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Constructing a Phylogenetic Tree

Introduction

According to the theory of evolution, all organisms can be traced back to a common ancestor. Scientists can determine how closely related two organisms are by studying:

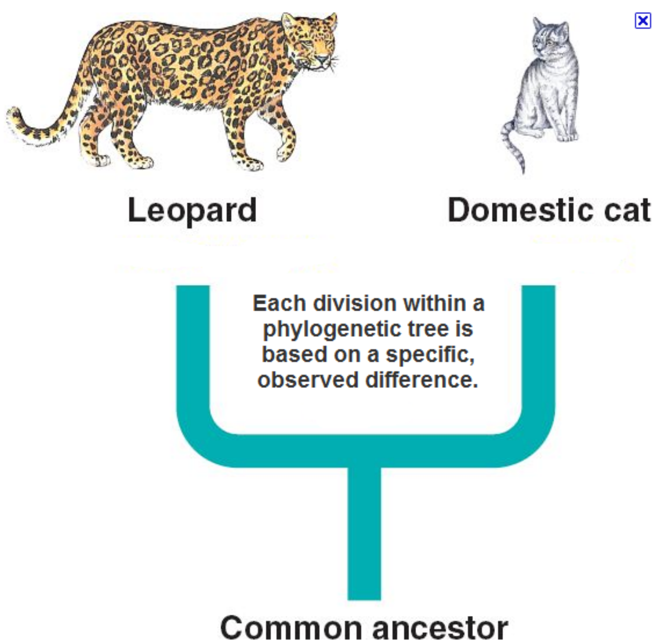
1. **Physical Characteristics –** Bone structure, body shape, musculature.

2. **Genetics –** Number of similar DNA base pairs.

3. **Behavior –** Social structure, personality traits.

The Tree of Life

One method commonly used to display evolutionary relationships is by constructing a **phylogenetic tree**. These diagrams are meant to show how closely related different species are in comparison to teach other. The base or "trunk" of the tree begins to divide into smaller and smaller branches. Each division separates the organisms into smaller groups based on observed physical characteristics, genetics, or behavior. Take the leopard and domestic cat as an example. What specific characteristic might be used to separate them?



For this assignment, you will take a diverse group of animal species and attempt to make a phylogenetic tree showing their evolutionary relationships. This tree should be primarily based on **physical characteristics**, such as:

- Presence of a backbone
- Cold or warm blooded
- Presence of hair/fur
- Breath air or water
- Carnivore, herbivore, or omnivore
- Any other external structures such as horns

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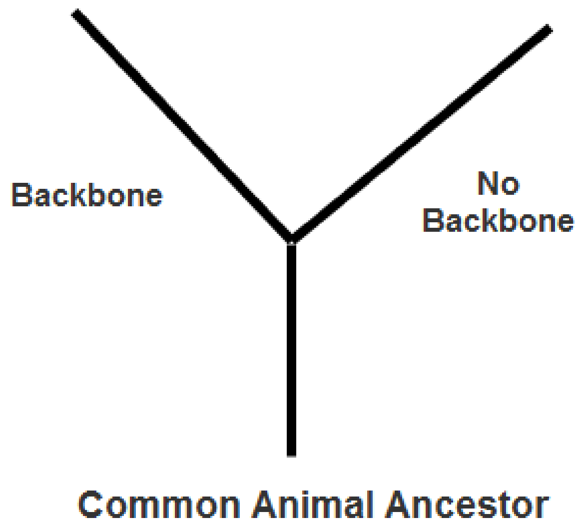
The Tree of Life

1. Detach the following page of animals from this assignment.

2. Individually cut out each animal, including the name.

3. Lay all the animals out on your desk and separate them into two groups by **presence of a backbone.**

4. On a separate sheet of paper, start drawing your phylogenetic tree like this:



5. Continue separating the animals into smaller and smaller groups. Draw each division into your tree.

6. When an animal occupies its own branch, glue it to the end of that branch on your tree.

7. Repeat for all the other animals in your collection.

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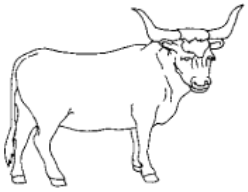
Animals

