2025 Bi H2 Q4

Section: Sustainability and Interdependence

Topic: Evolution (Phylogenetics)

Question Summary

A phylogenetic tree shows when different groups of land plants split from common ancestors. You are asked to: (a)(i) name another type of evidence used in phylogenetics besides fossils; (a)(ii) read the time of the last common ancestor of Amborella and Osmunda; (a)(iii) count how many groups share a common ancestor with monocots at 200 million years ago; (a)(iv) explain why monocots are more closely related to gymnosperms than to lycopodiophyta. Part (b) asks about the meaning of genome and how one gene can produce several enzymes.

Worked Solution

(a)(i) Phylogenetic trees are built using several lines of evidence.

Besides fossils, a key source is **molecular (genetic) evidence** such as DNA or protein sequences. Closely related organisms have more similar base / amino-acid sequences.

(a)(ii) On the diagram, trace Amborella and Osmunda branches back to their join.

Their branches meet just before the 300 million years ago mark. So the last common ancestor lived about **300 million years ago**.

(a)(iii) Draw a vertical line at 200 million years ago.

At this time, the monocot lineage is still joined to the same branch as Amborella and the eudicots. Therefore, monocots shared a common ancestor with **2 other groups** at 200 million years ago.

(a)(iv) Relatedness depends on how recently lineages split.

The monocot branch joins the gymnosperm branch further to the right on the time axis (more recently) than it joins the lycopodiophyta branch, which splits much earlier. A more recent common ancestor means a closer evolutionary relationship.

(b)(i) A genome is the complete genetic information of an organism.

It is the **entire set of DNA** (all genes plus non-coding DNA) found in its cells.

(b)(ii) One gene can lead to several enzymes by producing different mRNA versions.

During gene expression, the same primary transcript can be **alternatively spliced**. Different combinations of exons are kept, producing different mRNA molecules. These are translated into polypeptides with different amino-acid sequences, so **different enzymes** result. (Post-translational modification can also create variants.)

Final Answer

- (a)(i) Molecular / DNA (or protein) sequence evidence.
- (a)(ii) About 300 million years ago.
- (a)(iii) 2 groups.
- (a)(iv) Monocots share a more recent common ancestor with gymnosperms than with lycopodiophyta.
- (b)(i) The complete set of DNA / genetic material of an organism.
- (b)(ii) Alternative splicing of the ACS transcript produces different mRNAs and thus different enzymes.

Revision Tips

- On phylogenetic trees, the closer (more recent) the branching point, the closer the relationship.
- Use DNA / amino-acid comparisons as molecular evidence for relatedness.
- To find last common ancestors, trace both branches back to their shared node.
- Genome means ALL the DNA, not just the coding genes.
- Alternative splicing is a standard way one gene yields several proteins / enzymes.