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. Original classroom practice for IB HL; not an official IB paper.

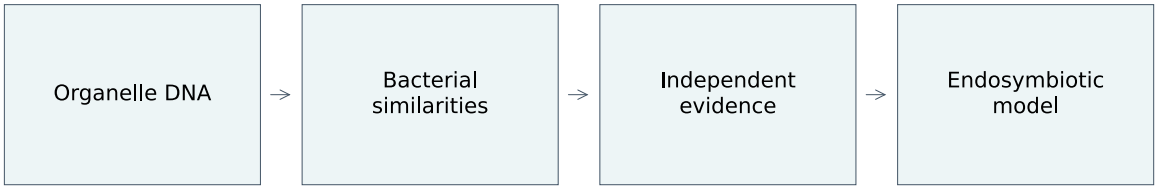
1 Key knowledge and worked examples

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.

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.

In the lab: 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

- 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.

Your turn: 21 of 28 compared sites match. Calculate percentage identity.

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.

Not true: One matching sequence proves the complete origin of life. One sequence match is one piece of evidence about one locus. Origins models rest on many independent lines - DNA, ribosomes, membranes, biochemistry - not a single comparison.

Key:

- The endosymbiotic model explains mitochondria and chloroplasts as descendants of bacteria living within another cell lineage.
- Independent observations strengthen a model when they make a consistent prediction.
- Watch for: the endosymbiotic model does not say that every organelle arose from an engulfed bacterium.

Write from an identity of 80 percent

- 16 of 20 compared sequence sites are identical.
- Find the percentage identity. Say what that percentage does not prove.

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]