I. Cetacea

A. Cetaceans are mammals
   - warm-blooded
   - breathe air via lungs
   - live young
   - mammary glands

Baby cetaceans swim on side, nurse from nipples concealed in abdominal mammary slits.

They are not fish: e.g., tail ("fluke") and mobility of cetaceans
They are not fish: e.g., blowhole

B. Two types

1. Toothed whales

2. Baleen whales
Baleen whales

Baleen = in two parallel rows of plates from upper jaw = modified epidermis = keratin (stiff, elastic) plus hydroxyapatite (bony mineral)

II. Evolutionary origins

Necessary evidence:
1. Phylogenetic evidence
2. Terrestrial -> aquatic
3. Front limbs -> flippers
4. Hind legs -> no legs
5. Nostril migration
topic 10 – Origins of Order Cetacea

II. Evolutionary origins

1. Phylogenetic evidence
2. Plenty of examples for terrestrial >> semi-aquatic >> aquatic transitions elsewhere in Animal kingdom.

b. Sirenians

Evoluted from protoungulates, related to elephants, aardvarks, etc. ca. 40 Ma

Dugongs = shallow coastal waters of Indo-Pacific.
Manatees = shallow coastal waters & rivers of Caribbean, Amazon, West Africa.

Hind legs lost, but foreflippers have remained pliable for maneuvering.
Habitat: shallow coastal waters, freshwater rivers.
II. Evolutionary origins

c. Pinnipeds ("fin-feet" or "wing-feet"): Evolved from "bear-like", carnivore ancestors ca. 30 Ma

Seals, sea lions, and walruses

Notice any similarities with the feet of terrestrial mammals? (Bull elephant seals, CA, USA)

Sea lions

The Visible Sea Lion
II.  Evolutionary origins

Walrus

Pacific Walrus

d.  Otters (13 spp.)
   Related to badgers, weasels, polecats; evolved ca. 5-7 Ma
   Least streamlined of marine mammals.
   Hind feet >> flippers, front limbs are those of terrestrial carnivore.

Pacific sea otter
topic 10 – Origins of Order Cetacea

II. Evolutionary origins

d. Otters (13 spp.)

Related to badgers, weasels, polecats; evolved ca. 5-7 Ma

Least streamlined of marine mammals.

Hind feet >> flippers. Front limbs are

those of terrestrial carnivore.

<table>
<thead>
<tr>
<th></th>
<th>Otters (5-7 Ma)</th>
<th>Pinnipeds (30 Ma)</th>
<th>Sirenians (40 Ma)</th>
<th>Whales (50 Ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Amount of hair</td>
<td>Thick coat; whiskers</td>
<td>Very sparse; whiskers</td>
<td>Very sparse; whiskers poorly developed</td>
<td>Very very sparse; no whiskers</td>
</tr>
<tr>
<td>2. Nasal position</td>
<td>Front</td>
<td>High Front</td>
<td>High Front</td>
<td>Top</td>
</tr>
<tr>
<td>3. Front limbs, toe development</td>
<td>Well</td>
<td>Fair</td>
<td>Non-existent</td>
<td>Non-existent</td>
</tr>
<tr>
<td>4. Nails/claws in feet</td>
<td>Well</td>
<td>Fair</td>
<td>Non-existent</td>
<td>Non-existent</td>
</tr>
<tr>
<td>5. Hind limbs as flippers</td>
<td>Yes</td>
<td>Yes</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>6. Blubber/fat as insulation</td>
<td>Poor</td>
<td>Fair</td>
<td>Well</td>
<td>Well</td>
</tr>
</tbody>
</table>

Northern river otter

[Diagram of number of adaptations for terrestrial living over millions of years of semi- or fully aquatic evolution]
II. Evolutionary origins

1. Phylogenetic evidence
2. Terrestrial >> aquatic
3. Front limbs >> flippers
4. Hind legs >> no legs

Modern cetaceans: vestigial pelvis & hind limbs; occasional atavisms

Valley of the Whales (150 km S of Cairo)

Basilosaurids & dorudontids
II. Evolutionary origins

4. Hind legs >> no legs: basilosaurids and dorudontids (ca. 40-30 Ma)

- Basilosaurus had 2 tiny legs, probably used as claspers when mating.
- Durodon had 2 tiny legs, probably used as claspers when mating.
II. Evolutionary origins

4. Hind legs >> no legs: protocetids (ca. 45-35 Ma)

- Rodhocetus: fore and hind limbs could support body on land but articulation show adaptations for swimming.
- Therefore, likely to have been amphibious.
- Unclear at present if they had flukes.

Doubled-pulleyed Astragalus of Rodhocetus and Artiocetus (pronghorn in middle)
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II. Evolutionary origins

4. Hind legs >> no legs : ambulocetids & remingtonocetids (ca. 50-40 Ma)
II. Evolutionary origins

4. Hind legs >> no legs: ambulocetids & remingtonocetid (ca. 50-40 Ma)

5. Nostril migration

- Nasal drift in cetaceans
- Blowhole in a blue whale

Arctocetus 47 mya

Pseudaliornis 29 mya

Inia geoffrensis

Amazonian Dolphin (recent)
topic 10 – Origins of Order Cetacea

II. Evolutionary origins

5. Nostril migration