Helicate

HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

# 3.4.7 Investigating diversity

Topic question bank

Version 2 · 15 October 2026

Name

Date

| QUESTIONS | TOTAL MARKS | TIME | YOUR SCORE |
|---|---|---|---|
| 6 | 53 | No time limit | / 53 |

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## Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Original questions by Helicate for AQA AS and A-level Biology (7401/7402), specification section 3.4.7. Not affiliated with or endorsed by AQA.

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## Ways of comparing genetic diversity 3.4.7

**0 1 . 1** Which of these is **not** a way of comparing the genetic diversity within a species?
**Tick (✓) one box.**

**[1 mark]**

- Comparing the base sequence of mRNA from different individuals ☐
- Comparing the frequency of an observable characteristic in different populations ☐
- Comparing the number of different species in the habitat of each population ☐
- Comparing the amino acid sequence of the same protein from different individuals ☐

**Question 1 continues on the next page**

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Fish of one species have bony plates along each side of the body. Each fish has one of three plate forms: fully plated, partially plated or low plated. Plate form is determined mainly by the alleles of one gene.

Scientists caught fish at random from a population in the sea and from a population in a lake. They recorded the plate form of each fish. Table 1 shows their results.

**Table 1**

| Plate form | Number of fish | |
|---|---|---|
| | Sea population | Lake population |
| Fully plated | 176 | 22 |
| Partially plated | 17 | 46 |
| Low plated | 7 | 92 |

**0 1 . 2** Calculate the difference between the percentage of low-plated fish in the lake population and the percentage of low-plated fish in the sea population.

**[2 marks]**

**Answer** .....

**Question 1 continues on the next page**

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**0 1 . 3** The frequency of plate forms is one way of comparing the genetic diversity of the two populations.
Give **two** other types of data the scientists could compare to find the genetic diversity of these populations.

**[2 marks]**

**1** .....

.....

**2** .....

.....

**0 1 . 4** Describe how gene technology has changed the way scientists investigate genetic diversity, such as the differences between these two populations of fish.

**[2 marks]**

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**Question 1 continues on the next page**

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**0 1 . 5** Suggest **two** reasons why comparing DNA base sequences gives a better measure of the genetic diversity of these populations than comparing the frequency of plate forms.

**[2 marks]**

**1** .....

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**2** .....

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9

**Turn over for the next question**


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## Using sequence data to suggest relationships 3.4.7

Scientists compared the same protein in five species of beetle, **P**, **Q**, **R**, **S** and **T**. They found the amino acid sequence of the same section of the protein in one beetle of each species. This section is 40 amino acids long.

Table 2 shows the 8 positions in the section where the species differ. At every other position, all five species have the same amino acid. Each abbreviation represents one amino acid.

**Table 2**

| Species | Amino acid at position | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **3** | **7** | **12** | **18** | **21** | **26** | **33** | **38** |
| **P** | Gly | Ser | Leu | Val | Lys | Asp | Thr | Ala |
| **Q** | Gly | Ser | Leu | Ile | Arg | Asp | Thr | Ala |
| **R** | Gly | Ser | Leu | Ile | Arg | Asp | Thr | Ala |
| **S** | Ala | Thr | Leu | Ile | Arg | Glu | Ser | Ala |
| **T** | Ala | Thr | Phe | Ile | Arg | Glu | Ser | Gly |

**0 2 . 1** Calculate the percentage of the amino acids in this 40-amino-acid section that are the same in species **P** and species **S**.

**[2 marks]**

**Answer** _____ **%**

**Question 2 continues on the next page**

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**0 2 . 2** Which species has the amino acid sequence most similar to that of species **S** in this section?
**Tick (✓) one box.**

**[1 mark]**

Species **P** ☐

Species **Q** ☐

Species **R** ☐

Species **T** ☐

Species **Q** and species **R** have the same amino acid sequence in this section. The scientists then compared the DNA that codes for this section in species **Q** and species **R**. They found that the base sequences differed at 4 positions.

**0 2 . 3** Explain how the base sequences can differ when the amino acid sequences are the same.

**[2 marks]**

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**Question 2 continues on the next page**

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A student concluded from Table 2 that species **S** and **T** are more closely related to each other than either is to any of the other three species.

**0 2 . 4** Evaluate the student's conclusion.

**[3 marks]**

8

**Turn over for the next question**

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A species of lizard lives on the mainland and on two islands, **A** and **B**. Scientists caught 15 lizards at random from each of the three populations.