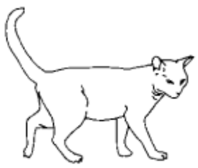


Bull

Panda

Kiwi

Sea star



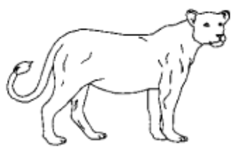
House cat

Bison

Sea turtle

Moth

Cocker spaniel



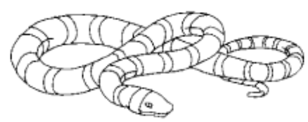
Lion

Frog

Spider

Duck-billed platypus

Large-mouth bass



Coral snake

Cockroach

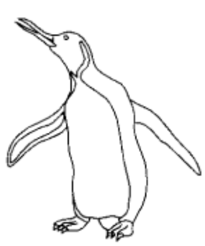
Koala bear

Hermit crab

Shrimp

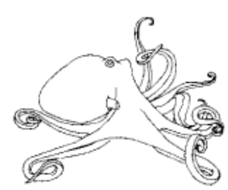
Jellyfish

Zebra



Penguin

Walrus



Octopus

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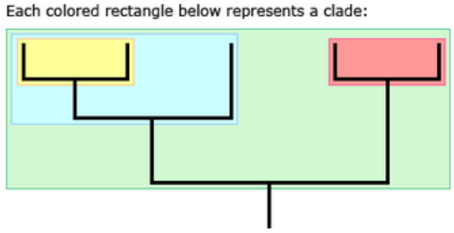
Teacher Notes:

One of the best ways to visualize evolutionary relationships is by drawing a evolutionary tree, also known as a phylogenetic tree or a "tree of life". This activity has students construct their own tree from a set of animals provided, using only specific, observable physical differences. This activity gives students an opportunity to classify organisms on their own, and begin to visualize the types of evidence used to show their evolutionary relationships. Due to the open-ended nature of this worksheet, students will come up with many different combinations and layouts. However, the end result should be an evolutionary tree that shows the basic relationship between each of the animals. Arthropods such as the spider and moth should be far apart from an aquatic mammal such as the walrus. This is also a good opportunity to gauge how well students understand the basis of different classifications, such as reptile, amphibian, and mammal.

For further discussion:

Evolutionary trees depict clades. A clade is a group of organisms that includes an ancestor and *all* descendants of that ancestor. You can think of a clade as a branch on the tree of life. Some examples of clades are shown on the tree below.

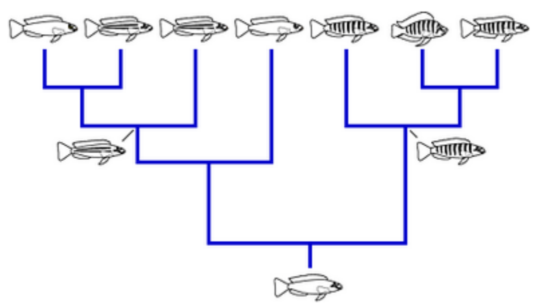
Each colored rectangle below represents a clade:



Using trees to learn about the evolution of complex features: The striped cichlid

Reconstructing ancestral characters can help us understand how a complex feature evolved. For example, the cichlid fish shown above and represented below vary in shape, color, and striping patterns.

Researchers reconstructed the phylogeny of these fish based on molecular data, then mapped striping patterns onto the phylogeny. Scientists used parsimony to infer the probable pattern of the ancestral fish. The resulting phylogeny shows how these complex patterns evolved in different lineages.



This technique helped biologists figure out that evolutionary changes in cichlid striping pattern seemed to be related to ecological shifts — not sexual selection. Similar techniques have been used to understand, for example, how birds evolved the ability to fly and how tetrapods evolved to live on land.

http://evolution.berkeley.edu/evolibrary/article/0_0_0/phylogenetics_11