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### CLADOGRAM ANALYSIS

What is a cladogram? It is a diagram that depicts evolutionary relationships among groups. It is based on **PHYLOGENY**, which is the study of evolutionary relationships. Sometimes a cladogram is called a phylogenetic tree (though technically, there are minor differences between the two).

In the past, biologists would group organisms based solely on their physical appearance. Today, with the advances in genetics and biochemistry, biologists can look more closely at individuals to discover their pattern of evolution, and group them accordingly - this strategy is called **EVOLUTIONARY CLASSIFICATION**

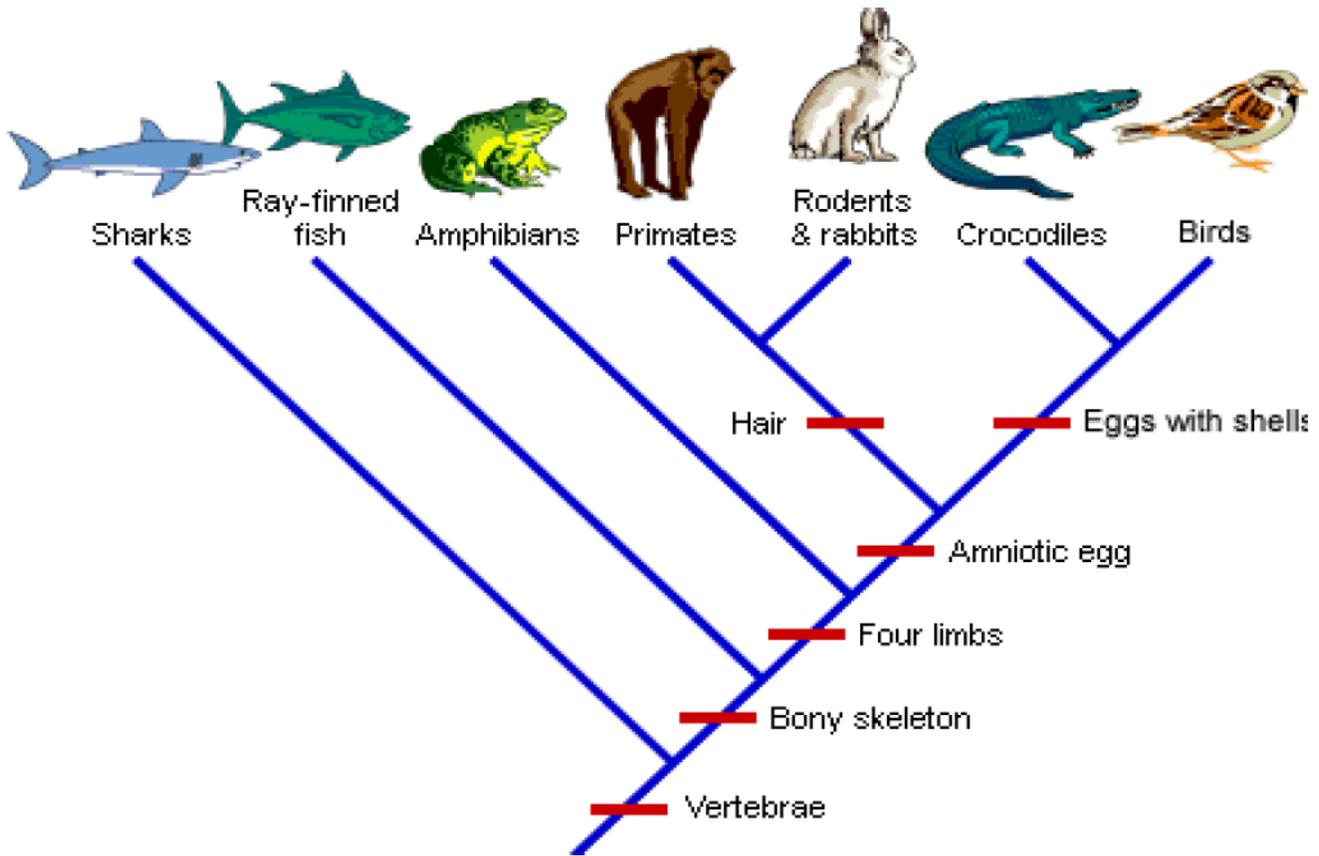
**CLADISTICS** is form of analysis that looks at features of organisms that are considered "innovations", or newer features that serve some kind of purpose. (Think about what the word "innovation" means in regular language.) These characteristics appear in later organisms but not earlier ones and are called **DERIVED CHARACTERS**.

**Fill out the following character matrix. Mark an "X" if an organism has the trait.**

	Cells	Legs	Antenna	Wings	2 sets of wings
Worm	X				
Spider	X	X			
Carpenter Ant	X	X	X		
House fly	X	X	X	X	
Dragonfly	X	X	X	X	X

**In the box below, create a cladogram based off your matrix.**

Use the following cladogram to answer the questions below.



