April 22 Plan-Introducing Phylogenetics

Activity adapted from Bishop Museum ECHO Project Taxonomy Module and ENSI/SENSI Making Cladograms Lesson

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Preparation:
Get objects to classify.
Get butcher paper.
Draw out big version of cladogram.
Get Ziploc bags and make little labels.
Worksheet copies

Lesson Outline:
1. Concept Inventory (5 minutes)
2. Classifying cars and trucks (15 min)
3. Introduction to cladograms (15 min)
4. Constructing cladograms (10)
5. Evaluation (5 min)

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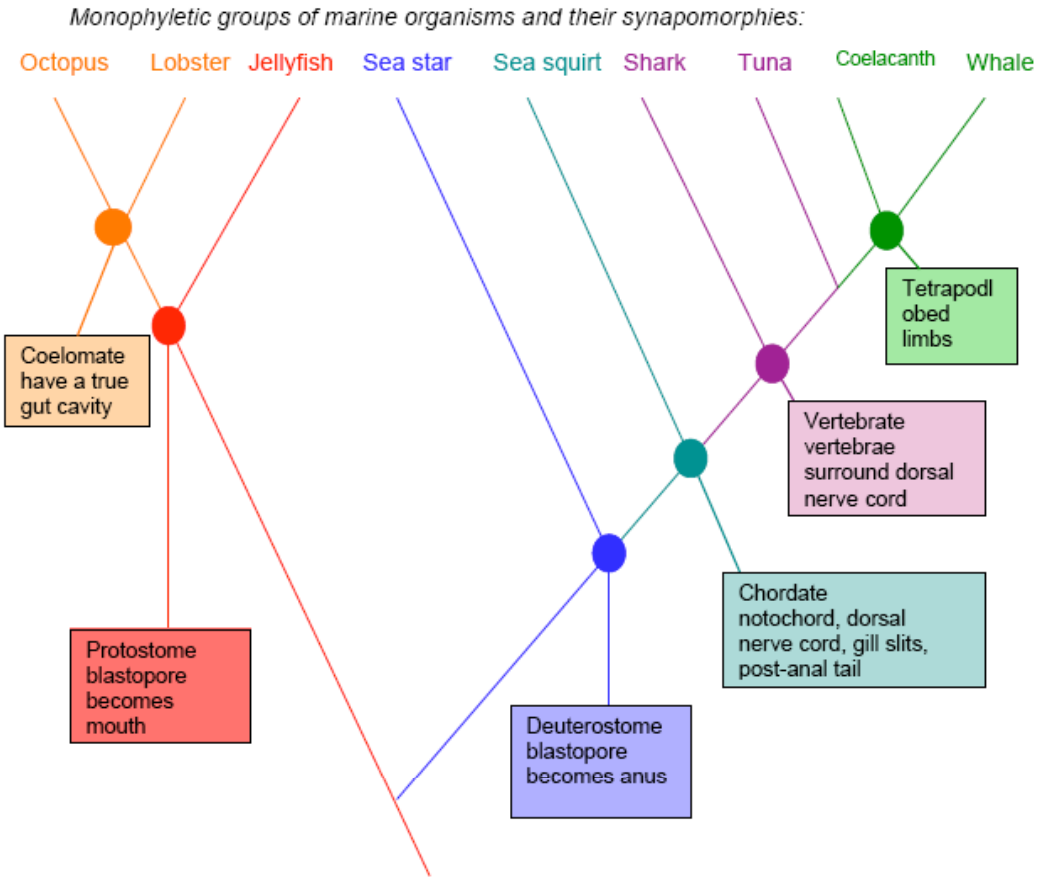
1. Complete Concept Inventory

2. Classifying objects. Pass out toy trucks, tractors, helicopters, etc. Divide students into two groups, and have each group decide how they would organize these objects into groups
    a. Have each group draw their classifications on butcher paper and present them to the class.
    b. Questioning Strategies
        i. Did both groups classify the objects in the same way?
        ii. What types of characters did you use to classify the objects?
        iii. What other types of **characters** (Heritable trait possessed by an organism; characters are usually described in terms of their states, for example: "hair present" vs. "hair absent,") could have been used?
        iv. What kind of characters might be misleading? In biological systems?
            1. Size, color, traits that change over time
        v. How is classifying living organisms different than classifying toy cars?
            1. **Classification** of organisms is based on their evolutionary relationships
        vi. What types of traits are most useful for classifying living organisms?
            1. **Synapomorphies**: shared, derived characters
        vii. Why is it important to know how organisms are related to each other?
            1. Conservation
            2. Understand biodiversity
            3. Invasive species
            4. Species biology

3. Introduction to cladograms. Show the following **cladogram** (the evolutionary relationships among organisms; the patterns of lineage branching produced by the true evolutionary history of the organisms being considered) to the class.
    a. What does a node represent? How is a node different from a branch?
        i. A node represents a hypothetical ancestor to all the organisms in the branches that come off the node. A branch represents an organism that is hypothesized to have descended from the ancestor represented by the node.
    b. Determine which of the following groups are:
        i. **Monophyletic**: a group composed of a collection of organisms, including the most recent ancestor of all those organisms and all the descendants of that most recent common ancestor. Also called a **clade**.
        ii. **Paraphyletic:** a group composed of a collection of organisms, including the most recent common ancestor of all those organisms. Unlike a monophyletic group, a paraphyletic taxon does not include all of the descendants of the most recent common ancestor (e.g. invertebrates)
        iii. **Polyphyletic**: a group composed of a collection of organisms in which the most recent common ancestor of all the included organisms is not included, usually because the common ancestor lacks the characteristics of the group (e.g. flying vertebrates)
            1. Invertebrates: octopus, lobster, jellyfish, seastar, sea squirt (paraphyletic)
            2. The chordates: sea squirt, shark, tuna, coelacanth, whale (monophyletic)
            3. The fishes: shark, tuna, coelacanth (paraphyletic)
            4. The radials: sea star and jellyfish (polyphyletic)
            5. The protostomes: octopus, lobster, jellyfish (monophyletic)
            6. The vertebrates: shark, tuna, coelacanth and whale (monophyletic)
    c. Why do we use synapomorphies as a basis for determining relationships?
        i. They indicate a relationship to the same ancestor because they are only shared by the group of organisms that are genetically related to the same ancestor, represented by the fact that they branch from the same node.
    d. What are **homoplasies**? What are some circumstances that could lead to homoplasy?
        i. Homoplasies are characters that appear to be the same, but are not the result of common ancestry. They appeared through different evolutionary pathways. **Convergent evolution**, when similar pressures select for the same kinds of features in different organisms, can lead to homoplasy. The secondary loss or reversal of a characteristic in one descendant of an ancestor can also lead ot homoplasy.

e. What are derived and ancestral (primitive) traits?
   i. **Derived trait**: a character state that is present in one or more subclades, but not all, of a clade under consideration. A derived character state is inferred to be a modified version of the primitive condition of that character, and to have arisen later in the evolution of the clade. For example, "presence of hair" is a primitive character state for all mammals, whereas the "hairlessness" of whales is a derived state for one subclade within the Mammalia.
   ii. **Primitive (ancestral) trait**: a character state that is present in the common ancestor of a clade. A primitive character state is inferred to be the original condition of that character within the clade under consideration. For example, "presence of hair" is a primitive character state for all mammals, whereas the "hairlessness" of whales is a derived state for one subclade within the Mammalia.



4. Creating a cladogram. Use the following worksheet to have the class construct their own cladograms. Demonstrate Venn Diagram using Ziploc bags.