Name _____ **Period** _____

Chapter 26: Phylogeny and the Tree of Life

Every topic you study ties in with evolution, but this chapter specifically deals with the evidence that can be used to build cladograms, and how these phylogenetic trees are interpreted. You will find this a useful skill to master, and one that is addressed in EK 1.B.2. Throughout your study of biology, you will use this skill over and over.

Overview

1. What is *systematics*? How is it used to develop *phylogenetic trees*?

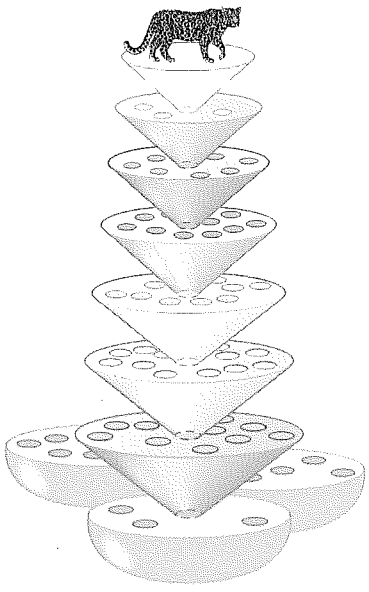
Concept 26.1 Phylogenies show evolutionary relationships

2. What is *taxonomy*?

3. Every organism on Earth may be referred to by a unique *binomial*, or a two-part name. These are in Latin, or latinized. What is your binomial? What does it mean?

4. What are the two components of every binomial?

5. Taxonomy uses hierarchical categories that nest within each other, like Russian dolls. The following figure shows the categories, each called a *taxon*. Label each taxonomic category and then give the one that applies exclusively to this panther to the side of each level.



You will notice that the most general category, *domain*, the one that encompasses the most organisms, is shown at the bottom of the figure. As you move up in the figure, the organisms show greater and greater degrees of relatedness. In order to discuss groups of organisms, try to memorize these taxonomic categories in order. Most students use a mnemonic device linked to the first letter of each taxon to remember them. Make up your own, or try ours:

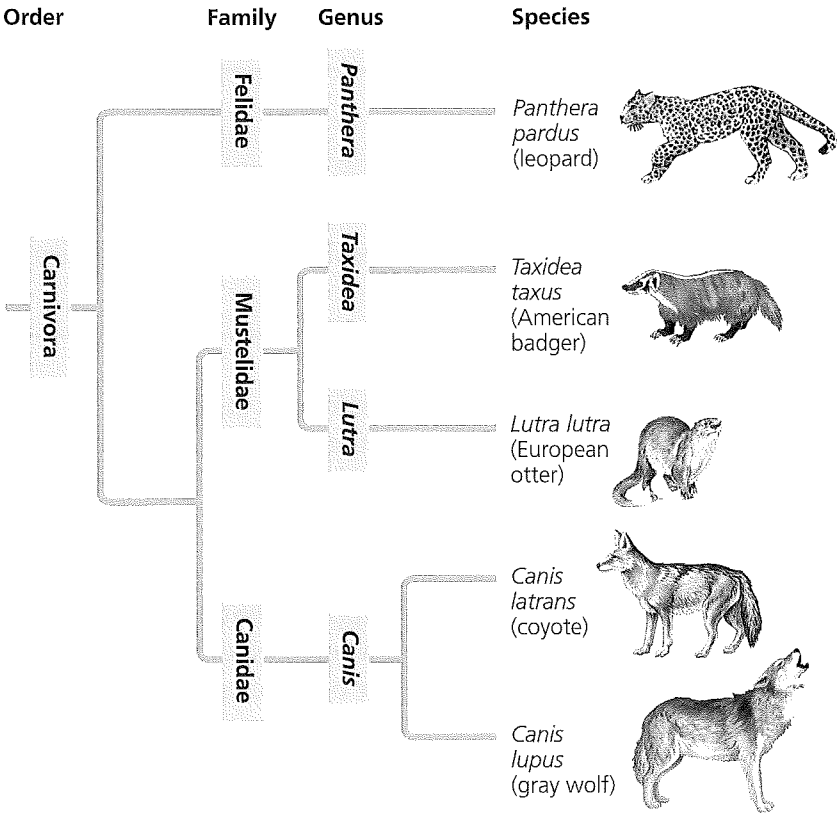
D K P C O F G S or *Dear King Phillip Comes Over For Good Spaghetti*

(You may choose to have Dear King Philip come over for something else—whatever you can remember best!)

