AP BIOLOGY | Natural Selection & Evolution

19.3 Phylogeny

1. Classification reflects _____;

one goal of systematics is to create phylogenetic trees.

2. Phylogeny is the evolutionary history of a group of organisms.

A. Interpreting a Phylogeny

1. A phylogenetic tree indicates _____ and lines of descent or _____.
2. When a new character evolves, a new evolutionary path diverges from the old, and a new lineage is formed.
3. Different lineages diverging from a common ancestor have _____—traits shared by the ancestor and the species in its lines of descent.
4. A _____ is present only in a specific line of descent.
    a. They define closer and closer evolutionary characteristics, and therefore provide a more detailed phylogeny.
5. Determining whether a trait is a derived characteristic or an ancestral characteristic is relative to its location within a phylogeny.
6. Because classification is hierarchical, it is possible to use classification categories to construct a phylogenetic tree.

B. _____

1. Analyze primitive and derived characters and constructs **cladograms** on the basis of shared derived characters.
    - a diagram showing relationships among

2. Homologies based on shared, derived characters
    - a cladogram thus traces the evolutionary history of the group

being studied.

3. Constructing a Cladogram
    a. First step: construct a table of characters of the taxa being compared.
    b. Any character found in the **outgroup** as well as the **ingroup** is a shared primitive character.
    c. Homologies shared by certain lineages are shared derived characters, or **synapomorphies.**
    d. A **clade** is an evolutionary branch that includes a common ancestor and all its descendent species.
4. How to Judge a Cladogram
    a. Cladists are guided by the principle of *parsimony*—the minimum number of assumptions is most logical.
    b. The best cladogram is one in which the fewest number of shared derived characters are left unexplained or that minimizes the number of assumed evolutionary changes.
    c. This approach is vulnerable if convergent evolution produces what appears to be common ancestry.

C. **Tracing Phylogeny**

1. Fossil Traits
    a. Because fossils can be dated, fossils can establish the age of a species.
    b. It can be difficult to associate fossils with currently living groups; e.g., a new view of turtle fossils could place them closer to crocodiles.
    c. The fossil record is often incomplete because soft-bodied organisms do not fossilize well.

d. Most organisms decay and the chances of becoming a fossil are low.

2. Morphological Traits
   a. _____ is character similarity that stems from having a common ancestor; homology helps indicate when species belong to a related group.
   b. _____ are related to each other through common descent but may differ in structure and function (e.g., the forelimbs of a horse and the wings of a bat).
   c. _____ is acquisition of similar traits in distantly related lines of descent as a result of adaptation to similar environmental conditions; convergent evolution may make it difficult to distinguish homologous from analogous structures.
   d. _____ have the same function but are not derived from the same organ in a common ancestor (e.g., the wings of an insect and the wings of a bat).
3. **Behavioral Traits**
   1. Since many different species may display some common behaviors, this may substantiate the morphological data that some species are related through evolution.
4. Molecular Traits
   1. Speciation occurs when mutations bring about changes in base pair sequences of DNA.
   2. Each distinct lineage accumulates changes in DNA base pair sequences and amino acid sequences in proteins over time.

3. Advances in analyzing nucleotide and amino acid sequences make abundant data available to researchers.
4. Protein Comparisons
    a. Earlier studies used immunological reactions to antibodies, made by injecting a rabbit with cells of one species, to determine the relatedness of two species.
    b. Amino acid sequences are now used to determine the differences in proteins between two species.
        1) Cytochrome *c* is a protein found in all aerobic organisms; the amino acid differences in cytochrome *c* between chickens and humans is 13 but between chickens and ducks is only 3.
    c. Since the number of universal proteins is limited, most new studies use RNA and DNA.
5. _____
    a. Nucleic acid changes are not tied to adaptation; the fairly constant changes
    b. Comparison of mtDNA sequences equated a 5.1% nucleic acid difference among songbird species to 2.5 million years.
    c. The fossil record can then be used to calibrate the clock and confirm the hypothesis drawn from molecular data.