Fruits of Evolution: Whales

The process of evolution has paved the way for some amazing creatures, but a group that has endured some of the most drastic evolutionary changes are the whales.

PRACTICAL SCIENCE WITH PHIL FREDA

We mammals are an amazing group of creatures.
We have an internally regulated body temperature, carry our young inside us for protection, produce milk for our young and have hair, which enables us to adapt to extreme environments.

However, we came from humble beginnings.

Mammals evolved from reptilian ancestors who lived in the shadows during the age of the dinosaurs.
We were small, rodent-like creatures that hid in the trees and underground. We fed on what we could, which usually comprised of scraps left over by the giant dinosaurs of the time.

Then, approximately 65-million years ago, something happened – almost all of the dinosaurs went extinct.
Those that survived lived on over the eons and evolved to become the birds we see today.
It was now our time to conquer the land.

And indeed we did. Mammals are now found in almost every type of environment from tundra to the hottest deserts.

But a very special group of mammals evolved to dwell in the waters and over many millions of years, have become expertly adapted to the aquatic environments.

The timeline of whale evolution

Just as mechanisms in geology have molded and shaped the land over many eons through the processes of plate tectonics, evolution works incrementally over enormous tracts of time.
The process of natural selection picks and chooses those forms that are the best adapted to changing environments, and for whales it was no different.
Our knowledge of how the whales, which include the dolphins, evolved comes from extensive study of the fossil record.
Through radiometric dating and comparative physiology and anatomy, paleontologists and biologists are able to create a model of how whales evolved from land dwelling ancestors to the massive, seafaring creatures that we know today.
Below is a timeline of this amazing process with help from National Geographic, PBS and the BBC.

- **Pakicetus (50 million years ago):** Pakicetus is the earliest cetacean fossil found to date. The name of the order Cetacea comes from the Greek word *ketos*, which means sea monster. Pakicetus was first discovered in Pakistan. It is disputed whether this animal was water dwelling or terrestrial, but had well developed limbs

and tail. Bone density of the rear limbs however suggests that this creature may have been mostly aquatic. Another interesting feature is that the ear region of the skull drastically resembles those of both modern and fossilized whales. It is most likely that this transitional form waded in shallow waters searching for food.

- **Ambulocetus (49 million years ago):** This more recent transitional form was unearthed in western India. The area where it was discovered, approximately 45-million years ago, was a river delta that periodically filled with water from the nearby Indian Ocean. Sharks, rays, bony fish, crocodile and turtle fossils have also been found in the area. Ambulocetus most likely returned to land in order to give birth and mate. Their bodies resembled a web-footed sea lion with short hind legs. Recent research with oxygen isotopes in the teeth of the fossil points to the possibility that Ambulocetus no longer needed to drink fresh water like modern whales today. Also, the nasal cavities of this fossil start to show a process called nasal drift in which the nasal opening starts to slowly migrate up the skull closer to where modern day whales have their blowholes.
- **Rodhocetus (46.5 million years ago):** Another important transitional form called Rodhocetus exhibits a fused pelvis bone to the vertebrae and differentiated teeth. The nostrils also have moved further up the skull. Rodhocetus most likely swam like a present day otter, using its powerful tail as a rudder.
- **Dorudon (37 million years ago):** These early whales, found in the U.S. & Egypt, reached sizes of near 15-feet in length and sported long snake-like bodies. At this point in the evolutionary tree, we start to see the hind limbs becoming less and less important. The hind limbs of Dorudon most likely served little purpose as to how small they were.
- **Basilosaurus (37 million years ago):** This genus of early whale most likely lived alongside Durodon and was a fierce hunter. Examinations of the stomach area of these giants revealed that they ate fish and even sharks. Upon finding the fossil remains, the discoverers mistakingly thought it was some sort of dinosaur, hence the suffix "saurus." The hind legs of Basilosaurus were extremely reduced also and did not aid in locomotion. At this point in whale evolution, we see a total detachment from life on land and the front limbs being almost completely converted to flippers.
- **Aetiocetus (24-26 million years ago):** These were probably the first baleen whales. Baleen whales use specialized structures instead of teeth called baleen. Baleen is akin to netting that traps small particles of food (usually plankton) that the whale collects and eats in mass quantities. Aetiocetus sported both baleen and teeth, leading to the belief that modern baleen whales most likely evolved from this transitional species. Also, the nostrils are now located halfway between the snout and the eyes and the hind limbs have now been totally absorbed.
- **Squalodon (16 million years ago):** These toothed whales had very long snouts lined with shark-like teeth. Squalodon shows the first signs of early echolocation ability because of its melon shaped forehead – a trait that all echolocating whales share. Squalodons may be the ancestors of all toothed whales which include dolphins and Orca Whales.
- **Cetotherium (15 million years ago):** This early baleen whale had well-developed baleen and no teeth. This genus very closely resembles the present day giant baleen whales like the Blue Whale.

- **Kentriodon (15 million years ago):** Just as Cetotherium appears to be the ancestor of the large baleen whales, Kentriodon is the ancestor of the dolphins. Their large melon shaped foreheads hint to the fact that echolocation had become highly advanced as seen in present day dolphins.
  Unfortunately, there are too many transitional forms that can be covered, but I selected the ones that I believe are most pertinent to the story of whale evolution.

  The most important things to realize at looking at the timeline are the reduction of hind limbs, the nasal drift into what are now blow holes, the reconstituting of the front limbs to flippers and the evolution of specialized structures like the toothed whales' echolocation organ (the melon) or the baleen structures in baleen whales.

  Although difficult to realize, it is also very important to understand that all species are in fact transitional.

  Just because we see dolphins and whales today as they are – static and unchanging from year to year, the process of evolution is both slow and universal.

  Evolutionary processes happen first in very small increments through mutation in small areas of the genome. Over millions of years, however, these changes start to add up and may have a drastic effect on the physiology and behavior of the species that evolution is acting upon.

  It can also be said, that we humans are too transitional species in our own evolutionary process.

  Think about it!