

Becoming Whales: DISCUSSION QUESTIONS: Sample Responses

1. Which typical whale traits were the **earliest** to appear?

Early whale **teeth**, then early whale-type **ear bones**; skulls becoming long and narrow (adapted for catching fish); shorter legs with big feet

2. Which whale traits evolved much **later**?

Nostrils shifted back toward top of skull; **hind legs reduced**, then eliminated; forelimbs become paddle-like; strong swimming tail with flukes form

3. What **age** sediments, and in what **region** of the world, would you search now to get the fossils which would shed more light on whale origins, and what specific **traits** would you expect to find?

40-50 million year old sediments, in the **Pakistan** region. Traits showing increasing adaptations to marine life over time, e.g. those suggested in items #1 and 2 above.

4. How closely did your “predicted traits” (expected for an **intermediate** between mesonychids and *Rodhocetus*) match the *Ambulocetus* fossil found? Does *Ambulocetus* seem to fit fairly well into the sequence between mesonychids and *Rodhocetus*?

[Should show some of the changes pointed out above in transition from terrestrial form to aquatic form.] Yes, Ambulocetus DOES fit well into the sequence, showing transitional features.

5. Notice the reconstruction of *Pakicetus*, showing it as a **four-legged animal**. What evidence, if any, would suggest such a reconstruction? (Get your information from the suggested resources and the skull picture). How confident are you of that reconstruction? What additional evidence would give you greater confidence in that reconstruction?

Ear bones more like land mammals; Oxygen isotopes indicate dependence on freshwater; very early age suggests a more terrestrial form. [There were no post-cranial fossils discovered until 2001, and these confirm the presence of four terrestrial legs (with tiny hooves yet!).]

6. As each new “intermediate fossil” was found, filling a “gap”, how many new gaps were formed?

Two new gaps (one above, and one below the new find).

7. Can we make predictions about past events? Why?

Yes. Based on existing fossils and assumed evolutionary trends, knowledge of anatomy, geography, and geological history

8. Explain why the **absence** of transitional (intermediate) fossils is **not** a fair argument against evolution.

They may not have been found yet; transition may have been fairly rapid, leaving few fossils; many new transitional fossils have been found in recent years, e.g. for whales.

9. Why is it very **UNlikely** that these fossils of early whale evolution are the **direct** ancestors of whales? How ARE they probably related to those direct ancestors? What is wrong with the popular “missing link” concept of evolution?

As in living species today, the tree is very bushy, with many different species in the same family (e.g. the cat family, antelope family, etc.). They are much more likely to be close cousins to any direct ancestors. “Missing link” suggests a simplistic linear evolutionary chain of life, rather than the more realistic “bushy” multi-branched tree-of-evolution concept.

10. Several species of modern whales have well-developed rear limbs while embryos. As the embryo continues to mature, these limbs atrophy (shrink) and become nonfunctional. Why do you suppose this happens? (Why do the limbs form, and then why do they atrophy?)

Genes for leg formation are still in the whale genome (as expected from a terrestrial ancestry), but are turned off during later development, since legs were selected against in the marine environment.

11. Summarize what you have learned about the process of science in this lesson.

[Should include comments about **testing hypotheses** (ideas) about whale origins (whale evolution), both in form and in geography, including the making of **predictions** of expected traits, age, and locations, looking for expected fossils, and finding them, which confirms the hypotheses.]

12. Summarize what you have learned about the process of evolution in this lesson.

[Should include that fossils were discovered which have traits intermediate between terrestrial mammals and whales, in fact with a mosaic of earlier and later features, which is consistent with the idea that whales have evolved from earlier non-whales, gradually acquiring features which enable them to survive better in a deep ocean environment.]