

# Whale Evolution

## What are we Doing Today?

- Whale fossil hunt
- Whale ankle comparisons
- Whale DNA comparisons
- WHALE EVOLUTION

## Diversity of Whales Today

Two types of whales:

## What Kind of Creature is a Whale?

Structure	Fish	Cat
Ears		
Eyes		
Jaws		
Four Legs		
Lungs		
Mammary Glands		
Hair		

## Where Did Whales Come From?

How do whales and the earliest mammals compare?

## The Earliest Modern Whales

Miocene

## Eocene Whales?

Where do we look for whale fossils and why?

## Let's Hunt for Whale Fossils

- Work in pairs
- Open Your Eocene Timeline
- Remove **whale strips** from plastic bag
- Listen for descriptions and timing
- Place whale strip on **timeline**
- Wait for next "discovery"

# Whale Evolution

## **Dorudon**

When it lived:

Why it is a whale ancestor:

## **Pachyaena**

When it lived:

Why it is a whale ancestor:

## **Pakicetus**

Where discovered:

When it lived:

Why it is a whale ancestor:

## **Basilosaurus**

Where discovered:

When it lived:

Why it is a whale ancestor:

## **Rodhocetus**

Where discovered:

When it lived:

Why it is a whale ancestor:

## **Intermediate Between Pakicetus and Rodhocetus**

Draw what you think it would look like below and where you would most likely find the animal.

## **Ambulocetus**

Where discovered:

When it lived:

Why it is a whale ancestor:

# Whale Evolution

Take a picture of your timeline. You should take one picture of the top, one picture of the bottom and put them together below. Label if you can't read the fossil names and year it lived.

# Whale Evolution

## DISCUSSION QUESTIONS

(Discuss these with your team, record your answers, and be prepared to share with the class)

1. Which typical whale traits were the earliest to appear?
2. Which whale traits evolved much later?
3. 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?
4. As each new “intermediate fossil” was found, filling a “gap”, how many new gaps were formed?
5. Can we make predictions about past events? Why?
6. Explain why the absence of transitional (intermediate) fossils is not a fair argument against evolution.
7. Why is it very unlikely that these fossils of early whale evolution are the direct ancestors of whales?
8. How ARE they probably related to those direct ancestors? What is wrong with the popular “missing link” concept of evolution?



# Whale Evolution

## Whale Phylogeny

What type of mammal are whales most closely related to?

**But Mesonychids are EXTINCT!**

SO, Who are the Closest Living Relatives of Whales?

Maybe Hooved Mammals?: = Ungulates

Two Orders:

Perissodactyls

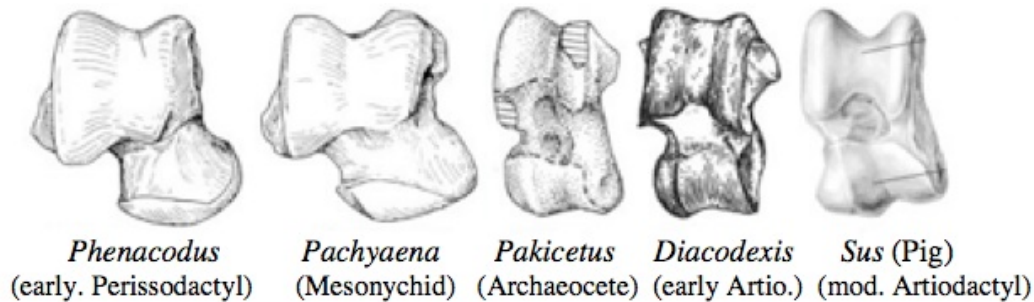
Artiodactyls

### Leg Anatomy

#### Ungulate Foot Bones

#### WHALE ANCESTRY: The Ankle Bone Connection

- Look at the pieces and try to figure out:
  - Is Pakicetus more like Perissodactyls, Mesonychids, or Artiodactyls?




1. Are the Mesonychid ankles more like the ankles of Perissodactyls or of Artiodactyls? Why?
2. Are early whale ankles (*Pakicetus*) more like those of Perissodactyls, Mesonychids, or Artiodactyls? Why?
3. Therefore, which do whales most likely share their most recent common ancestry with: Perissodactyls, Mesonychids, or Artiodactyls? Why?
4. So what does this change in our ideas about ancestry and what does it tell us about the nature of science?

# Whale Evolution

## DNA Analysis

Compare segments of beta-casein gene of Right Whale with each of the DNA Sequences. Shown here is Right Whale vs. Cow.

