MAKING CLADOGRAMS: Background and Procedures
Phylogeny, Evolution, and Comparative Anatomy

A. Concept: Modern classification is based on evolution theory.

B. Background: One way to discover how groups of organisms are related to each other (phylogeny) is to compare the anatomical structures (body organs and parts) of many different organisms. Corresponding organs and other body parts that are alike in basic structure and origin are said to be homologous structures (for example, the front legs of a horse, wings of a bird, flippers of a whale, and the arms of a person are all homologous to each other). When different organisms share a large number of homologous structures, it is considered strong evidence that they are related to each other. When organisms are related to each other, it means they must have had a common ancestor at some time in the past. If there are specific modifications of those features shared by different groups of organisms, we say that those features are "shared derived characters".

When we do studies in comparative anatomy, and find different numbers of shared derived characters exist between different groups, we can draw a diagram of branching lines which connect those groups, showing their different degrees of relationship. These diagrams look like trees and are called "phylogenetic trees" or "cladograms" (CLAY-doe-grams); see examples provided by your teacher. The organisms are at the tips of the stems. The shared derived features of the homologous structures are shown on the cladogram by solid square boxes along the branches, and common ancestors are shown by open circles. The more derived structures two organisms share, the closer is their evolutionary relationship -- that is, the more recently their common ancestor lived. On the cladogram, close relationships are shown by a recent fork from the supporting branch. The closer the fork in the branch between two organisms, the closer is their relationship.

C. Objectives: Given some groups of organisms and some of their distinguishing characteristics, you will construct a cladogram, and properly interpret and analyze that cladogram in terms of how it shows common ancestry and degrees of evolutionary relationship.

D. Procedure:
Step 1. Using your textbook and the explanations below, determine which of the characteristics each animal has. In the Data Table provided (on your Cladogram Worksheet), place an "x" in the box if the animal has the characteristic.

Explanations of Characteristics:

set #1:   Dorsal nerve cord (running along the back or "dorsal" body surface)
          Notochord (a flexible but supporting cartilage-like rod running along the back or "dorsal" surface)

set #2:   Paired appendages (legs, arms, wings, fins, flippers, antennae)
          Vertebral column ("backbone")

set #3:   Paired legs

set #4:   Amnion (a membrane that holds in the amniotic fluid surrounding the embryo; may or may not be inside an egg shell)

set #5:   Mammary glands (milk-secreting glands that nourish the young)

set #6:   Placenta (structure attached to inside of uterus of mother, and joined to the embryo by the umbilical cord; provides nourishment and oxygen to the embryo)

set #7:   Canine teeth short (same length as other teeth)
          Foramen magnum forward (spinal cord opening, located forward, under skull)

1

Step 2: Below the Data Table on your Worksheet, make a <u>Venn diagram</u>, placing your seven animals in groups to illustrate those characteristics which different animals have in common. See example below:

Human: Foramen magnum forward

Horse: Placenta

Tuna: Backbone
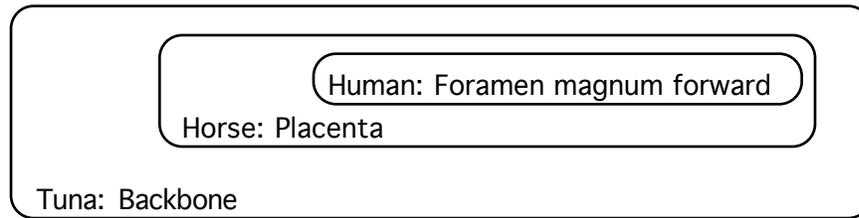
Step 3: Using the Venn diagram of the groupings just completed (as a guide), draw a <u>cladogram</u> on the <u>back</u> of your <u>Worksheet</u> to illustrate the ancestry of these animals. The diagram should reflect shared characteristics as time proceeds. An example is shown below. Notice how the different animals are all at the same time level (across the top) since they all live today.

Example of Cladogram

TUNA   HORSE   HUMAN

TIME

Foramen magnum forward

Placenta

Backbone

\# OF SHARED CHARACTERISTICS
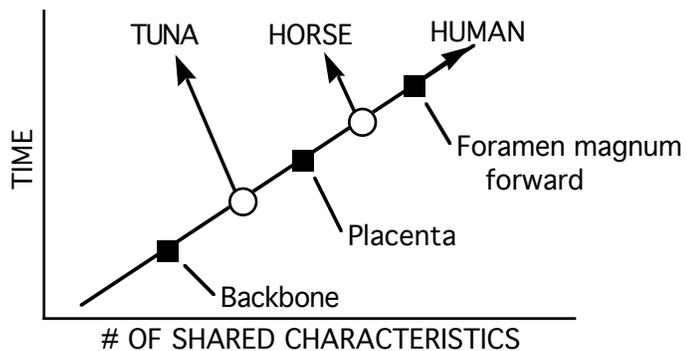
E. <u>Summary</u>: On the <u>back</u> of your <u>Worksheet</u>, explain at least <u>three</u> <u>types</u> of <u>information</u> which can be obtained from a cladogram.

F. <u>Application</u>: 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. Place these animals on your cladogram and explain <u>why</u> you placed them where you did (on <u>back</u> of the <u>Worksheet</u>).

G. <u>Extension</u>: If you need further practice, your teacher may provide you with another set of organisms and their distinguishing characteristics. On a separate sheet, prepare a table for analyzing the data, draw a Venn diagram, and draw a cladogram for those organisms, similar to the work done above.

2

Name_____SN_____   Date_____ Per._____

CLADOGRAM WORKSHEET

Step 1: DATA TABLE

Animals

SETS	TRAITS	Kangaroo	Lamprey	Rhesus Monkey	Bullfrog	Human	Snapping Turtle	Tuna
SET 1	Dorsal Nerve Cord Notochord							
SET 2	Paired Appendages Vertebral column							
SET 3	Paired legs							
SET 4	Amnion (Amniotic sac)							
SET 5	Mammary Glands							
SET 6	Placenta							
SET 7	Canine teeth short Foramen magnum fwd							
	TOTALS of Xs-------->							

Step 2: Venn Diagram:

Step 3: Cladogram:

E. Summary: Three types of new information shown by a cladogram:

      1. Shows ...

      2. Shows ...

      3. Shows ...

F. Application: (For each new vertebrate, add its branch line and name in the appropriate place in the cladogram drawn above).
Reason for placing each branch where you did:

      "Iguana-like" animal:

      "Rat-like" animal:

      "Goldfish-like" animal: