

BLOSSOMS Video Teacher's Guide: Meet the Family: Investigating Primate Relationships

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The overall goal for this lesson is for students to see the different types of evidence scientists use to understand evolutionary relationships among organisms. They will first use shared physical characteristics to predict relationships and then use amino acid sequences to build a phylogenetic tree. Finally, they will look at the tree in the context of time in order to see divergence times.

At the end of the lesson your students will understand that:

- Everything alive today and in the past is related through evolution
- Humans are part of a larger, related group of animals, the primates, just as all organisms are members of other, larger groups
- Phylogenetic groups are based on evolutionary relationships
- Multiple lines of evidence can be used to establish evolutionary relationships

Prerequisites:

Students should:

- Know that DNA is the genetic material, made of nucleotide bases (A,T,G,C)
- Know that triplets of bases code for amino acids
- Understand that amino acids are the building blocks of proteins

Some familiarity with phylogenies, the concept of common ancestors and molecular clocks is useful but not required. If you want some good background lessons in evolution and phylogenetics, take a look at the UCMP site listed in the resources page of the lesson.

Supplies:

- Paper and writing utensils
- Large sheets of paper or whiteboard and markers for sharing phylogenies (Segment 5 activity)
- Graph paper can be useful for drawing phylogenies
- Printouts of images and handouts provided
- The animal images are open source. The skeletal images you will use were provided by permission through [Bone Clones](#).

Length of Time: The video footage totals a little more than 30 minutes. The total lesson time, including video and activities, can be covered in about 55-110 minutes. The total will depend on the background students have in the subject, how much time you allow for group discussion and expanding on the activity, and which activity choices you make.

Lesson Outline:

This lesson is designed to be interactive and activity-based. You are encouraged to invite discussion and debate among your students.

Before the lesson you might introduce the idea of phylogenetic relationships and ask:

- “How do scientists determine relatedness among species?” Answers might include: molecular data, fossils, comparisons of extant species, or development. (Development will not be explored in this lesson.)
- “Which of these approaches do you think is most useful?” There is no right or wrong answer. Each is useful and all of them together provide the most data.

Notes and explanation of activities in lesson:

In segments 1 and 2 students practice using some of the ideas and concepts they will use later in the lesson:

After Segment #1: Using their previous knowledge, video images in lesson, and printed images of cats provided, students will consider what morphological characteristics they see in all of the cat species listed and share with the group. You might also ask, “Which characteristics do you see that are not shared by all group members?” to have them understand that both similarities and differences are explainable through evolution.

Materials: Image of 3 cats

After Segment #2: Students place 4 cats on the tree provided and share their trees with the group. The teacher can facilitate a discussion asking why students placed species in the positions they chose.

Materials: Images of 4 cats, blank cat phylogeny, completed cat phylogeny 4 species, completed cat phylogeny all species

In segments 3 and 4 students compare physical characteristics of primates and use their observations to propose possible evolutionary relationships among the species.

After Segment #3: In segment 3 students will work in small groups to come up with a list of species they think are closely related to *Homo sapiens* and then share answers with their group. You should facilitate discussion asking how students chose their answers, i.e. what criteria they used.

After Segment #4: Students compare the morphology of 7 primates and answer the questions posed in their small groups about the similarities and differences they see. Students should be encouraged to use observations of the specimens shown in the pictures, rather than prior knowledge, to inform their answers. You can choose from primate photos, skull images and skeleton images for student comparisons.

Materials: Primate photos, Skull images and Skeleton images

In segments 5 and 6 students use the amino acid sequences of HBB to create a probable phylogeny of primate species and compare their results with the predictions they made based on morphology.

After Segment #5: This activity has several versions. Students use amino acid sequences (more challenging) or the table showing just amino acid differences (less challenging) of hemoglobin B to either create a data table (more challenging) or fill in the data table provided (less challenging).

Materials: HBB alignments, Differences in amino acids HBB, Blank amino acid comparison chart

After Segment #6: Students use their data tables to create a phylogeny (challenging) or fill in the tree provided (less challenging). This exercise is the probably most difficult part of the lesson. The data does not dictate one “correct” tree because some of the data is ambiguous. Students can draw their phylogenies on large pieces of paper or on a whiteboard so that the entire class can see them. This is a good place for discussion or debate, especially among more advanced students.

Here you can discuss the degeneracy of the genetic code, i.e. the fact that more than one sequence can specify the same amino acid. Therefore, working backwards from amino acids, you can't know the precise DNA sequence and ask them how they would determine whether this was a factor. (DNA sequences can be obtained online through various sequencing sites.) The possibility of back mutations can also be proposed, i.e. a mutation that erases its “footsteps” by returning the gene to its original form.

Materials: Amino acid comparison chart filled, Blank primate phylogeny, Single letter codes for amino acids

In segments 7 and 8 students look at phylogenetic changes in the context of time.

After Segment #7: By looking at a primate phylogeny, students consider the questions posed concerning relatedness among the species. The last question asks about why the lemur has so many amino acid differences than all of the other species. The basic answer is that the lemur group diverged from the rest of the group long before the other members diverged from each other. If you would like to extend this lesson, see the additional resources provided and look for the [UCMP lesson on Madagascar](#).

Materials: Primate phylogeny filled

Segment #8 Students look at the primate phylogeny with a timeline below to see when the 7 primates diverged from each other.

Materials: Primate phylogeny with timeline