WLHS/Biology/Oppelt

Name _____

# Cladograms and Evolutionary Relationships

**Part A: Background on Cladograms and Phylogeny**
Read pages 516- in your biology textbook and answer the following questions.

1. What is phylogeny? What did early classification systems reflect in organism's relationships?

2. Define clade:

3. Describe how cladograms are similar pedigrees.

4. What are derived characters?

**Part B: Using Cladograms to Show Relationships**
Refer to Figure 18-9 in your text book

1. Sketch the cladogram in Figure 18-9 in the space below.

2. What is a node?

3. How many traits does the marsupial share with :
Reptiles _____ Dogs_____ Cats _____

4. Traits that evolved very early, such as four limbs are called **primitive traits**. The traits that evolved later, such as the retractable claws, are called **derived traits**.
   a. Are primitive traits typical of broader or smaller clades? Give an example _____
   b. Are derived traits typical of broader or smaller clades? Give an example _____

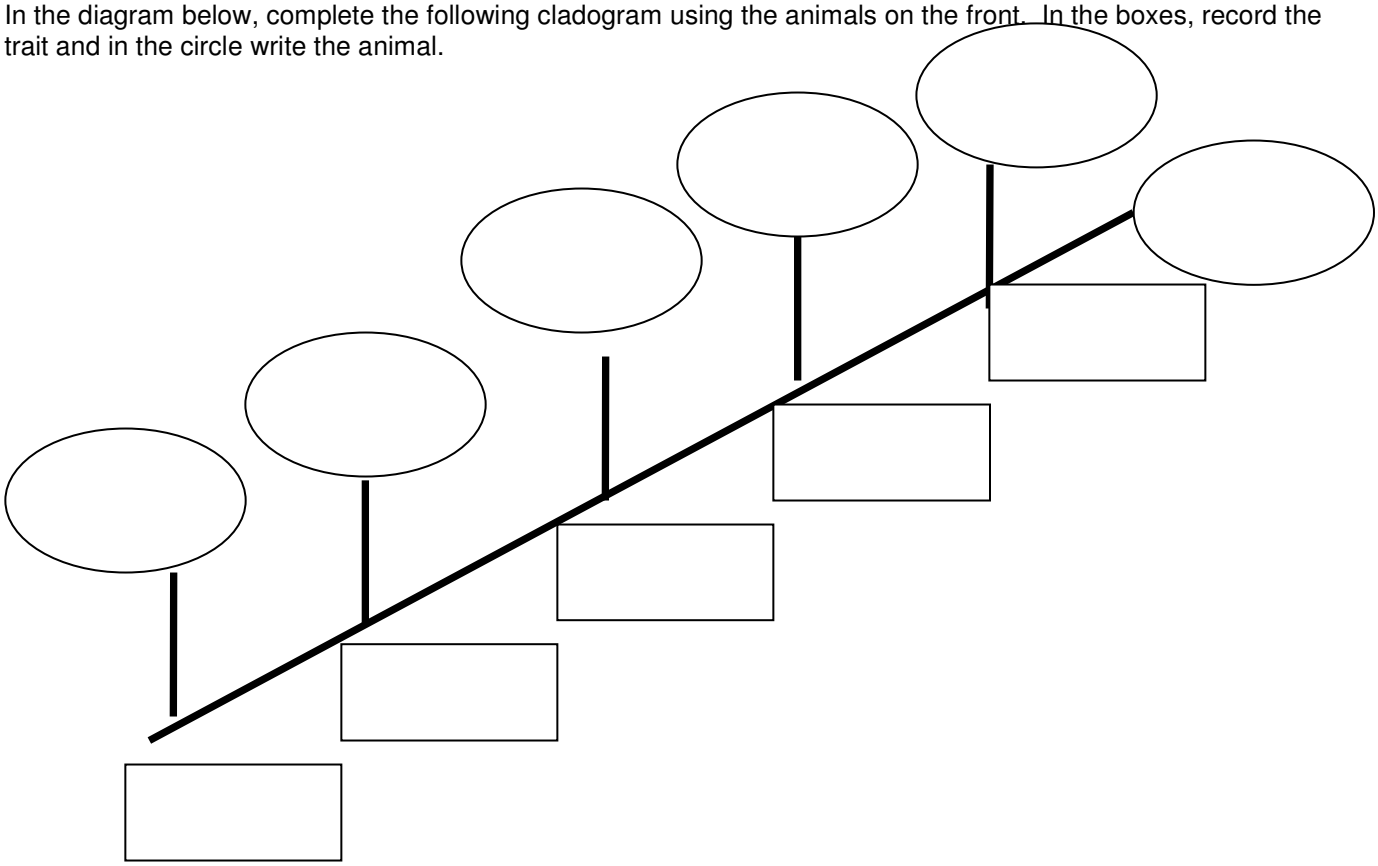
**Part C. Another practice cladogram**

Study the table below, and use the information to construct a cladogram based on the derived traits of a modern bird. Note: In the table below, an "X" means that the organism has the trait.