6. So, which are more closely related: organisms in the same phylum or those in the same order?

_____

7. In a *phylogenetic tree*, recall that branch points represent common ancestors of the two lineages beyond the branch or *node*. Circle the common ancestor of badgers and otters, and label it as A. Circle the common ancestor of cats and dogs, and label it as B. Explain the relationship between leopard, badger, and wolf.



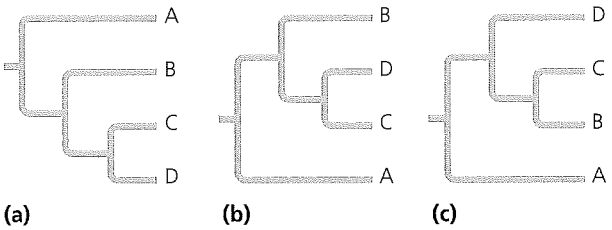
8. What are the three key points summarized about phylogenetic trees?

   1.

   2.

   3.

9. Which of the trees shown here depicts an evolutionary history different from the other two? Explain.



***Concept 26.2** Phylogenies are inferred from morphological and molecular data*

Look back at the Study Tip from Chapter 22. This idea is repeated in the current chapter.

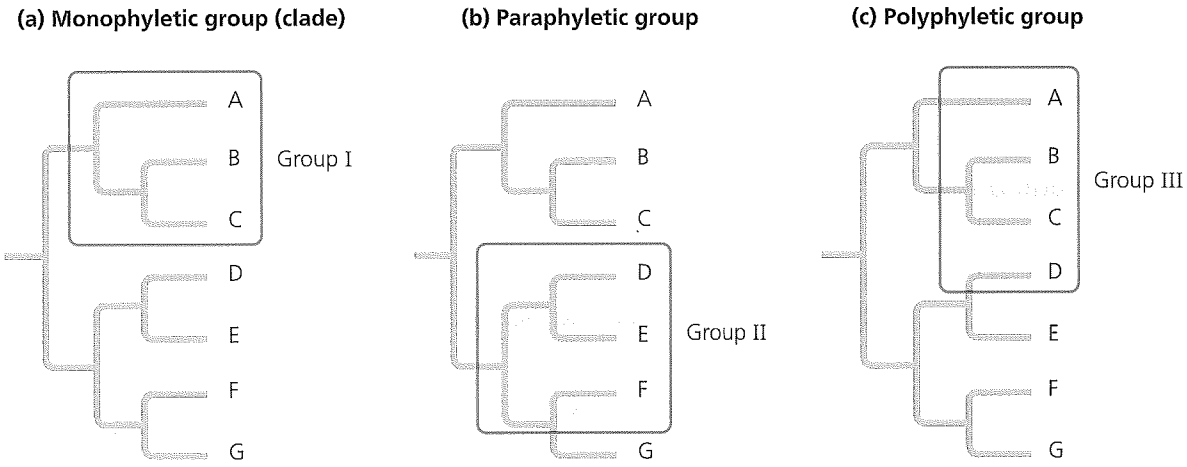
> **Study Tip**
>
> ***Homologous structures*** show evidence of relatedness (whale fin, bat wing).
>
> ***Analogous structures*** are similar solutions to similar problems but do *not* indicate close relatedness (bird wing, butterfly wing).

10. Why is it important to sort homologous from analogous structures? Study Figure 26.8 in your book. Mutations accumulate in similar gene sequences in different species over time. How can DNA homologies be determined after these genetic changes?

11. The WHAT IF? question on page 553 of your textbook is a good check to see if you understand the point about molecular homologies. Suppose that two species, A and B, have similar appearances but very divergent gene sequences, whereas species B and C have very different appearances but similar gene sequences. Which pair of species is more likely to be closely related: A and B or B and C? Explain.

***Concept 26.3** Shared characters are used to construct phylogenetic trees*

12. The following figure shows three *cladograms*. What is a *clade*? Circle a clade that is not highlighted below.



13. Why is Group I *monophyletic*?

14. Explain why Group II is *paraphyletic*.

15. Why is Group III *polyphyletic*?

16. Clades are developed by using *shared derived characters*. What are these?

17. Explain why, for mammals, hair is a shared derived character, but a backbone is a shared ancestral character.

18. Earlier, we emphasized that the sequence of branching in a tree does not necessarily indicate the actual ages of the species. However, this is not the case for the phylogenetic tree in Figure 26.14. Explain what is different about it in comparison to the other trees you have looked at so far.

