

2023 Bi H2 Q4

Section: DNA and the Genome

Topic: Evolution

Question Summary

This question uses a phylogenetic tree and gene sequence data to explore evolutionary relationships among fish species, including the role of mutation and gene loss in evolution.

Worked Solution

(a)(i) Last common ancestor of Nile tilapia and medaka:

From the phylogenetic tree, their lineages join at about 120 million years ago.

■ Answer: 120 million years ago

(a)(ii) Number of species evolved from a common ancestor 100 million years ago:

At 100 million years ago, branches exist for stickleback, fugu, mudskipper, zebrafish, and medaka — 5 separate lineages trace back to one ancestor.

■ Answer: 5 species

(a)(iii) Species most distantly related to the mudskipper:

From the tree, seahorse diverged earliest from the lineage leading to mudskipper.

■ Answer: Seahorse

(b)(i) Gene responsible for pelvic fin development:

Pelvic fins are present in Nile tilapia, zebrafish, and Atlantic cod, but absent in seahorses. Comparing their genes: seahorse lacks gene C, which is present in the others. Therefore, gene C must control pelvic fin development.

■ Answer: Gene C

(b)(ii) Type of mutation in Atlantic cod:

The gene order in cod (A E D C B F) differs from the normal sequence (A B C D E F). This rearrangement indicates a translocation mutation.

■ Answer: Translocation

Final Answers

■ (a)(i) 120 million years ago

■ (a)(ii) 5 species

■ (a)(iii) Seahorse

■ (b)(i) Gene C

■ (b)(ii) Translocation

Revision Tips

- Phylogenetic trees show evolutionary relationships — species branching later are more closely related.

- Common ancestor points indicate shared heritage; the more recent, the closer the relationship.
- Gene loss or mutation (e.g. translocation) drives divergence between species.
- Mutation types:
 - Deletion — loss of a gene
 - Duplication — gene copied
 - Inversion — reversed order
 - Translocation — gene segment moved to new position.