The Origins of Cetaceans

It should be obvious that cetaceans—whales, porpoises, and dolphins—are mammals. They breathe through lungs, not through gills, and give birth to live young. Their streamlined bodies, the absence of hind legs, and the presence of a *fluke** and *blowhole*** cannot disguise their affinities with land dwelling mammals. However, unlike the cases of sea otters and pinnipeds (seals, sea lions, and walruses, whose limbs are functional both on land and at sea), it is not easy to envision what the first whales looked like. Extinct but already fully marine cetaceans are known from the fossil record. ■ How was the gap between a walking mammal and a swimming whale bridged? ■ Missing until recently were fossils clearly intermediate, or transitional, between land mammals and cetaceans.

■ Very exciting discoveries have finally allowed scientists to reconstruct the most likely origins of cetaceans. ■ In 1979, a team looking for fossils in northern Pakistan found what proved to be the oldest fossil whale. The fossil was officially named *Pakicetus* in honor of the country where the discovery was made. *Pakicetus* was found embedded in rocks formed from river deposits that were 52 million years old. The river that formed these deposits was actually not far from an ancient ocean known as the Tethys Sea.

The fossil consists of a complete skull of an archaeocyte, an extinct group of ancestors of modern cetaceans. Although limited to a skull, the *Pakicetus* fossil provides precious details on the origins of cetaceans. The skull is cetacean-like but its jawbones lack the enlarged space that is filled with fat or oil and used for receiving underwater sound in modern whales. *Pakicetus* probably detected sound through the ear opening as in land mammals. The skull also lacks a blowhole, another cetacean adaptation for diving. Other features, however, show experts that *Pakicetus* is a transitional form between a group of extinct flesh-eating mammals, the mesonychids, and cetaceans. It has been suggested that *Pakicetus* fed on fish in shallow water and was not yet adapted for life in the open ocean. It probably bred and gave birth on land.

Another major discovery was made in Egypt in 1989. Several skeletons of another early whale, *Basilosaurus*, were found in sediments left by the Tethys Sea and now exposed in the Sahara desert. This whale lived around 40 million years ago, 12 million years after *Pakicetus*. Many incomplete skeletons were found but they included, for the first time in an archaeocyte, a complete hind leg that features a foot with three tiny toes. Such legs would have been far too small to have supported the 50-foot-long *Basilosaurus* on land. *Basilosaurus* was undoubtedly a fully marine whale with possibly nonfunctional, or vestigial, hind legs.

An even more exciting find was reported in 1994, also from Pakistan. The now extinct whale *Ambulocetus natans* ("the walking whale that swam") lived in the Tethys Sea 49 million years ago. It lived around 3 million years after *Pakicetus* but 9 million before *Basilosaurus*. The fossil luckily includes a good portion of the hind legs. The legs were strong and ended in long feet very much like those of a modern pinniped. The legs were certainly functional both on land and at sea. The whale retained a tail and lacked a fluke, the major means of locomotion in modern cetaceans. **The structure of the backbone shows, however, that *Ambulocetus* swam like modern whales by moving the rear portion of its body up and down, even though a fluke was missing.** The large hind legs were used for propulsion in water. On land, where it probably bred and gave birth, *Ambulocetus* may have moved around very much like a modern sea lion. It was undoubtedly a whale that linked life on land with life at sea.

1. **In paragraph 1, what does the author say about the presence of a blowhole in cetaceans?**
   (A) It clearly indicates that cetaceans are mammals.
   (B) It cannot conceal the fact that cetaceans are mammals.
   (C) It is the main difference between cetaceans and land-dwelling mammals.
   (D) It cannot yield clues about the origins of cetaceans.

2. **Which of the following can be inferred from paragraph 1 about early sea otters?**
   (A) It is not difficult to imagine what they looked like.
   (B) There were great numbers of them.
   (C) They lived in the sea only.
   (D) They did not leave many fossil remains.

3. **The word "precious" in the passage is closest in meaning to**
   (A) exact
   (B) scarce
   (C) valuable
   (D) initial

4. ***Pakicetus* and modern cetaceans have similar**
   (A) hearing structures
   (B) adaptations for diving
   (C) skull shapes
   (D) breeding locations

5. **The word "It" in the passage refers to**
   (A) *Pakicetus*
   (B) fish
   (C) life
   (D) ocean

6. **The word "exposed" in the passage is closest in meaning to**
   (A) explained
   (B) visible
   (C) identified
   (D) located

7. **The hind leg of *Basilosaurus* was a significant find because it showed that *Basilosaurus***
   (A) lived later than *Ambulocetus natans*
   (B) lived at the same time as *Pakicetus*
   (C) was able to swim well
   (D) could not have walked on land

8. **It can be inferred that *Basilosaurus* bred and gave birth in which of the following locations**
   (A) on land
   (B) both on land and at sea
   (C) in shallow water
   (D) in a marine environment

9. **Why does the author use the word "luckily" in mentioning that the *Ambulocetus natans* fossil included hind legs?**
   (A) Fossil legs of early whales are a rare find.
   (B) The legs provided important information about the evolution of cetaceans.
   (C) The discovery allowed scientists to reconstruct a complete skeleton of the whale.
   (D) Until that time, only the front legs of early whales had been discovered.

