

Systematics: connecting phylogeny and taxonomy

- Taxonomy = the science of classifying organisms
- Phylogenetics = the study of phylogeny, or the history of evolutionary relationships among species

Perceived similarities can be misleading



Jellyfish



Starfish



Human

Perceived similarities can be misleading



Jellyfish



Starfish



Human

Which pair is most similar?

Perceived similarities can be misleading



Jellyfish



Starfish



Human

- Live in water
- No backbone
- Live on land
- Have backbone

Perceived similarities can be misleading



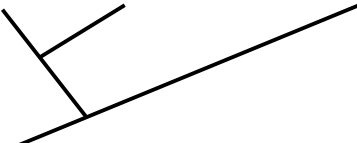
Jellyfish



Starfish



Human



Classification based on phylogeny

- Phylogeny = patterns of ancestry
- Cladistics introduced by Willi Hennig in 1950's
- Goals of cladistics:
 - Base classifications on phylogeny
 - Recognize continuum of evolution
 - Make taxonomists "show their work", make explicit hypotheses based on data they present

Key principles of cladistics

- Since organisms are related by descent, close relationship implies recent common ancestors.
- Organisms differ genetically and pass on these differences (and resultant traits) to their ancestors.
- Therefore, organisms which are closely related should **share** new features, **acquired by evolution**, that are **not present** in other groups.

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- Therefore, organisms which are closely related should share new features, acquired by evolution, that are not present in other groups.
- These uniquely shared derived characters are the best guide to the evolutionary sequence.

The more DERIVED characters two lineages share, the more closely related they are.

But how do we identify derived characters?

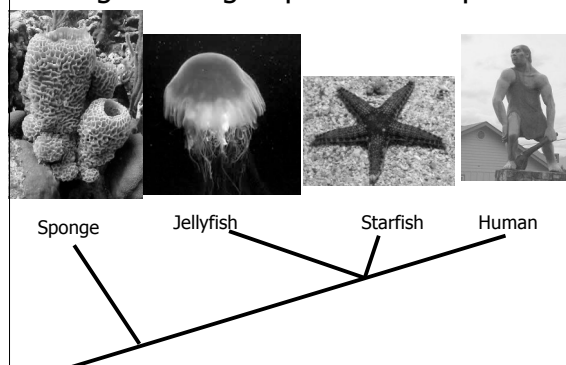
Derived characters are identified through comparison with an outgroup.

- An outgroup is a taxon known (or assumed) to have diverged from a common ancestor less recently than any of the other taxa we wish to classify
 - Relies on other studies, theory, or intuition

Derived characters are identified through comparison with an outgroup.

- An outgroup is a taxon known (or assumed) to have diverged from a common ancestor less recently than any of the other taxa we wish to classify
- Then derived characters are those which are found in some of the taxa under consideration but not the outgroup.

Adding an outgroup to our comparison



Derived characters must be absent from outgroup



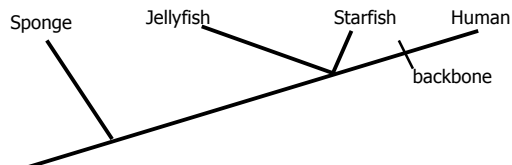
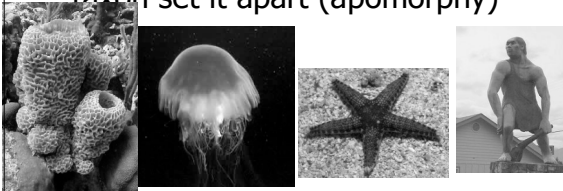
Sponges, jellyfish, and starfish all live in water and do not have backbones, therefore these are NOT derived characters.

Derived characters found in only one taxon set it apart



Backbones and living on land are unique to humans.

Derived characters found in only one taxon set it apart (apomorphy)

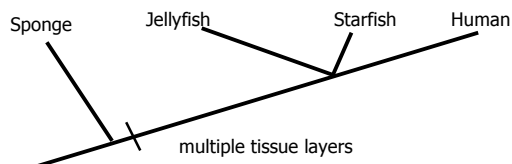


Derived characters found in all taxa do not resolve relationships



Sponges have only one tissue layer. The other taxa all have multiple tissue layers.

Derived characters found in all taxa do not resolve relationships

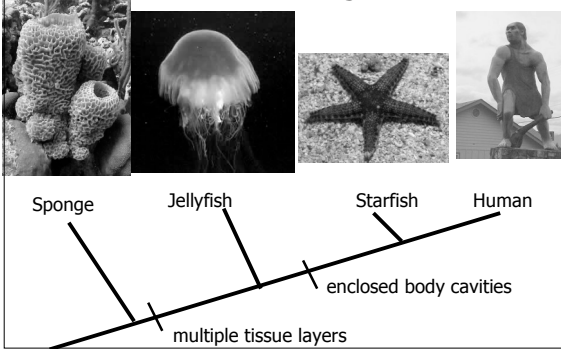


Shared, derived characters group related taxa together



Sponges and jellyfish lack enclosed body cavities. (ancestral)
 Starfish and humans have enclosed body cavities. (derived)
 Shared derived characters are called SYNAPOMORPHIES.

Shared, derived characters group related taxa together



We have just made a cladogram

- Phylogenetic tree showing the order in which different lineages diverged from a common ancestor
- Each branch point is labeled with (a) diagnostic synapomorphy(ies)
- Each synapomorphy is found on one branch of the tree but not the other branch

Synapomorphies mark each branch on a cladogram

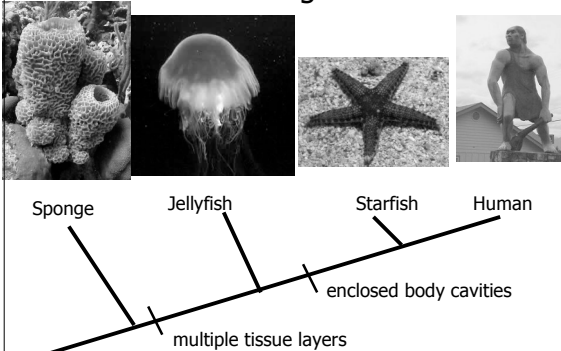
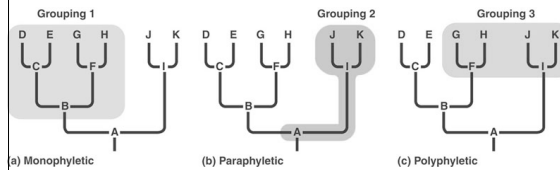


Figure 25.10 Note: Legitimate taxa, such as genera or families, are composed of monophyletic groups of species. These represent evolutionarily unified groups.



- Monophyletic groups contain a common ancestor and all of its descendants.
- Paraphyletic groups are missing one or more descendants, and polyphyletic groupings are missing a common ancestor.
- How do we construct hypothesized monophyletic groups? Using shared, derived, homologous traits.

What are shared, derived, homologous traits?

- Shared traits are similarities among organisms
- Some similarities are homologous, i.e. shared because of inheritance from a common ancestor
- Other similarities are analogous, i.e. due to convergent evolution, NOT from inheritance from a common ancestor