Title: Kissing Cousins? From Cladogram to Phylogenetic Tree

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Abstract:

Kissing Cousins? From Cladogram to Phylogenetic Tree is a collection of activities that may be completed in class, assigned as homework, or a combination of the two. A variety of methods and resources are presented that can be used to clarify the concepts of evolution and the methods used to support the ideas of evolutionary relationships. **NOTE:** The computational analysis section is designed to facilitate the use of Chromebooks, therefore the analysis of DNA sequences requires internet access.

Subject, Grade, Level:

Honors Biology, 9-10

SC.912.L.15.1 - Explain how the scientific theory of evolution is supported by molecular biology.

SC.912.L.15.2 - Discuss the use of molecular clocks to estimate how long ago various groups of organisms diverged evolutionarily from one another.

SC.912.L.15.5 - Explain the reasons for changes in how organisms are classified.

SC.912.L.16.9 - Explain that the genetic code is universal and is common to almost all organisms.

SC.912.L.16.10 - Evaluate the impact of biotechnology.

Learning objectives:

Students will recognize and understand-

Phylogeny is based on evolutionary relationships.

A phylogenetic tree can be built by identifying the most dissimilar members in a group of organisms.

A phylogenetic tree can be built by identifying the most similar members in a group of organisms.

Superficial similarity does not always indicate a close evolutionary relationship.

Even experts do not always agree on the subtleties of some evolutionary relationships.

Timeframe:

It is recommended that teachers allow a minimum of 2-110 min blocks to sufficiently cover all material, enabling students the opportunity for mastery. However, these materials allow for flexibility and may be used independently or in conjunction with further research into areas of interest to fit teachers classroom needs.

Teacher Guide: Kissing Cousins? From Cladogram to Phylogenetic Tree

List of materials:

[A list of materials needed to complete the activity.]

Animal cards - 1 set per group of 2 students (Printing on cardstock and laminating prior to cutting will allow for multiple uses)

Common/Scientific names list - 1 set per group

NCBI Nucleotide Links - uploaded to class webpage or projected on the board

Computers with internet access

Video Clip Suggestions

Constructing a Cladogram - ***https://www.youtube.com/watch?v=46L_2RI1k3k***

How the tree works! - ***https://www.treetender.org/***

Benefits of the Tree - ***https://www.treetender.org/***

Grassland Evolution - ***https://www.treetender.org/***

Procedure and general instructions.

Hands on sorting activity

Picture cards of the 13 animals are available in color and located in the appendix. Using the animal cards, briefly describe each animal to the students and allow them to sort the animals in a way that makes sense to them. They must create a minimum of 3 groups. Ask students to explain why they sorted the animals the way they did. Discuss problems of sorting according to phenotypic similarities, and why those characteristics are not necessarily indicative of evolutionary relationships.

Note: Students will tend to inherently group organisms by phenotypic similarities, however some students may struggle. See extension below for suggestions.

Extension: To help them group the animals, teachers may wish to introduce the concept to students by viewing Constructing a Cladogram prior to the sorting activity or to provide students with the common and scientific names of each animal.

Enrichment: Have students defend their reasoning while debating the merits of the criteria used to sort their animal cards. Allow students to alter their groupings as a result of these debates.

Enrichment/Additional Practice:

Click and Learn: Sorting Seashells **https://www.hhmi.org/biointeractive/sorting-seashells**
Explore principles of taxonomy by sorting seashells according to their morphological characteristics and constructing an evolutionary tree.

[Include suggested direct instruction of cladogram and phylogenetic trees here.]

Comparative Analysis of cytochrome oxidase gene (coi)

[Include instructions for MAFFT and Simple Phylogeny and here.]

https://www.ebi.ac.uk/Tools/msa/mafft/

https://www.ebi.ac.uk/Tools/phylogeny/simple_phylogeny/

Extension: As students progress through the online exercise, you can enhance the hands-on nature of the activity by drawing the resulting phylogenetic tree on a long piece of butcher paper and placing the animal cards, or student created illustrations, on the appropriate branches. Teacher can also use the blackboard to build the phylogenetic tree derived from the class data. Instead of drawing the branches, you could also use painters tape or brightly colored pieces of yarn to represent them.

Enrichment/Additional Practice:

Click and Learn: Creating Phylogenetic Trees from DNA Sequences
https://www.hhmi.org/biointeractive/creating-phylogenetic-trees-dna-sequences
This Click and Learn explains how DNA sequences can be used to generate such trees, and how to interpret them.

Student Guide: Kissing Cousins? From Cladogram to Phylogenetic Tree

Procedure and general instructions (for students).

[Provide a student version of the instructions if applicable. Include any student handouts here.]

