

Temperature, evolution and speciation: practice questions

9 questions · 35 marks · mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 35

1 UNIT 4 STYLE [1 mark]

The rate of an enzyme-controlled reaction in a plant is 6 units at 20 °C and 15 units at 30 °C. What is the Q_{10} for this reaction?

- A. ☐ 0.4
B. ☐ 2.5
C. ☐ 9.0
D. ☐ 0.9

2 UNIT 4 STYLE [4 marks]

Explain the effect of increasing temperature on the rate of an enzyme-controlled reaction in a bacterium, from 10 °C to 60 °C.

3 UNIT 4 STYLE

[3 marks]

The table shows the rate of oxygen consumption of a species of beetle at three temperatures. Calculate Q_{10} for the beetle between 10 °C and 20 °C, and between 20 °C and 30 °C.

Oxygen consumption of a beetle at different temperatures	
Temperature / °C	Oxygen consumption / mm ³ g ⁻¹ h ⁻¹
10	20
20	50
30	90

Answer = ...

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4 UNIT 4 STYLE

[4 marks]

Using the data in the previous question, suggest what the change in Q_{10} shows about the beetle, and explain the possible impact of a rise in mean temperature on the beetle population.

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5 UNIT 6 STYLE

[6 marks]

Describe how you would investigate the effect of temperature on the hatching of brine shrimp eggs. Include the variables you would control and how you would take account of the ethical use of the organisms.

6 UNIT 6 STYLE

[4 marks]

A student measured the hatching of brine shrimp eggs. At 20 °C, 36 of 120 eggs hatched. At 30 °C, 84 of 120 eggs hatched. At 40 °C, 12 of 120 eggs hatched. Calculate the percentage hatching at each temperature and suggest why the percentage is lower at 40 °C.

Answer = ...

7 UNIT 4 STYLE

[5 marks]

Explain how a population of insects that was susceptible to an insecticide can become resistant to it.

8 UNIT 4 STYLE

[5 marks]

Two populations of a species of lizard became isolated on two islands when a land bridge was submerged. Explain how this could lead to the formation of two new species.

9 UNIT 4 STYLE

[3 marks]

Describe how sympatric speciation differs from allopatric speciation, and give one way in which reproductive isolation could arise in sympatric speciation.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B: $Q_{10} = 15 \div 6 = 2.5$. A divides the lower rate by the higher rate; C is the difference in rate ($15 - 6$); D is the difference divided by the 10 °C interval.

2. [4]

- as temperature increases, molecules have more kinetic energy (1)
- so more frequent / more energetic collisions between enzyme and substrate, so more enzyme-substrate complexes (1)
- rate increases up to the optimum (1)
- above the optimum, bonds (hydrogen) break and the tertiary structure / active site changes shape (1)
- enzyme denatures, so substrate no longer fits and rate falls (1)
- Max 4

3. [3]

- $Q_{10} = \text{rate at higher temperature} \div \text{rate at lower temperature}$ (1)
- 10 to 20 °C: $50 \div 20 = 2.5$ (1)
- 20 to 30 °C: $90 \div 50 = 1.8$ (1)
- correct answers with no working gain full marks; Q_{10} has no unit (ignore units given)

4. [4]

- Q_{10} falls as temperature increases / rate does not double between 20 and 30 °C (1)
- the rate of increase is falling because enzymes are approaching their optimum / some enzymes begin to denature (1)
- beetle is an ectotherm, so its metabolic rate follows the environment temperature (1)
- warming may increase growth and development until the optimum, but above this enzymes denature and survival falls (1)
- Max 4

5. [6]

- set up water baths / incubators at several temperatures, for example 15 to 35 °C, checked with a thermometer (1)
- same volume and concentration of salt solution in each container (1)
- same number / mass of eggs from the same batch in each (1)
- same light, time and aeration in each (1)
- count the number hatched (or percentage hatching) after a fixed time (for example 24 h) (1)
- repeat at each temperature and calculate a mean (1)
- ethical: use minimum number of eggs / organisms (1)
- ethical: avoid extreme temperatures / treat humanely and dispose of the organisms humanely (1)
- Max 6

6. [4]

- 20 °C: $36 \div 120 \times 100 = 30 \%$ (1)
- 30 °C: $84 \div 120 \times 100 = 70 \%$ (1)
- 40 °C: $12 \div 120 \times 100 = 10 \%$ (1)
- enzymes (involved in development / hatching) denature at high temperatures / 40 °C is above the optimum, so development is disrupted (accept embryos killed / membranes damaged) (1)

7. [5]

- a mutation in a gene produced an allele giving resistance (1)
- mutation occurs at random / was present before the insecticide was used (1)
- insecticide is a selection pressure (1)
- resistant individuals survive and reproduce (1)
- they pass the allele to offspring (1)
- the frequency of the allele increases in the population (over generations) (1)
- Max 5

8. [5]

- geographical isolation prevents interbreeding / there is no gene flow between the populations (1)
- mutations occur independently in each population (1)
- different selection pressures on each island (1)
- allele frequencies diverge over generations (1)
- populations become unable to interbreed to produce fertile offspring (reproductive isolation) (1)
- this is allopatric speciation (1)
- Max 5

9. [3]

- sympatric occurs in the same area / allopatric requires a geographical barrier (1)
- in sympatric speciation, reproductive isolation arises without a physical barrier (1)
- valid example: different breeding seasons / different habitats within the same area / behavioural changes / polyploidy (1)