8. What separates rabbits/primate from the crocodiles on this cladogram?

Hair and Shelled Eggs

9. Which organism is most related to the rodents and rabbits on this cladogram?

Primates

10. What 5 traits do the bird and its closest relative share?

a.

b.

Eggs with shells, Amniotic Egg, Four Limbs, Bony Skeleton, Vertebrae

c.

d.

e.

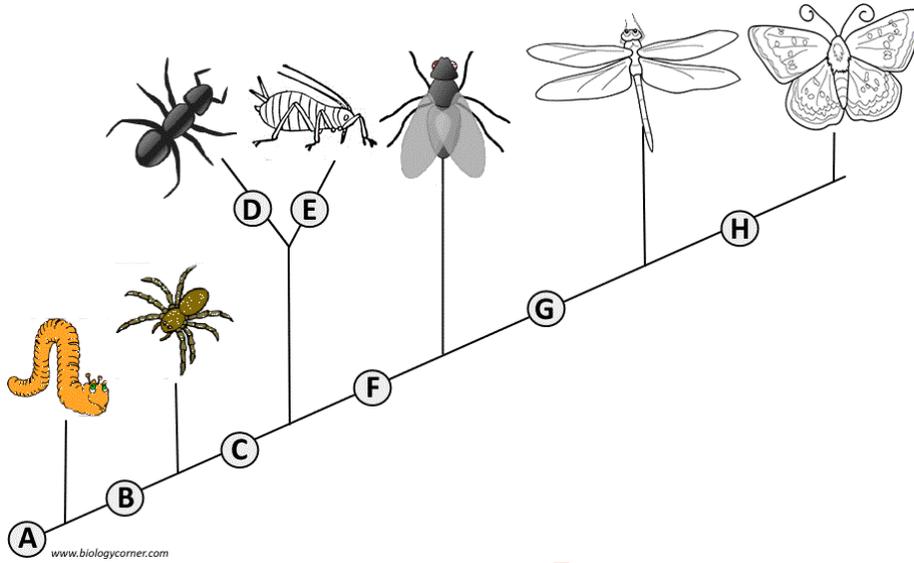
11. Which organism will have DNA most similar to the bird? **Why?**

Crocodile. Most recent divergent (remember - upward in time!) and most shared derived characters

12. Which organism's DNA will differ the most from the bird? **Why?**

Sharks - Diverged from a common ancestor long ago. Lots of change and speciation events in between (as seen by nodes)

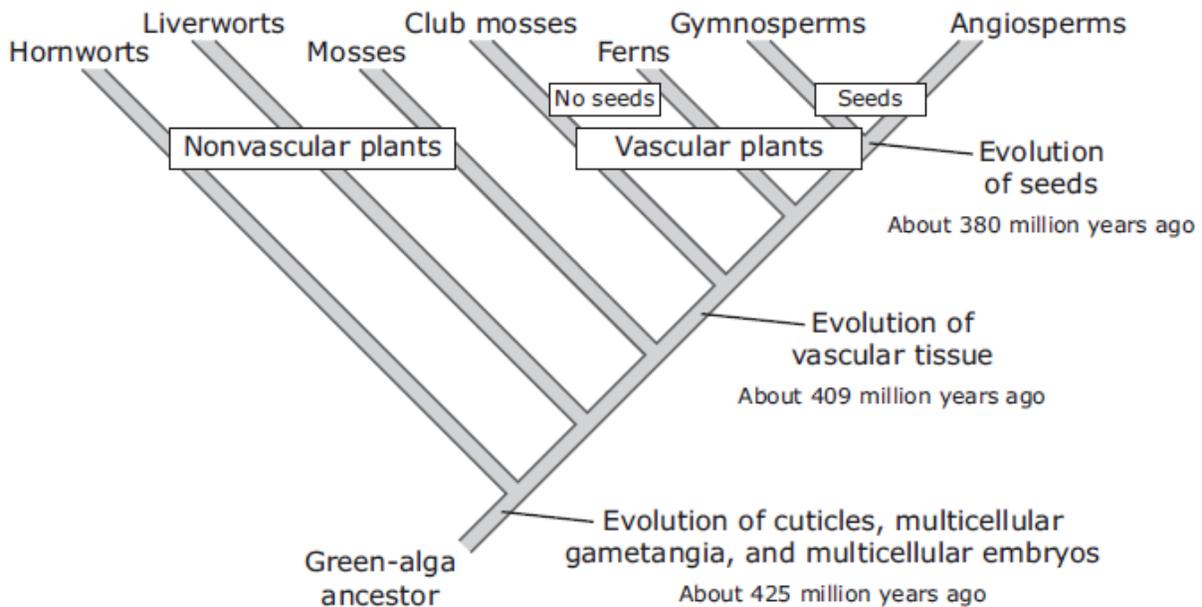
Examine the cladogram below. Each letter represents a derived characteristic. Match the letter to its characteristic.



