

Model 3 – Evolution

Activity 2

WHALES IN TRANSITION - DNA Activity

The plot thickens. We have narrowed the search for the origin of whales to a close connection with hooved mammals. The next question is: which one of the diverse members of that group are whales *most* closely aligned?

DNA to the rescue! As we learn the DNA sequences of more and more organisms, we can compare corresponding sequences to see which living species have DNA that is most alike. The more time that has passed (the more distant the ancestry) the more differences we will find.

You will be provided with eleven DNA segments from the gene for beta-casein, a milk protein found in all mammals. The segment is 60 base pairs (bp) long, from bp 141 to bp 200 in the gene. That same corresponding segment is presented for 11 species, including 3 Cetaceans: Right Whale, Sperm Whale, and a Porpoise; 7 Artiodactyls: a Giraffe, a Hippo, a Cow, a Camel, a Deer, Domestic Pig, and a Peccary; and one Perissodactyl: the Indian Rhino.

PROCEDURE:

Align the DNA segments from two species and count the number of places where the bases differ. For each pair of species compared, place the number of differences in the proper space on the grid 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

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WHALES IN TRANSITION - DNA Discussion

You will find that the numbers sort into two groups: Pairs with 2-4 differences, then pairs with 7-18 differences.

1. List the pairs of species with only 2-4 differences in their DNA (show number of differences for each pair)

2 Porpoise - Sperm Whale	3	3
3	3	4
3	3	4

- There are 4 species that are found in all possible combinations with each other. What are those species? (Give common names, as used on the strips):
- What does this suggest about how close those 4 species are related (or how relatively recent they branched from a common ancestry)?
- Then there are 3 species that are found in their own 3 possible combinations. What are those 3 species?
- What does this suggest about how close those 3 species are related (or how relatively recent they branched from a common ancestry)?
- Notice that there is a gap in the number of differences between pairs of DNA segments, showing none with 5-6 differences, and only one with 7 differences. What two species show 7 differences?
- What does that suggest about when those two species branched from each other relative to the other two groups previously discussed?
- The remaining pairings all range between 8 and 18 differences in this segment of DNA. What are the 2 remaining species that were not listed already?
- How do the 2 species in question 8 compare in common ancestry with,
 - Species in question 2? More recent, about the same, or earlier?
 - Species in question 4? More recent, about the same, or earlier?
 - Species in question 6? More recent, about the same, or earlier?

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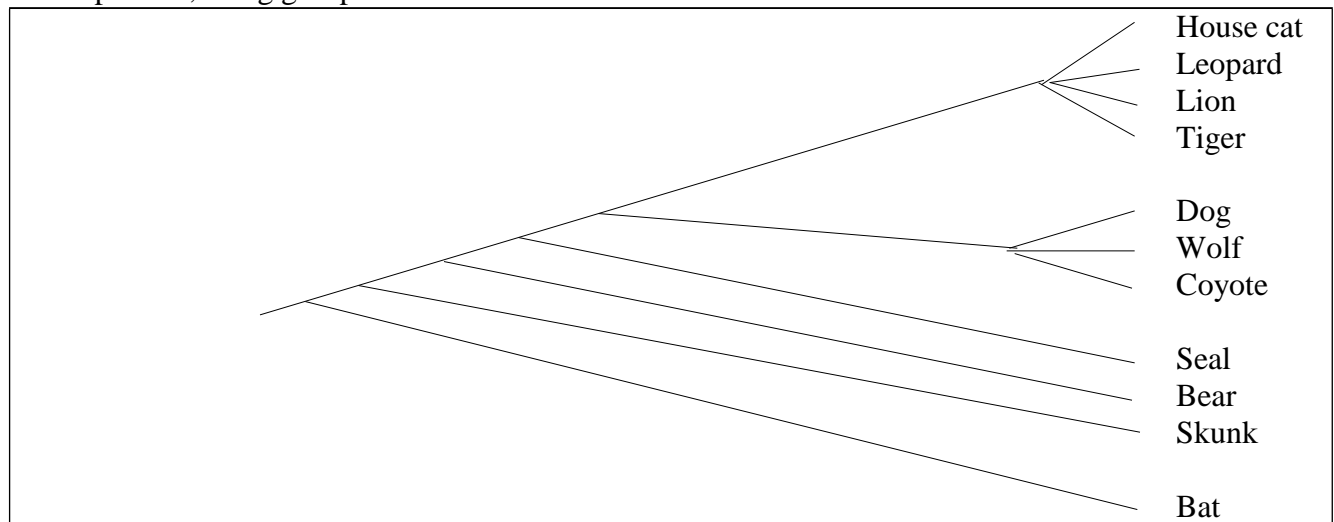
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10. As for our original question, to which species are cetaceans (whales) most closely related?

Comparing the specific numbers of differences between these last 4 species and those previous 7 species can be a little tricky, mainly because differences of 1-3 don't seem very significant, and the range is fairly wide (from 8 to 18, with no real gaps in the continuum). However, for our purposes, this isn't important.

11. 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:

