

3.1 Origins of cells: evidence and limits

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS endosymbiosis • inference

Objective

Origins of cells: evidence and limits. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

■ What would explain this observation?

- Mitochondria have their own DNA and divide within cells. These features invite an evolutionary explanation that can be tested against other evidence.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- The endosymbiotic model explains mitochondria and chloroplasts as descendants of bacteria living within another cell lineage. Double membranes, ribosomes, DNA and division provide several lines of evidence. This model is distinct from a complete explanation for the origin of the first life.
- **endosymbiosis** : One organism living within another in an evolutionary association; **inference** : An explanation drawn from observations and reasoning.



■ Choose evidence that can test it

- Independent observations strengthen a model when they make a consistent prediction. Similarity is evidence to evaluate alongside ancestry, sequence comparisons and alternative explanations, rather than proof from one feature.
- Use attributed micrographs and sequence data. Separate observations from inferences in a table. Check whether each comparison concerns a mitochondrion, chloroplast, bacterial cell or eukaryotic nucleus.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: 18 of 24 compared sequence sites are identical. Identity = $18/24 \times 100 = 75\%$. Identity across this short alignment cannot alone date an evolutionary split or establish that one organism is the direct ancestor of another.

Example:

21 of 28 compared sites match. Calculate percentage identity. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ Check the conclusion and its limits

- The endosymbiotic model does not say that every organelle arose from an engulfed bacterium. A laboratory model of early chemistry is not a recreation of the whole historical event.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

One matching sequence proves the complete origin of life. This claim is false: The endosymbiotic model does not say that every organelle arose from an engulfed bacterium. A laboratory model of early chemistry is not a recreation of the whole historical event.

Key:

Origins of cells: evidence and limits: Independent observations strengthen a model when they make a consistent prediction. Similarity is evidence to evaluate alongside ancestry, sequence comparisons and alternative explanations, rather than proof from one feature.

2 Practice

2.1 Which observation is relevant evidence for mitochondrial endosymbiosis? Choose one answer.

- **A** Mitochondria have their own DNA
- **B** All cells have exactly the same size
- **C** Every organelle has a nucleus

[1]

2.2 21 of 28 compared sites match. Calculate percentage identity. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: One matching sequence proves the complete origin of life.

[2]

2.4 One organism living within another in an evolutionary association: write the technical term.

[1]

3 Exam-style questions

3.1 Sequence comparisons give 18/24 and 30/40 matching sites. Compare identity; can one organism be declared the other's ancestor?

[4]

Solutions

2.1 A Independent observations strengthen a model when they make a consistent prediction. Similarity is evidence to evaluate alongside ancestry, sequence comparisons and alternative explanations, rather than proof from one feature.

2.2 identity= $21/28 \times 100 = 75\%$.

2.3 False. The endosymbiotic model does not say that every organelle arose from an engulfed bacterium. A laboratory model of early chemistry is not a recreation of the whole historical event.

2.4 endosymbiosis. endosymbiosis means One organism living within another in an evolutionary association.

3.1 Both 75%. Short alignments and identity alone do not establish ancestry or dates; homologous loci, models and wider evidence are required.