OPTIONAL SECTIONS (other sections you can add if applicable)

Suggestions and materials for assessing student learning

Student data

Reference list:

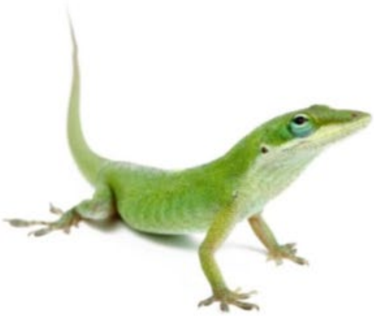
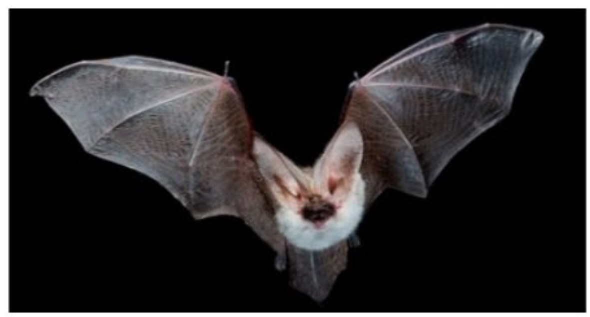
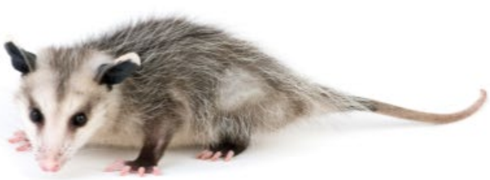
Student assignments related to the activity

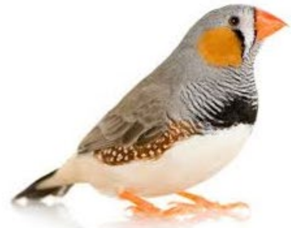
Any other appendices appropriate for your particular activity

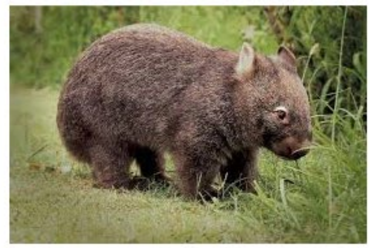
Scientific Names

Cod fish - *Gadus morhua*
Zebrafish - *Danio rerio*
African clawed frog- *Xenopus laevis*
Mouse-eared bat- *Myotis myotis*
Opossum- *Philander didelphimorphia*
Zebra finch- *Taeniopygia guttata*
Lungfish- *Dipnoi ceratodontiformes*
Wombat- *Vombatus ursinus*
Austalasian frog- *Litoria caerulea*
Green anole- *Anolis carolinensis*
Belgian Malinois - *Canis lupus familiaris*
Friesian - Equus caballus

Card Sort and Answer Key



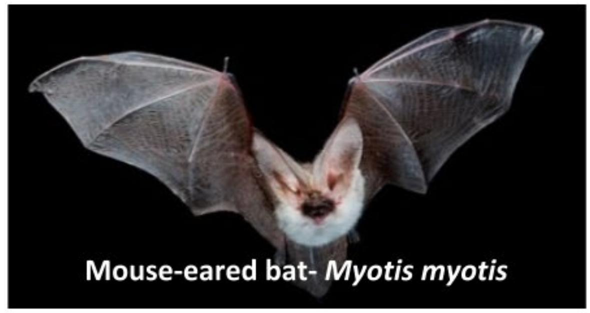
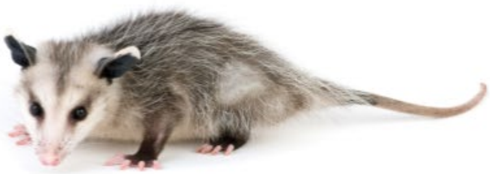
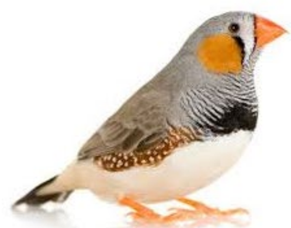


Cod fish - *Gadus morhua*

Zebrafish - *Danio rerio*

Austalasian frog- *Litoria caerulea*

African clawed frog- *Xenopus laevis*

Green anole- *Anolis carolinensis* 	
 Opossum- *Philander didelphimorphia*	 Lungfish- *Dipnoi* ceratodontiformes
 Belgian Malinois - *Canis lupus familiaris*	Zebra finch- *Taeniopygia guttata* 
 Friesian - Equus caballus	Wombat- *Vombatus ursinus* 

Unaligned sequences

>KY250729.1 Gadus morhua voucher 16_UNE_cicy_08A cytochrome oxidase subunit 1 (COI) gene, partial cds; mitochondrial
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CGAGCAGAG
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CGCTTTCG
TAATAATTTTCTTTATAGTAATACCACTAATAATTGGAGGCTTTGGGAACTGACTCATTCCTC
TAATGAT
CGGTGCACCAGATATAGCTTTCCCTCGAATAAATAACATAAGCTTCTGACTTCTTCCTCCAT
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GATTTCATC
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GTACCAA
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CTTAGCAG
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>KC750828.1 Danio rerio cytochrome oxidase subunit I (COI) gene, partial cds; mitochondrial
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>EU847726.1 Taeniopygia guttata cytochrome oxidase subunit I-like gene, partial sequence; mitochondrial
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>KF930173.1 Neoceratodus forsteri voucher KUT 3509 cytochrome oxidase subunit 1 (COI) gene, partial cds; mitochondrial
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>LC143640.1 Vombatus ursinus mitochondrial COI gene for cytochrome oxidase subunit I, partial cds, specimen_voucher: SDNCU:SDNCU-A2707
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