| | **Derived Characteristics** | | | | |
|---|---|---|---|---|---|
| Animal | Light bones | 3-toed foot | Down feathers | Feathers w/ veins | Flight feathers |
| Allosaurus | **X** | | | | |
| Archaeopteryx | **X** | **X** | **X** | **X** | |
| Robin | **X** | **X** | **X** | **X** | **X** |
| Sinornis | **X** | **X** | | | |
| Theropod | | | | | |
| Velociraptor | **X** | **X** | **X** | | |

1. Which animal has all of the derived traits? _____
2. What is the least common derived trait? _____

In the diagram below, complete the following cladogram using the animals on the front. In the boxes, record the trait and in the circle write the animal.



**Part D. Using Amino Acid Sequences to Show Evolutionary Relationships: Introduction**

With advances in molecular biology, scientists are able to take a closer look at similarities among organisms and to look for evolutionary relationships at the molecular level. The amino acid sequence of a protein can be examined in much the same way as the derived traits shown in the previous sections, and a cladogram can be constructed based on the number of differences in the sequences.

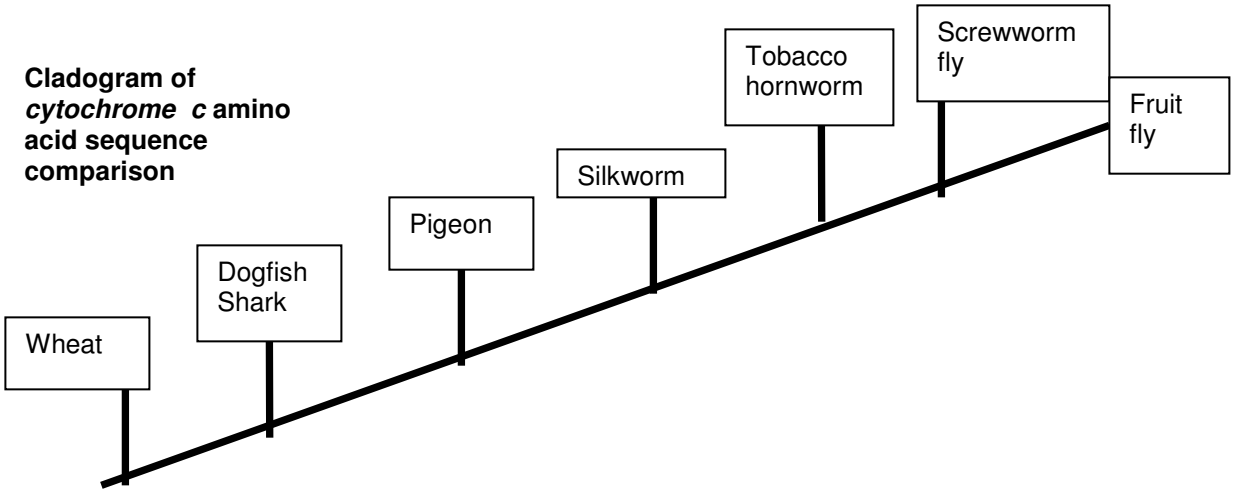
Examine the data table below, which shows the number of differences in the amino acid sequence of a protein called **cytochrome c** between fruit flies and other organisms, and the cladogram made from it (on the next page).

| Species | # of amino acid differences from fruit fly |
|---|---|
| Dogfish shark | 26 |
| Pigeon | 25 |
| Screwworm fly | 2 |
| Silkworm | 15 |
| Tobacco hornworm | 14 |
| Wheat | 47 |

1. As you move from left to right in this cladogram, what happens to the number of difference amino acid sequences?

2. Which species is most closely related to the fruit fly?

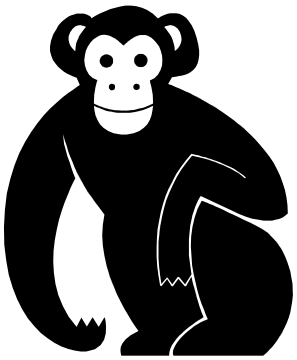
**Cladogram of *cytochrome c* amino acid sequence comparison**



