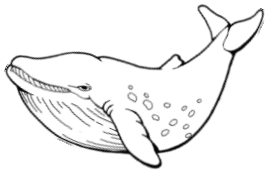
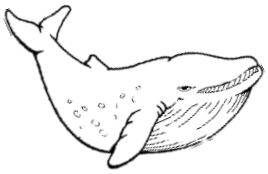


Whale Ancestry Lab

Analyzing DNA to Determine Relatedness



Name: _____ Date: _____ Block: _____

BACKGROUND INFORMATION:

There are several ways that scientists can determine how closely related different organisms are. By comparing similarities in **teeth, skulls, hooves, and ankle bones**, scientists were able to narrow the most likely candidate for the closest living relative of whales down to a group of organisms called **artiodactyls**. Artiodactyls are ungulates that have an **even** number of toes on each foot, and include such modern animals as cows, deer, giraffes, camels, pigs, and hippos. (Perissodactyls are ungulates with odd numbers of toes and include such animals as horses, zebras, and rhinos.)

Now that we have narrowed the search for whale origins to the group known as artiodactyls, the question becomes – **to which animal is the whale *most closely* related?** 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. As the DNA for a particular gene is **inherited** by new descendent species, and time passes, ***mutations*** can occur (replacements of former DNA bases by different bases), many without any significant effect. The more distant the ancestry, the more mutations will have occurred, and the more differences we will find in the DNA of the organisms.

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. The Rhino serves as a basis for comparison as an "outgroup."

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 place in the grid provided.

WHALE DNA ANALYSIS:

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) in the table below.

2 Porpoise/ Sperm Whale	3	3
3	3	4
3	3	4 Cow/ Deer

2. Based on the table you just created, notice that there are 4 species that are found in all possible combinations with each other. List the four species.

3. What might that suggest about how closely related those 4 species are? Or how recently they branched from a common ancestry?

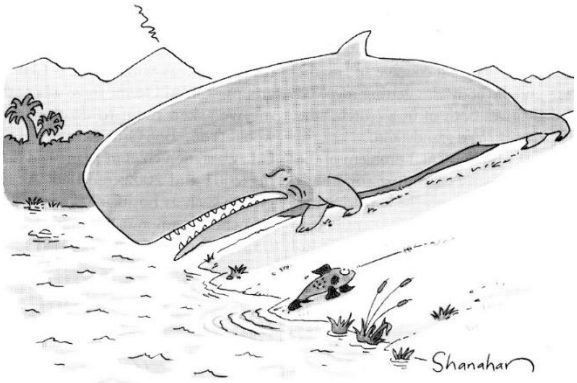
4. Notice that there is a gap in the number of differences in the DNA sequences, showing none with 5-7 differences, and only one with 7 base pairs difference. Which two species show 7 base pair differences?

5. What might that suggest about when those two species branched from each other, relative to the group previously discussed?

6. The remaining pairings all range between 8-18 base pair differences in this segment of DNA.
   a. Based on these sequences, to which other animal are our two whale species most closely related? _____

   b. What is the closest living land relative? _____

   c. What might the answer to #6(b) suggest about the origin of whales?



"It's all yours."