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.

<table>
<thead>
<tr>
<th></th>
<th>Cells</th>
<th>Legs</th>
<th>Antenna</th>
<th>Wings</th>
<th>2 sets of wings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worm</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spider</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpenter Ant</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>House fly</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Dragonfly</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

| JUNEBUGS       | x     | x    | x       | x     | x               |

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

1. Start with a timeline: oldest organisms on the bottom left, newest on the top right.
2. Use your derived characters to show the appearance of new species carrying that trait in your timeline.
3. Remember: your derived characters are cumulative!
4. Show each new species branching off to the left and up in your timeline. Name each species.
1. According to your cladogram, which two species are more closely related: worms and spiders or worms and ants? **How do you know?**

   Worms and spiders are more closely related. They have more traits in common.

2. According to your cladogram, what species are dragonflies most closely related to? **How do you know?**

   Dragonflies are closely related to the flies. They have more traits in common.

3. In a different colored writing utensil, add a June Bug to your cladogram based on its characteristics.

   **Use the following cladogram to answer the questions below.**

4. What trait separates lampreys from tuna on this cladogram? **JAWS**

5. What separates a salamander from a turtle? **AMNIOTIC EGG**

6. Which organism is most related to the leopard? **TURTLE**

7. Which organism’s DNA will differ the most from the leopard? **Why?**

   THE LANCELET’S DNA. IT’S THE ORGANISMS WITH LEAST TRAITS IN COMMON AND FARTHEST IN THE CLADOGRAM.
8. What separates rabbits/primate from the crocodiles on this cladogram?

EGGS WITH SHELLS

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. EGGS WITH SHELL
   b. AMNIOTIC EGG
   c. FOUR LIMBS
   d. BONY SKELETON
   e. VERTEBRAE

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

   CROCODILE. LARGEST NO. OF TRAITS. ALSO CLOSE PROXIMITY IN CLADOGRAM.

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

   SHARKS HAVE THE LEAST TRAITS IN COMMON WITH BIRDS. ALSO FARthest IN CLADOGRAM.
Examine the cladogram below. Each letter represents a derived characteristic. Match the letter to its characteristic.

13.  _______  Wings
14.  _______  6 legs
15.  _______  Segmented Body
16.  _______  Double set of wings
17.  _______  Cerci (back appendages)
18.  _______  Crushing mouthparts
19.  _______  Legs
20.  _______  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
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.

<table>
<thead>
<tr>
<th>Organism</th>
<th>Biochemical Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kangaroo</td>
<td>Amino Acid Sequence: LEU-ISO-PRO-PHE-ILE-LEU-GLN-SER-LEU-SER DNA Sequence: CTAATCCCCCGTTTATCCTACTTTCCCATCTACTAAGT</td>
</tr>
<tr>
<td>Earthworm</td>
<td>Amino Acid Sequence: LEU-ISO-ASP-PRO-PHE-ILE-LEU-HIS-ARG-LEU-ARG DNA Sequence: CTTATCGACCCGTTTATCCTACTTTCCCATCTACTAAGT</td>
</tr>
<tr>
<td>Cat</td>
<td>Amino Acid Sequence: LEU-ISO-PRO-PHE-ILE-LEU-LEU-LEU-SER-HIS-LEU-LEU DNA Sequence: TTAATCCCCCCGTTTATCCTACTTTCCCATCTACTAAGT</td>
</tr>
<tr>
<td>Shark</td>
<td>Amino Acid Sequence: LEU-ISO-PRO-PHE-ILE-LEU-LEU-LEU-SER-HIS-VAL-VAL-SER DNA Sequence: CTTATCCCCCGTTTATCCTACTTTCCCATGTAGTAAGT</td>
</tr>
</tbody>
</table>

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. LARGEST NO. OF SIMILAR AMINO ACIDS IN ORDER.**

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

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

**THE SEQUENCE OF AMINO ACIDS IN A PROTEIN DETERMINE ITS FUNCTION. THE MORE SIMILAR THE SEQUENCE BETWEEN TWO ORGANISMS, THE MORE SIMILAR THE FUNCTION OF THEIR PROTEIN, THE MORE SIMILAR THEIR FUNCTION IN EACH ORGANISM.**