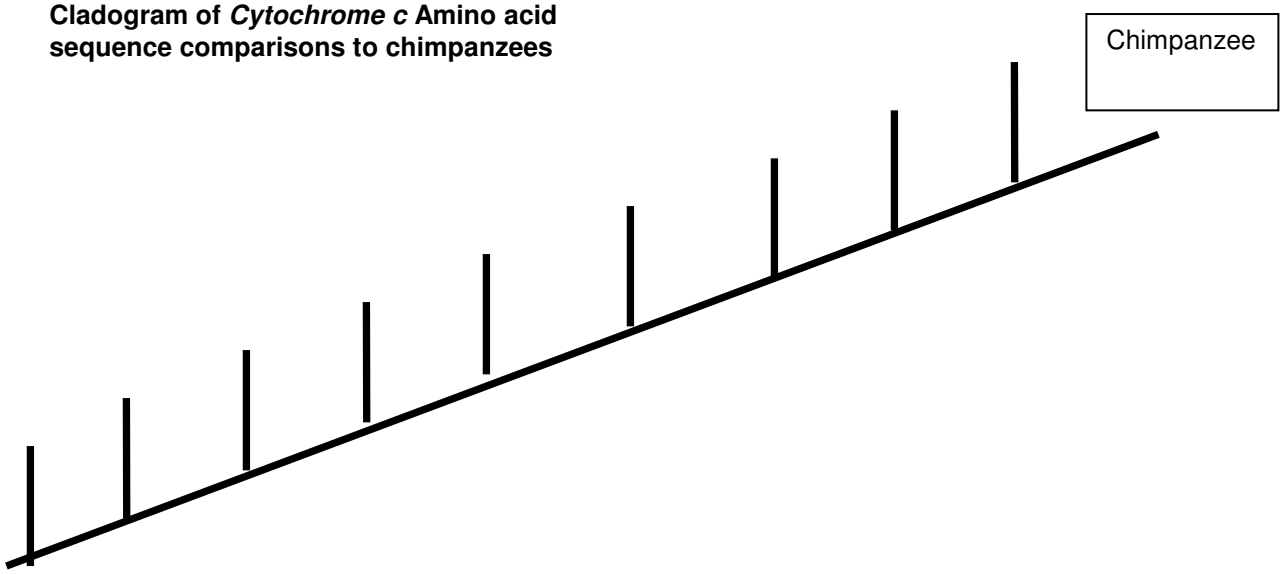

**Part E. Practice Amino Acid Cladogram**

Now you will practice constructing a cladogram based on the amino acid differences in cytochrome c between chimpanzees and other animals. Use the data table to construct your cladogram. Your cladogram should look similar to the one above when you are finished.

| Species | # of amino acid differences from fruit fly |
|---|---|
| Fruit Fly | 29 |
| Horse | 12 |
| Rattlesnake | 14 |
| Red Bread Mold | 48 |
| Rhesus monkey | 1 |
| Screwworm fly | 27 |
| Snapping Turtle | 15 |
| Tuna | 21 |
| Wheat | 43 |



**Cladogram of *Cytochrome c* Amino acid sequence comparisons to chimpanzees**



**Part F. On your own!**

Now you are ready to construct a cladogram from amino acids. Follow the procedure below.

1. Examine the amino acid relationship for part of the hemoglobin in the table below. You will be comparing the other animals to human beings and determining cladistic relationships between them. Circle any differences in the amino acid sequence between the animals and humans.

| Species | AMINO ACID SEQUENCE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Human | THR | LEU | SER | GLU | LEU | HIS | CYS | ASP | LYS | LEU | HIS | VAL | ASP | PRO | GLU | ASN | PHE | ARG | LEU | LEU | GLY | ASN | VAL | LEU | VAL | CYS | VAL | LEU | ALA | HIS |
| Gorilla | THR | LEU | SER | GLU | LEU | HIS | CYS | ASP | LYS | LEU | HIS | VAL | ASP | PRO | GLU | ASN | PHE | LYS | LEU | LEU | GLY | ASN | VAL | LEU | VAL | CYS | VAL | LEU | ALA | HIS |
| Horse | ALA | LEU | SER | GLU | LEU | HIS | CYS | ASP | LYS | LEU | HIS | VAL | ASP | PRO | GLU | ASN | PHE | ARG | LEU | LEU | GLY | ASN | VAL | LEU | ALA | LEU | VAL | VAL | ALA | HIS |
| Kangroo | LYS | LEU | SER | GLU | LEU | HIS | CYS | ASP | LYS | LEU | HIS | VAL | ASP | PRO | GLU | ASN | PHE | LYS | LEU | LEU | GLY | ASN | ILE | ILE | VAL | ILE | CYS | LEU | ALA | GLU |
| Rhesus Monkey | GLN | LEU | SER | GLU | LEU | HIS | CYS | ASP | LYS | LEU | HIS | VAL | ASP | PRO | GLU | ASN | PHE | LYS | LEU | LEU | GLY | ASN | VAL | LEU | VAL | CYS | VAL | LEU | ALA | HIS |

2. Add up the total differences for each species and complete the table below.

| Species | # of amino acid differences from human |
|---|---|
| Gorilla | |
| Horse | |
| Kangaroo | |
| Rhesus monkey | |

3. Construct a cladogram in the box below

4. Based on the hemoglobin data above, which animal is most closely related to humans? Explain your answer.

5. Based on the hemoglobin data above, which animal is least closely related to humans? Explain your answer.

6. Similarities in amino acid sequence between organisms, means that there will also be similarities in DNA sequence. Why?