CLADOGRAM ANALYSIS

Background Information: A cladogram is a diagram that shows evolutionary relationships among groups. It is based on phylogeny, which is the study of evolutionary relationships. 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 **E Volutionary Classification**. Cladistics is a form of analysis that looks at features of organisms that are considered "innovations", or newer features that serve some kind of purpose. These characteristics appear in later organisms but not earlier ones and are called derived characters.

Pre-lab Questions: Use the following word bank to identify the descriptions by writing the correct term on the line. Not all words will be used:

<table>
<thead>
<tr>
<th>Derived characters</th>
<th>Cladogram</th>
<th>Cladistics</th>
<th>Phylogeny</th>
<th>Derived characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Characteristics that appear in recent parts of a lineage but not in its older members.</td>
<td>2. A diagram of the evolutionary relationships among organisms</td>
<td>3. The study of evolutionary relationships among organisms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PART I - Analyze the Cladogram
Examine the sample cladogram below. Each letter on the diagram points to a derived character, or something different (or newer) than what was seen in previous groups. Derived characters that are on the main, bottom line are found in all the organisms after that point. If a derived character is not found in all the later organisms, it is located above the main lower line, on a separate branch. For questions 1-8, match each letter on the cladogram to its character. **Note: this cladogram was created for simplicity and understanding; it does not represent the established phylogeny for insects and their relatives.**

1. __ F __ Wings
2. __ C __ 6 Legs
3. __ A __ Segmented Body
4. __ G __ Double set of wings
5. __ E __ Cerci (pair of appendages at rear end)
6. __ D __ Crushing/pinching mouthparts
7. __ B __ Legs
8. __ H __ Curly Antennae

9. Why aren’t letters “D” and “E” located on the bottom line where all the other letters are located? **Those derived characters are not found in all the organisms after that point.**
**PART II - Create Your Own Cladogram**

To make a cladogram, you must first look at the animals you are studying and establish characteristics that they share and ones that are unique to each group.

1. For the animals in the table below, **indicate** which animals have the characteristics by marking an “X” in each box if an organism has that trait.

2. Based on that chart, **create** a cladogram with the animals in the correct order.

3. **Label** the animal names at the top of the cladogram branches and **label** the derived characters at the bottom of the cladogram, like the samples in your notes.

<table>
<thead>
<tr>
<th></th>
<th>Cells</th>
<th>Legs</th>
<th>6 Legs</th>
<th>Wings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worm</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spider</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ant</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Fly</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**DRAWING OF YOUR CLADOGRAM:**

4. According to your cladogram, which two species are more closely related (circle your answer): **worms and spiders** OR **worms and ants**

Cite evidence to support your answer: **There is only 1 derived character difference between worms and spiders (Legs)**

5. According to your cladogram, what species are flies most closely related to? **Ants**

Cite evidence to support your answer: **Ants and flies are next to each other with only 1 derived character difference between them (wings)**

**PART III – Create Another Cladogram**

1. Fill in the DATA TABLE below by placing an “X” in the box if the animal has the characteristic:

<table>
<thead>
<tr>
<th>Animal</th>
<th>Jaws</th>
<th>Lungs</th>
<th>Claws / Nails</th>
<th>Feathers</th>
<th>Fur and mammary glands</th>
<th>TOTAL Number of X’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lizard</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Hagfish</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Perch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Mouse</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Chimpanzee</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Pigeon</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Salamander</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
2. Using the Subset Diagram of the grouping just completed (as a guide), label the Cladogram below to illustrate the ancestry of these 7 animals in the correct order. The diagram should reflect all the derived characteristics from the data table, including feathers.

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hagfish     perch     salamander     lizard     pigeon     mouse     chimp
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3. According to your cladogram, which two species are more closely related (circle your answer):
   perch and lizard OR hagfish and lizard
Cite evidence to support your answer: There are only 2 derived character differences between perch and lizard and there are 3 between hagfish and lizard

4. Look at the total number of X’s for each animal. What trend occurs with this number as you compare it to the order of animals in the cladogram? The number of X’s increases as you move left to right in order of the animals (0,1,2,3,4,4,4 X’s)

Part IV - Summary
1. Explain three types of information which can be obtained from a cladogram:

   A Cladogram shows: how organisms are related to each other
   ___________________________ the likely order of evolution for the included species
   ___________________________ the derived characters shared by the included species

2. Three previously unknown vertebrates have been discovered in a rain forest in South America. One animal is very similar to an iguana lizard. The second animal resembles a large rat. The third is similar to a goldfish. Label the cladogram below “Iguana-like,” “Rat-like,” and “Goldfish-like” in the appropriate place and answer the question below.

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    “Goldfish-like”  “Iguana-like”  “Rat-like”
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Explain the reason for placing each animal where you did:
Answers may vary but should place them in order based on similar Species and derived characters discussed in the lab.