

1. Find the human, rhesus monkey, kangaroo, snapping turtle, bullfrog, and tuna on the "Amino Acid Sequences in Cytochrome-C Proteins from 20 Different Species" chart and underline their names. (Cytochrome-c is a small protein found on the inner membrane of the mitochondria).

2. Compare the human amino acid sequence with each of these five animals by counting the number of times an amino acid in that animals' cytochrome-c is different from the amino acid in that same position of the human sequence. For examples, the number of differences between human and dog is 10.

Write the information below:

Number of amino acid differences between human and:

a. Rhesus Monkey = _____

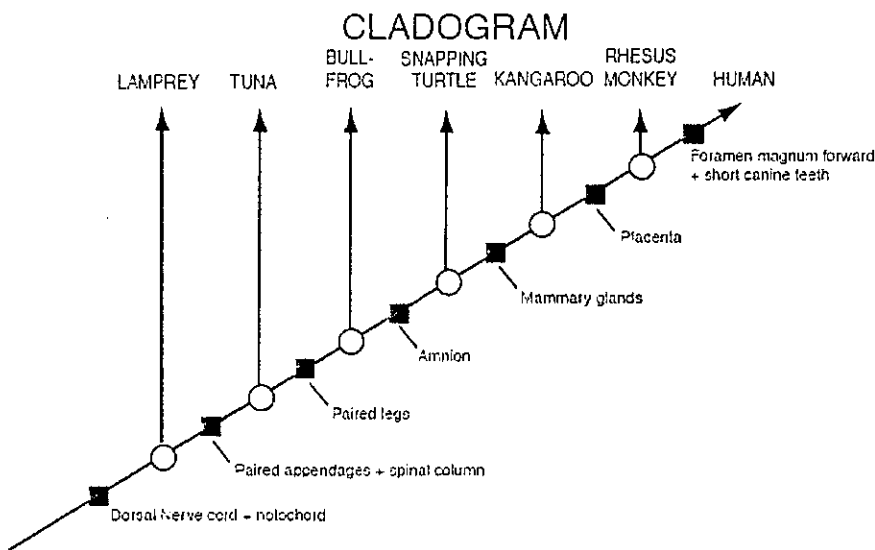
b. Kangaroo = _____

c. Snapping Turtle = _____

d) Bullfrog = _____

e) Tuna = _____

3. The cladogram diagram below shows the relationship of selected animals based on their shared anatomical features. For example, out of seven key traits, all of these animals have a dorsal nerve cord, but only humans, monkeys and kangaroos have mammary glands.



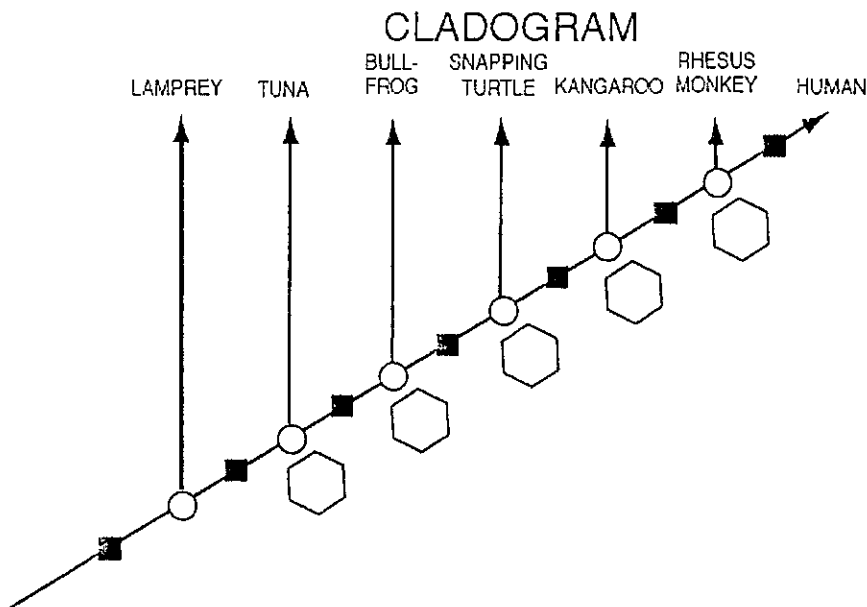
a) Out of the seven traits (indicated by the solid square), what trait is common to all of the animals listed above?

b) What traits are common between the snapping turtle and the rhesus monkey?

c) What traits on the cladogram do all of the mammals have in common?

d) What traits do only humans have?

4. Record the total number of amino acid differences between humans and each animal shown below. Write your answer in the hexagon below the arrow pointing to the name of that animal.



5. Does the data from the amino acid sequence generally agree with the anatomical data that was used to make the cladogram? Explain.

6. a) Do organisms with fewer shared anatomical traits also have more amino acid differences?

b) Choose another mammal on the amino acid sequence chart and compare the shared anatomical traits and the amino acid differences. Does it fit with your answer above?

7. Based on the molecular data, how does the "human-monkey" relationship compare to the "duck-chicken" relationship? (Which shows three amino acid differences?)

8. If the molecular data, the structural similarities, and the fossil record all support the same pattern of relationships, can we be fairly confident that the pattern is accurate? Why or why not?

9. Chickens and turkeys are both birds and have the same sequence of amino acids in their cytochrome-c protein. Explain how two species can have identical cytochrome-c and still be different species.

10. *Neurospora* (bread mold) and *Saccharomyces* (bakers yeast) are both fungi. Chickens and turkeys are both birds. What can you say about the inferred evolutionary relationships between the two birds compared to the relationship between the two fungi? Explain your reasoning.

11. Write a short summary on the important information that can be obtained from cladograms (not the information used to make them).