Fish or Mammals?

Evidence organizer

Guiding question
What does evidence from anatomy, fossils, embryos, and DNA reveal about the closest living relative of cetaceans?

Instructions
Use this Evidence Organizer with the Fish or Mammals? Case Study document.

Evidence from Anatomy
Use the table on page 2 to answer the questions:

1. How many anatomical characteristics do Cetaceans share with Mammals?
   10: all but 4 limbs vs. flippers

2. How many anatomical characteristics do Cetaceans share with Fish?
   3: internal skeleton, flippers/fins & tail, embryos with 4 limb buds

3. Circle the tree diagram that best shows the relationship between fish, cetaceans, and mammals. Explain your answer.

Evidence from Fossils
Use the information on pages 3–5 to answer the questions:

4. Summarize how the fossil cetacean ancestors changed over time. Give at least one example of a specific trait and how it changed.
   Anatomy changed over time from being more land-mammal-like (older fossils) to more whale-like (younger fossils). Possible examples:
   • Nostrils moved from end of snout to top of head
   • Hindlimb anatomy changed from long legs with hooves to completely internal
5. Does the fossil evidence support or refute the claim that cetaceans evolved through change over time from an ancestral mammal that lived on land? Explain your answer.

Support. There are many similarities in fossils connecting whales to animals that look like land mammals. The fossils gradually change in limb, tail, and body anatomy, including many intermediate forms.

6. Look at the ankle bones at the top of page 6. Which group of modern-day land mammals has ankle bones that are most similar to those of the fossil whales?

Even-toed ungulates (pig and deer)

Evidence from Embryos

Look at the information on the bottom of page 6.

7. What does nostril position say about the ancestry of dolphins and other cetaceans?

Dolphin embryos first develop nostrils at the end of their snout, supporting the idea that cetaceans share a common ancestor with land mammals, which also have nostrils at the end of their snouts.

8. What does hindlimb shape say about the ancestry of dolphins and other cetaceans?

Dolphin embryos grow hindlimb buds, suggesting they share a common ancestor with land mammals, which also have four legs.
DNA Evidence

9. (Use the data table on page 7) Which animal makes casein protein that is MOST similar to the whale protein? What does this suggest about this animal’s relationship to whales?

Hippopotamus. Cetaceans share a more recent common ancestor with hippos than with the other animals in the table.

10. Use the data table on page 8 to fill in the even-toed ungulates on tree
   a. Find the animal with the fewest traits (in this case, the fewest transposons) in common with the others. Write the name in the box labeled ‘outgroup.’
   b. Find the animal with the next-fewest traits in common with the others. Add a new branch to your tree (follow the dashed line). Write the name of the animal at the top of the new line.
   c. Follow the pattern, adding branches for the other animals.
   d. Mark the tree to show where each transposon first appeared (A has been marked for you).

Even-toed Ungulate Tree

Note: Other tree arrangements are also correct. Rotating branches around a "node," or branch point, will result in trees that look different but are equivalent. For more details, see the Practice with Trees extension.
Summary

11. Which living animal is most closely related to (shares a most common ancestor with) Cetaceans such as whales?
   Hippopotamus

12. From the early 1700s to the modern day, how did various lines of evidence refine scientists’ understanding about the ancestry of Cetaceans?
   a. Anatomy
      Cetaceans are mammals

   b. Fossils
      Cetaceans are the descendants of hoofed land mammals with an even number of toes.

   c. Embryological development
      Cetaceans are mammals, and their ancestors had nostrils on the end of their snouts like other land mammals.

   d. DNA (including amino acid sequences)
      Cetaceans’ closest living relative is the hippopotamus.

Note: If students have trouble answering this question, skip it and move on to the next activity, Fish or Mammals? Identifying Evidence.