**Right Whale (a baleen Cetacean)**



AAT CCC CAA AGC TAA GGA GAC TAT CCT TCC TAA GCA TAA AGA AAT GCC CTT CCC TAT ATC  
 AGT CCC CAA AGT GAA GGA GAC TAT GGT TCC TAA GCA CAA GGA AAT GCC CTT CCC TAA ATA

**DNA Differences** – Compare the rest of your DNA sequences and write the number of differences in the table below.

RESULTS:

S.Whale										
Porpoise										
Giraffe										
Hippo										
Cow										
Camel										
Deer										
Pig										
Peccary										
Rhino										
	R.Whale	S.Whale	Porpoise	Giraffe	Hippo	Cow	Camel	Deer	Pig	Peccary

List the organism comparisons with fewer than 5 differences:

List the organism comparisons with seven differences

Remaining Species With Higher Numbers Means =

# Whale Evolution

1. What species are the most closely related and how do you know?
2. What species are the least related to each other and how do you know?
3. To which species are cetaceans (whales) most closely related and how do you know?

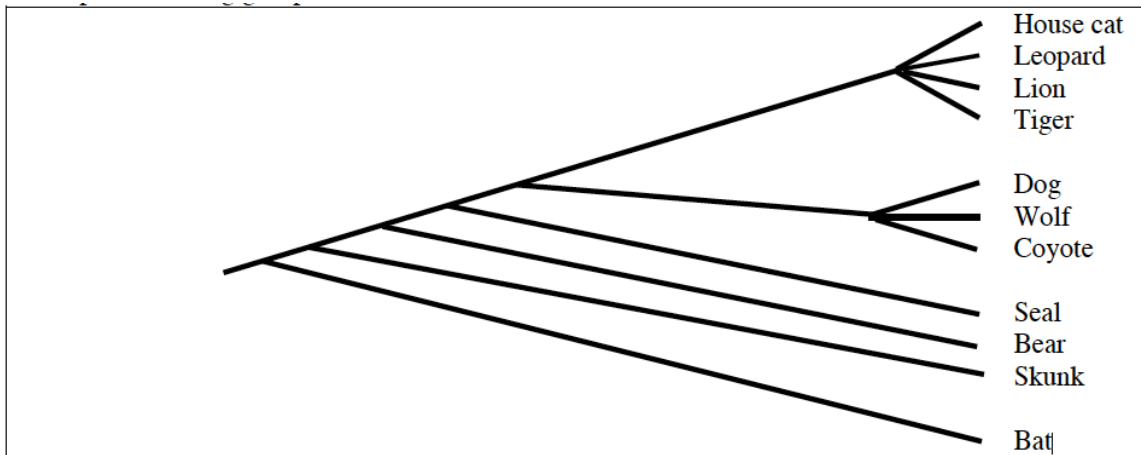


# Whale Evolution

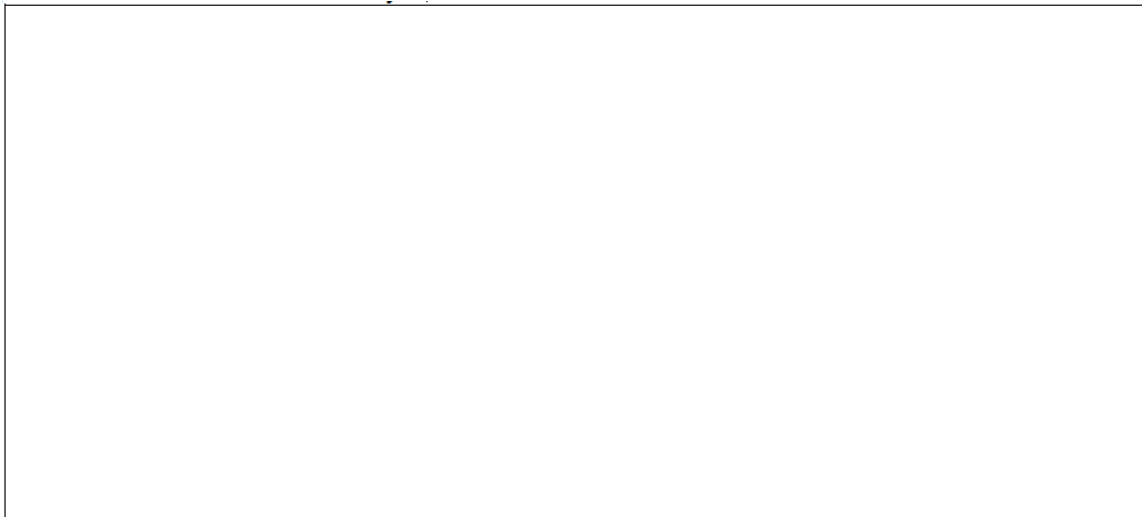
## Phylogenetic Tree – WHALES - Based on DNA Differences

Using the analysis you've made above, try drawing a "family tree" with all the species we've looked at here. Show short branches for closely related (recently branching) species, and longer branches for the more distantly related species. Label the common name for each species at the end of each branch. Most people find it easier to draw the tree as if it's lying on its side, with the "trunk" end to the left, and the shorter branches on the right. You might want to practice before drawing it in neatly in lower box.

Here's a sample tree, using groups of carnivores:



Family Tree for Cetaceans and Artiodactyls:



# Whale Evolution

## Whale Evolution Recap

Put notes below from board.