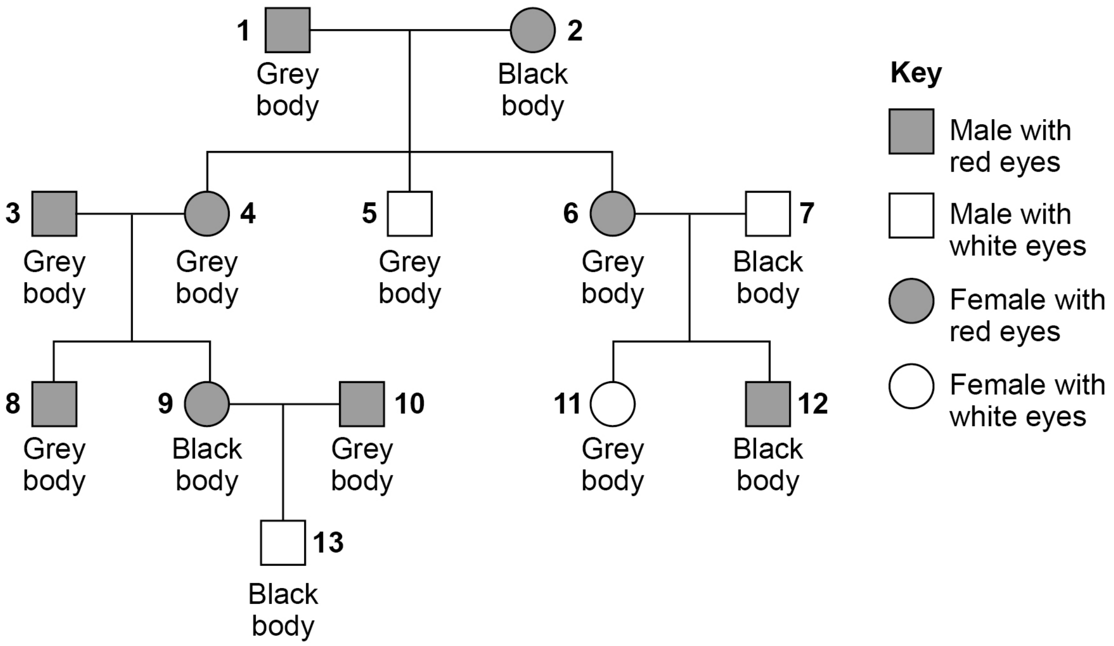
9

0 6 In fruit flies, a gene for body colour has a dominant allele for grey body, **G**, and a recessive allele for black body, **g**.

A gene for eye colour has a dominant allele for red eyes, **R**, and a recessive allele for white eyes, **r**, and is located on the **X chromosome**.

Figure 4 shows the phenotypes of fruit flies over four generations.

Figure 4



0 6 . 1 Give the full genotype of the fly numbered **6** in **Figure 4**.

[1 mark]

Genotype = ______________________________

0 6 . 2 Give **one** piece of evidence from **Figure 4** to show that the allele for grey body colour is dominant.

[1 mark]

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Do not write outside the box

0 6 . 3 Explain one piece of evidence from **Figure 4** to show that the gene for body colour is **not** on the **X chromosome**.

[2 marks]

0 6 . 4 A heterozygous grey-bodied, white-eyed female fly was crossed with a black-bodied, red-eyed male fly.

Complete the genetic diagram below to show all the possible genotypes and the ratio of phenotypes expected in the offspring from this cross.

[3 marks]

Phenotypes of parents: Grey-bodied, white-eyed female × Black-bodied, red-eyed male

Genotypes of parents: ____________________ × ____________________

Genotypes of offspring ____________________

Phenotypes of offspring ____________________

Ratio of phenotypes ____________________

Question 6 continues on the next page

Do not write outside the box

0 6 . 5 A population of fruit flies contained 64% grey-bodied flies. Use the Hardy–Weinberg equation to calculate the percentage of flies heterozygous for gene **G**.

[2 marks]

Answer = ______________________________ %

9

0 7 . 1 In photosynthesis, which chemicals are needed for the light-dependent reaction?
Tick (✓) **one** box.

[1 mark]

Reduced NADP, ADP, Pi, water and oxygen. ☐

NADP, ATP and water. ☐

Reduced NADP, ATP, water and carbon dioxide. ☐

NADP, ADP, Pi and water. ☐

0 7 . 2 Describe what happens during photoionisation in the light-dependent reaction.

[2 marks]

Question 7 continues on the next page

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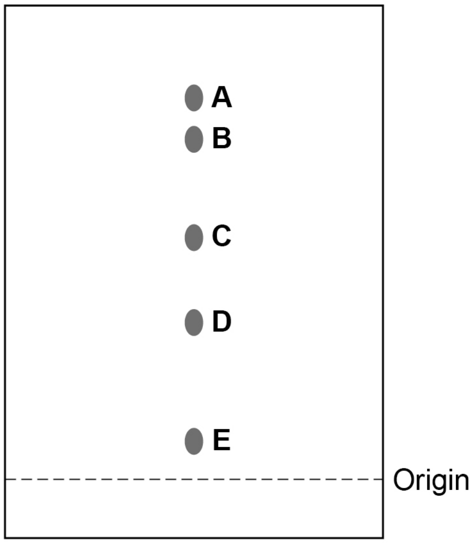
A student obtained a solution of pigments from the leaves of a plant. Then the student used paper chromatography to separate the pigments.

Figure 5 shows the chromatogram produced.

Figure 5



0 7 . 3 Explain why the student marked the origin using a pencil rather than using ink.

[1 mark]

____

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0 7 . 4 Describe the method the student used to separate the pigments after the solution of pigments had been applied to the origin.

[2 marks]

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0 7 . 5 Calculating the R_f values of the pigments can help to identify each pigment. An R_f value compares the distance the pigment has moved from the origin with the distance the solvent front has moved from the origin.

$$R_f = \frac{\text{distance pigment has moved from the origin}}{\text{distance solvent front has moved from the origin}}$$

The distance each pigment has moved is measured from the middle of each spot.

Pigment **A** has an R_f value of 0.95

Use **Figure 5** to calculate the R_f value of pigment **C**.

[1 mark]

R_f value of pigment **C** = ____________________

0 7 . 6 The pigments in leaves are different colours. Suggest and explain the advantage of having different coloured pigments in leaves.

[1 mark]

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8

Turn over for the next question

Do not write outside the box

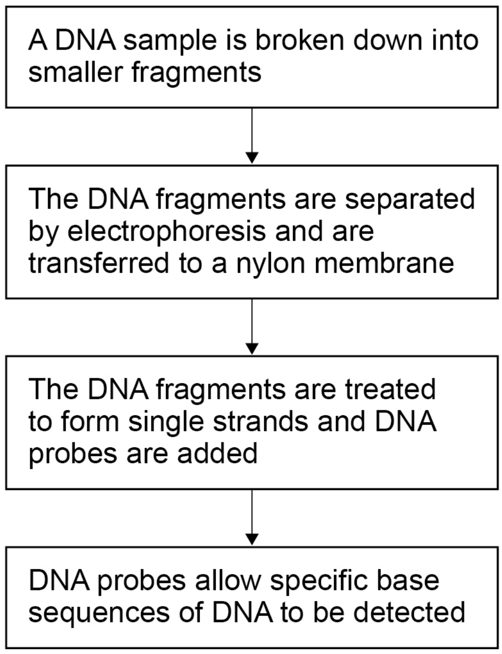
0 8 . 1 What is a DNA probe?

[2 marks]

DNA probes are used to detect specific base sequences of DNA.

The process is shown in **Figure 6**.

Figure 6



0 8 . 2 Describe how the DNA is broken down into smaller fragments.