In each lizard, they found the base sequence of the same 800-base section of a mitochondrial gene. They compared every lizard with every other lizard and calculated the percentage of bases that differed for each pair. Table 3 shows their results. For each row, the sample size used to judge whether differences are significant is n = 15 (the number of lizards in each population).

**Table 3**

| Lizards compared | Mean percentage of bases that differ | Standard deviation |
|---|---|---|
| Mainland with mainland | 0.9 | 0.3 |
| Island **A** with island **A** | 1.0 | 0.3 |
| Island **B** with island **B** | 0.9 | 0.3 |
| Mainland with island **A** | 1.1 | 0.3 |
| Mainland with island **B** | 4.2 | 0.4 |
| Island **A** with island **B** | 4.0 | 0.4 |

**0 3 . 1** Calculate the mean number of bases in this section that differed between a lizard from the mainland and a lizard from island **B**.

**[1 mark]**

**Answer** ..... **bases**

**0 3 . 2** Explain why the scientists caught the lizards at random.

**[1 mark]**

**Question 3 continues on the next page**

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**0 3 . 3** Explain why the scientists compared lizards within each population as well as lizards from different populations.

**[2 marks]**

Over 95% of the data lie within 2 standard deviations either side of the mean.

**0 3 . 4** Use this information and Table 3 to decide whether there is a significant difference between the 'mainland with mainland' results and the 'mainland with island **A**' results.
Show your working.

**[2 marks]**

**Question 3 continues on the next page**

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A scientist suggested that the island **A** population is more closely related to the mainland population than the island **B** population is.

**0 3 . 5** Use Table 3 to evaluate this suggestion.

**[4 marks]**

10

**Turn over for the next question**

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## Investigating variation within a species 3.4.7

A student investigated variation in the diameter of daisy flower heads in a park. She compared daisies growing on a lawn that was mown every week with daisies growing in a meadow that was mown once a year.

The student's first plan was to walk along the path that crosses the lawn and measure the 30 largest flower heads she could see from it.

**0 4 . 1** Explain why this plan would not give a valid mean diameter for the daisies on the lawn.
Describe how she could select the flower heads at random instead, and explain why random selection is better.

**[5 marks]**

**Question 4 continues on the next page**

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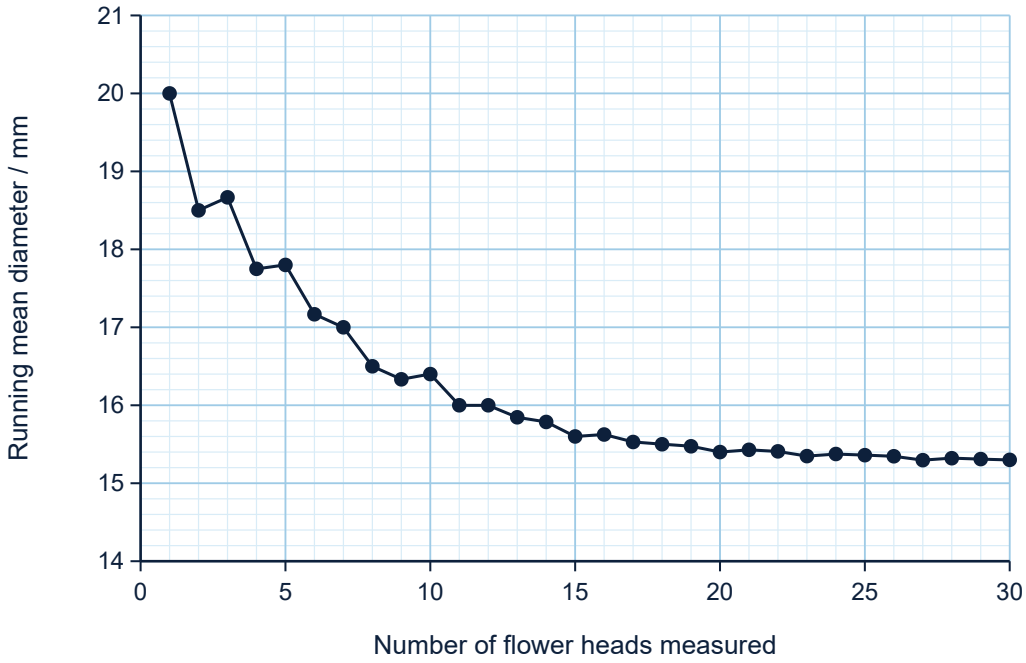
The student selected flower heads at random. She measured 30 flower heads on the lawn. After each measurement, she calculated the running mean diameter. Figure 1 shows her results.

