1. Use the four cladograms below to answer the following questions: (5)

```
1   2   3   4
A   B   C   D  A   B   D   C  A   D   C   B  B   C   D   A
```

a. Which cladograms have identical topologies (show the same pattern of relationships)?

b. On tree 1, circle two different monophyletic groups.

c. On tree 2, can you circle those same monophyletic groups. If so, do it!

d. On tree 3 circle a paraphyletic group.

e. On tree 4, circle the MRCA of A, B, C and D

2. Answer the questions associated with the following cladogram: (9)

```
Clowns  Mimes  Jugglers  Comedians  Carnies  Biologists
          
          Unpleasant body odor
          
          Unpleasant body odor
          
          Uses face paint
```

a. Circle the MRCA of Clowns & Jugglers.

b. Circle the monophyletic group that includes Mimes & Carnies.

c. Which group(s) are most closely related to Carnies?

d. Are Clowns, Jugglers & Comedians a monophyletic group? If not, who else would need to be included?

e. Who is more closely related to Jugglers: Mimes or Clowns, or are they equally related?

f. Box the homologous, shared derived trait.

g. Underline the analogous, homoplasious trait

h. Draw any other equivalent phylogenetic tree (one with the same taxa and topology, but rotated about some nodes).
3. Complete part a, then answer the questions that follow. (7)
   a. Use the cladograms posted on the class website to help you draw a phylogenetic tree using Cyanobacteria, Proteobacteria, Archaea, Animals, Fungi and Plantae (Archaeplastids) as tips.
   b. Map the following shared derived traits onto your tree.
      o Cell walls made of cellulose
      o Gain of a nucleus
      o Cell walls made of peptidoglycan
      o Store energy as glycogen
   c. Circle the group from which Archaeplastids probably got their chloroplasts

4. The data we use to reconstruct cladograms comes in various types. Name the three major types of data (synapomorphies, of course!) that we use to construct cladograms. (3)

5. I think I have found a very phylogenetically informative morphologic trait. Before I use it to help construct a phylogenetic tree, I must make sure the trait possess some key features. (4)
   a. Name two features that this trait must have?
   b. In order to be an ideal trait, name two additional features that it must have.

6. Use your Green Plant phylogeny from the class website to construct two additional, equivalent trees. Explain in words why these trees are equivalent. (4)