[2 marks]

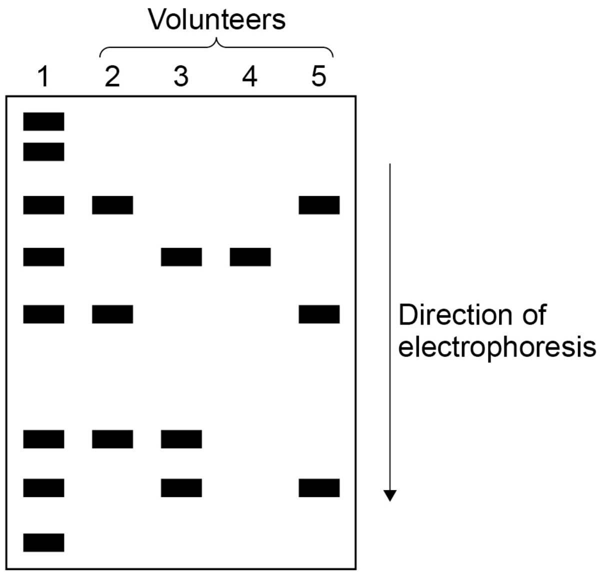
0 8 . 3 The DNA on the nylon membrane is treated to form single strands. Explain why.

[1 mark]

A scientist used DNA probes and electrophoresis to screen four volunteers for five different viral DNA fragments.

Figure 7 shows the results the scientist obtained. The lanes numbered 2 to 5 represent the four volunteers.

Figure 7



0 8 . 4 Lane 1 of **Figure 7** enabled the size of the different viral fragments to be determined.

Suggest and explain how.

[2 marks]

Do not write outside the box

The lengths of the viral DNA fragments were:

- 600 base pairs
- 250 base pairs
- 535 base pairs
- 300 base pairs
- 500 base pairs.

0 8 . 5 Which volunteers had at least one of the viral DNA fragments with 250 base pairs or 535 base pairs?

[1 mark]

8

Do not write outside the box

0 9 The sundew is a small flowering plant, growing in wet habitats such as bogs and marshes. The soil in bogs and marshes is acidic and has very low concentrations of some nutrients. The sundew can trap and digest insects.

0 9 . 1 Describe how you could estimate the size of a population of sundews in a small marsh.

[5 marks]

0 9 . 2 Suggest and explain how digesting insects helps the sundew to grow in soil with very low concentrations of some nutrients.

[2 marks]

7

1 0 Guillain–Barré syndrome is a rare disease in which the immune system damages the myelin sheath of neurones. Myelin sheath damage can cause a range of symptoms, for example numbness, muscular weakness and muscular paralysis. Sometimes, neurones of the autonomic nervous system are affected, causing heart rate irregularities.

Huntington's disease is a disorder caused when a protein called huntingtin damages the brain. Huntingtin is produced because of a dominant, mutant allele.

The first successful drug trial to reduce concentrations of huntingtin in the human brain involved 46 patients. The patients received the drug for 4 months. The concentration of huntingtin was reduced in all the patients. The drug was injected at the base of the spine into the cerebrospinal fluid bathing the brain and spinal cord. The drug contains single-stranded DNA molecules. These single-stranded molecules inhibit the mRNA needed to produce huntingtin.

Symptoms of Huntington's disease can start at any time, but usually develop between 30 and 50 years of age. The likelihood and age when symptoms start are linked to the number of CAG base sequence repeats in the gene for Huntington's disease. However, recent studies have suggested that epigenetics may also affect the age when symptoms first start.

1 0 . 1 Damage to the myelin sheath of neurones can cause muscular paralysis (lines 2–4).

Explain how.

[3 marks]

Do not write outside the box

1 0 . 2 Sometimes Guillain–Barré syndrome causes heart rate irregularities (lines 4–5).

Suggest and explain why.

[3 marks]

1 0 . 3 The first successful drug trial to reduce concentrations of huntingtin in the brain used single-stranded DNA molecules (lines 13–14).

Suggest and explain how this drug could cause a reduction in the concentration of the protein huntingtin.

[3 marks]

Do not write outside the box

1 0 . 4 Scientists from the first successful drug trial to reduce concentrations of huntingtin (lines 9–11) reported that the drug is not a cure for Huntington's disease.

Suggest **two** reasons why the drug should **not** be considered a cure.
Do **not** include repeats of the drug trial in your answer.

[2 marks]

1 ____

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2 ____

____

1 0 . 5 Suggest **two** reasons why people had the drug injected into the cerebrospinal fluid (lines 12–13) rather than taking a pill containing the drug.

[2 marks]

1 ____

____

2 ____

____

1 0 . 6 Suggest and explain **one** way epigenetics may affect the age when symptoms of Huntington's disease start.

[2 marks]

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15

END OF QUESTIONS