Study Tip

If you are still struggling with this concept, Figure 26.11 on page 554 will give you another explanation to help. It would also be worth your time to study how the character table in Figure 26.12 is used to develop the phylogenetic tree. We have seen AP essays where students are given a character table such as this, and asked to develop the phylogenetic tree. Try it!

***Concept 26.4** An organism's evolutionary history is documented in its genome*

Let's summarize some important information from this section. The rate of evolution of DNA sequences varies from one part of the genome to another; therefore, comparing different sequences helps us to investigate relationships between groups of organisms that diverged a long time ago. For example, DNA that codes for *ribosomal RNA (rRNA)* changes relatively slowly and is useful for investigating relationships between taxa that diverged hundreds of millions of years ago. DNA that codes for *mitochondrial DNA (mtDNA)* evolves rapidly and can be used to explore recent evolutionary events.

19. Which method reveals that fungi are more closely related to animals than to plants?

20. Which method reveals that the Pima of Arizona and Yanomami of Venezuela are descendants of the same Native Americans who crossed the Bering Land Bridge 15,000 years ago?

21. How do *orthologous genes* indicate descent from a common ancestor? You might use humans and mice and humans and yeast as examples.

22. A phrase that you will encounter in other contexts is that the genes for these shared biochemical and developmental pathways are *conserved.* How does this indicate descent from a common ancestor?

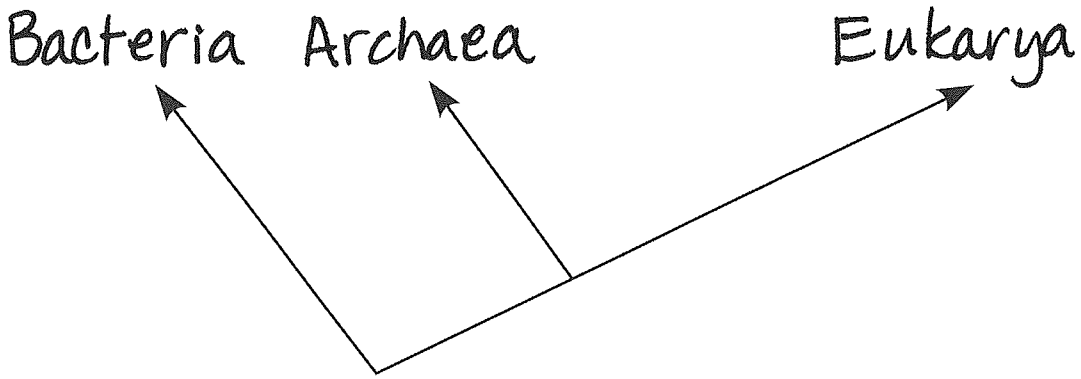
***Concept 26.5** Molecular clocks help track evolutionary time*

23. What are *molecular clocks*?

24. If we use a *molecular clock*, approximately when did HIV emerge?

***Concept 26.6** Our understanding of the tree of life continues to change based on new data*

Taxonomy is in flux! When your authors were in high school, we were taught there were two kingdoms: Plants and Animals. Then in our college courses, we were introduced to five kingdoms: Monera, Protista, Plantae, Fungi, and Animalia. Now biologists have adopted a *three-domain system*, which consists of the domains Bacteria, Archaea, and Eukarya. This system arose from the finding that there are two distinct lineages of prokaryotes.



25. On the previous figure, place an arrow at the point showing the *common ancestor* of all three domains and label it. What features would you predict for this common ancestor? (You will not find the answer to this in your text, but should be able to pull some ideas from your previous knowledge.)

26. What two domains include all prokaryotes? _____

27. Which two domains are most closely related? _____ Explain your reasoning.

28. Which kingdom is made obsolete by the three-domain system? Why?

29. Which kingdom crumbled because it is polyphyletic?

30. *Horizontal gene transfer* has played a key role throughout the evolutionary history of life. What is it?

31. Explain the role of horizontal gene transfer in the tree of life by giving several examples.

Test Your Understanding Answers

Now you should be ready to test your knowledge. Place your answers here:

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

6. _____ 7. _____