10. **Which of the sentences below best expresses the essential information in the highlighted sentence in the passage? Incorrect choices change the meaning in important ways or leave out essential information.**
    (A) Even though *Ambulocetus* swam by moving its body up and down, it did not have a backbone.
    (B) The backbone of *Ambulocetus*, which allowed it to swim, provides evidence of its missing fluke.
    (C) Although *Ambulocetus* had no fluke, its backbone structure shows that it swam like modern whales.

(D) By moving the rear parts of their bodies up and down, modern whales swim in a different way from the way *Ambulocetus* swam.

11. The word "propulsion" in the passage is closest in meaning to

(A) staying afloat
(B) changing direction
(C) decreasing weight
(D) moving forward

12. Look at the four squares [■] that indicate where the following sentence could be added to the passage.

This is a question that has puzzled scientists for ages.

Where would the sentence best fit?

13. Directions: An introductory sentence for a brief summary of the passage is provided below. Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some sentences do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. This question is worth 2 points.

This passage discusses fossils that help to explain the likely origins of cetaceans—whales, porpoises, and dolphins.

Answer choices

(A) Recent discoveries of fossils have helped to show the link between land mammals and cetaceans.
(B) The discovery of *Ambulocetus natans* provided evidence for a whale that lived both on land and at sea.
(C) The skeleton of *Basilosaurus* was found in what had been the Tethys Sea, an area rich in fossil evidence.
(D) *Pakicetus* is the oldest fossil whale yet to be found.
(E) Fossils thought to be transitional forms between walking mammals and swimming whales were found.
(F) *Ambulocetus'* hind legs were used for propulsion in the water.

参考答案与解析（摘自 Official Guide）

1. **B.** It is essentially a rephrasing of the statement in paragraph 1 that blowholes cannot disguise cetaceans' affinities with other mammals. The other three choices are refuted, either directly or indirectly, by that paragraph.
2. **A.** Paragraph 1 says that sea otters are unlike early mammals whose appearances are not easy to imagine. By inference, then, the early appearance of sea otters must be easy (or not difficult) to imagine.
3. **C.** Anything that is *precious* is very important and therefore valuable.
4. **C.** Paragraph 3 describes the differences and similarities between *Pakicetus* and modern cetaceans. Sentence 3 of that paragraph states that their skulls are similar. The other three choices describe differences, not similarities.
5. **A.** This is a simple pronoun referent item. Choice A, "*Pakicetus*" is the correct answer. The word *It* here refers to a creature that probably bred and gave birth on land. *Pakicetus* is the only one of the choices to which this could apply.
6. **B.** *Exposed* means "uncovered." A skeleton that is uncovered can be seen. Visible means "can be seen."
7. **D.** Choice D is the best answer because it is the only detail about the skeleton of *Basilosaurus* mentioned in paragraph 4, meaning that it is significant. Choice A is true, but it is not discussed in the detail that choice D is, and does not represent the significance of the discovery. Choice C is not mentioned, and choice B is not mentioned.
8. **D.** That implies that everything it did, including breeding and giving birth, could have been done only in a marine environment.
9. **B.** Paragraph 5 explains that this discovery provided important information to scientists that they might not have been able to obtain without it. Therefore, you can infer that the discovery was a "lucky" one. The passage offers no support for the other choices.
10. **C.** Choice A is not true because *Ambulocetus* did have a backbone. Choice B is not true because the sentence says that the backbone showed how the *Ambulocetus* swam, not that it was missing a fluke. Choice D is untrue because the sentence states that *Ambulocetus* and modern whales swam in the same way.
11. **D.** The whale in the sentence used its hind legs to push itself forward in the water.
12. **B.** The sentence that precedes square B is in the form of a rhetorical question and the inserted sentence explicitly provides a response to it. None of the other sentences preceding squares is a question, so the inserted sentence cannot logically follow any one of them.
13. **ABE.** Choice C, "The skeleton of *Basilosaurus* was found in what had been the Tethys Sea, an area rich in fossil evidence," is true, but it is a minor detail and therefore incorrect. Choice D, "*Pakicetus* is the oldest fossil whale yet to be found," is true, but it is a minor detail and therefore incorrect. Choice F, "*Ambulocetus*' hind legs were used for propulsion in the water," is true, but it is a minor detail and therefore incorrect. Choice A, "Recent discoveries of fossils have helped to show the link between land mammals and cetaceans," is correct because it represents the major idea of the entire passage. The bulk of the passage consists of a discussion of the major discoveries (*Pakicetus*, *Basilosaurus*, and *Ambulocetus*) that show this link. Choice B, "The discovery of *Ambulocetus natans* provided evidence for a whale that lived both on land and at sea," is correct because it is one of the major discoveries cited in the passage in support of the passage's main point, that land mammals and cetaceans are related. Choice E, "Fossils thought to be transitional forms between walking mammals and swimming whales were found," is correct because like choice A, this is a statement of the passage's major theme as stated in paragraph 1: these fossils were "clearly intermediate, or transitional between land mammals and cetaceans." The remainder of the passage discusses these discoveries.