**Figure 1**




**0 4 . 2** Did the student measure enough flower heads? Use Figure 1 to explain your answer.

**[2 marks]**

**Question 4 continues on the next page**

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**0 4 . 3** What does a large standard deviation show about a set of measurements?
**Tick (✓) one box.**

**[1 mark]**

Most of the measurements are close to the mean. ☐

The measurements are widely spread around the mean. ☐

A large number of measurements were taken. ☐

The mean is significantly different from another mean. ☐

**Question 4 continues on the next page**

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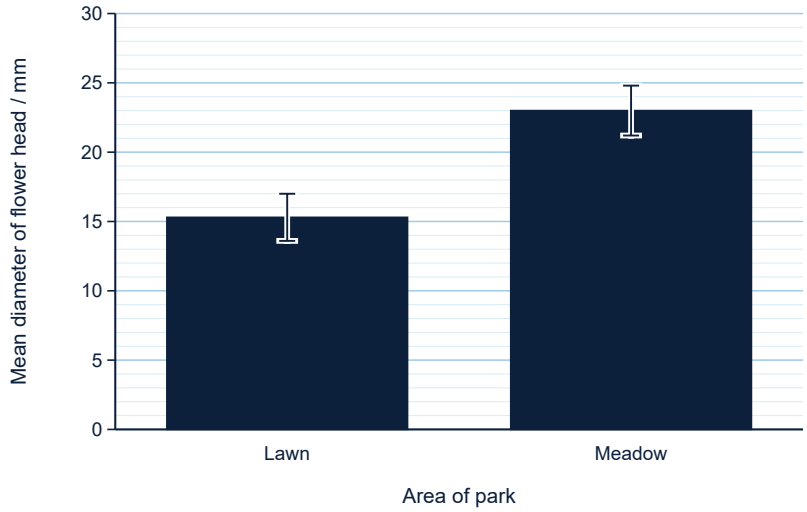
The student also measured a random sample of flower heads in the meadow. Figure 2 shows the mean diameter of flower heads in each area. The error bars show ± 1 standard deviation.

**Figure 2**




**0 4 . 4** What can you conclude from Figure 2 about the difference in mean diameter of flower heads between the lawn and the meadow? Explain your answer.

**[2 marks]**

**Question 4 continues on the next page**

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The mean diameter of flower heads was 15.3 mm on the lawn and 23.0 mm in the meadow.

**0 4 . 5** Calculate the percentage by which the mean diameter in the meadow is greater than the mean diameter on the lawn.
Give your answer to **three** significant figures.

**[2 marks]**

**Answer** ..... **%**

The student concluded that the daisies in the meadow are genetically different from the daisies on the lawn.

**0 4 . 6** Evaluate the student's conclusion.

**[3 marks]**

**15**

**Turn over for the next question**

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A species of grass grows on the zinc-polluted soil around an old mine and in a meadow 2 km away. Scientists collected seeds at random from 25 plants in each population. They grew the seeds in the same conditions until the plants had flowered and produced seeds. They then measured three characteristics of 25 plants from each population. The results are shown in Table 4.

**Table 4**

| Characteristic | Mine population | | Meadow population | |
|---|---|---|---|---|
| | Mean | Standard deviation | Mean | Standard deviation |
| Height of flowering stem / cm | 36 | 5 | 38 | 6 |
| Increase in root length in a solution containing zinc / mm | 46 | 7 | 12 | 4 |
| Mass of 100 seeds produced / g | 0.42 | 0.05 | 0.45 | 0.06 |

**0 5 . 1** Use the means and standard deviations in Table 4 to compare the two populations.

**[3 marks]**

**Question 5 continues on the next page**

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**0 5 . 2** Explain why the scientists grew the seeds from both populations in the same conditions before measuring the plants.

**[2 marks]**

5

**Turn over for the next question**


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## Extended response: comparing two populations 3.4.7

A rare species of beetle lives in two separate areas of woodland. Conservation scientists want to find out whether the two populations differ genetically.

**0 6** Describe how the scientists could collect samples of beetles and use DNA base sequences to find out whether the two populations differ genetically.
In your answer, explain how they could decide whether any difference between the populations is significant.

**[6 marks]**

6

**END OF QUESTIONS**

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