I. Cetaceans
   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

Sperm whale starts to exhale just below surface

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

1. Phylogenetic evidence
II. Evolutionary origins

1. Phylogenetic evidence
2. Independent examples of terrestrial >> aquatic transitions in animals

b. sirenians

Evolved 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)

The Visible Sea Lion
topic 10 – Origins of Cetaceans
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
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

Characters under selection during evolution

<table>
<thead>
<tr>
<th>Characters under selection</th>
<th>Otters (5-7 Ma)</th>
<th>Proboscidea (50 Ma)</th>
<th>Sirenia (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 poorly developed</td>
<td>Very very sparse; no whiskers</td>
<td></td>
</tr>
<tr>
<td>2. Nasal position</td>
<td>Front</td>
<td>High</td>
<td>High</td>
<td>Top</td>
</tr>
<tr>
<td>3. Front limbs, toe developent</td>
<td>Wall</td>
<td>Fair</td>
<td>Non-existent</td>
<td>Non-existent</td>
</tr>
<tr>
<td>4. Nails/claws in foot</td>
<td>Wall</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 for insulation</td>
<td>Poor</td>
<td>Fair</td>
<td>Well</td>
<td>Well</td>
</tr>
</tbody>
</table>
II. Evolutionary origins

1. Phylogenetic evidence
2. Independent examples of terrestrial >> aquatic transitions in animals
3. Front limbs >> flippers
4. Hind legs >> no legs

Modern cetaceans: vestigial pelvis & hind limbs; occasional atavisms
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.
topic 10 – Origins of Cetaceans
II. Evolutionary origins

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

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

Nasal drift in cetaceans
blowhole in a blue whale

Arktocara
Petreius
Inia

Nostrils
Nostrils
Nostrils