- |                                  |                                      |
|----------------------------------|--------------------------------------|
| 13. <u>F</u> Wings               | 17. <u>E</u> Cerci (back appendages) |
| 14. <u>C</u> 6 legs              | 18. <u>D</u> Crushing mouthparts     |
| 15. <u>A</u> Segmented Body      | 19. <u>B</u> Legs                    |
| 16. <u>G</u> Double set of wings | 20. <u>H</u> Curly Antennae          |

Circle the correct answer for the cladogram question below.

The cladogram shows the evolution of land plants as indicated by fossil records.



21. Which discovery would challenge the validity of this cladogram?

- A. A large aquatic vascular plant about 200 million years old
- B. A species of algae that has existed for less than one million years
- C. A moss species that has existed for less than 380 million years
- D. A fossil of a fern more than 425 million years old

D - Derived Character (Vascular Tissue) evolved 209 million years ago. Ferns have this trait.

Biologically, one could use anatomical features, behavior, or molecular similarities and differences in constructing a cladogram. Molecularly, one could look at the number of mutations in a common strand of DNA. Another way would be to compare strings of amino acids and note differences in the order of the amino acids.

Cytochrome c is a protein located in the mitochondria of cells involved with cellular respiration. Below is a table showing the amino acid sequences for cytochrome c in several organisms.

Organism	Biochemical Data
Amoeba	Amino Acid Sequence: ISO-SER-ASP-GLN-PHE-ILE-LEU-GLN-SER-ARG-LEU-LEU-HIS DNA Sequence: ATTAGCGACCAGTTTATCCTACAATCCCGTCTACTTCAT
Kangaroo	Amino Acid Sequence: LEU-ISO-PRO-PRO-PHE-ILE-LEU-LEU-SER-HIS-LEU-LEU-SER DNA Sequence: CTAATCCCCCGTTTATCCTACTTTCCCATCTACTAAGT
Earthworm	Amino Acid Sequence: LEU-ISO-ASP-PRO-PHE-ILE-LEU-HIS-SER-ARG-LEU-LEU-ARG DNA Sequence: CTTATCGACCCGTTTATCCTACATTCCCGTCTACCTTCGT
Cat	Amino Acid Sequence: LEU-ISO-PRO-PRO-PHE-ILE-LEU-LEU-SER-HIS-LEU-LEU-SER DNA Sequence: TTAATCCCCCGTTTATCCTACTTTCCCATCTACTAAGT
Shark	Amino Acid Sequence: LEU-ISO-PRO-PRO-PHE-ILE-LEU-LEU-SER-ARG-LEU-LEU-ARG DNA Sequence: CTTATCCCCCGTTTATCCTACTTTCCCGTCTACTTCGT
Dolphin	Amino Acid Sequence: LEU-ISO-PRO-PRO-PHE-ILE-LEU-LEU-SER-HIS-VAL-VAL-SER DNA Sequence: CTAATCCCCCGTTTATCCTACTTTCCCATGTAGTAAGT
Lizard	Amino Acid Sequence: LEU-ISO-PRO-PRO-PHE-ILE-LEU-LEU-SER-ARG-LEU-LEU-ARG DNA Sequence: CTAATCCCCCGTTTATCCTACTTTCCCGTCTACTTCGT
Sponge	Amino Acid Sequence: ISO-ISO-ASP-GLN-PHE-ILE-LEU-HIS-SER-ARG-LEU-LEU-ARG DNA Sequence: ATTATCGACCAGTTTATCCTACATTCCCGTCTACTTCGT

22. The more amino acids that an organism has in common, both type and order, indicates the closer the relationship. The same is true for nucleotides. Compare the biochemical data above. Which organism is most closely related to the lizard? Why?

Shark - All same amino acid chain. Fewest nucleotide differences.

23. Which organism is most closely related to the Dolphin? Why?

Kangaroo - Kangaroo and Cat have 2 amino acid differences with a dolphin, but there are only 2 nucleotide differences with a kangaroo.

24. How do you think different amino acid sequences would effect organisms? Explain your answer.

Amino acid chains = proteins. Proteins create all traits we see. Differences in amino acids chains can lead to differences in a protein (in shape and function). This could alter the trait they code for. For example, the protein may not be functional if the amino acid sequence is changed. It could lead to positive, neutral, or negative changes. More on mutation and DNA in the future units - any change to DNA is called a mutation. You can see, some nucleotides are different (i.e. CTA vs CTT) but produce the same amino acid. Where as some do cause change.

On the first quiz, I will not ask you about mutation.