Evolution and DNA
- Extended Version –

Originally developed for the Pittsburgh Zoo & PPG Aquariums

GRADE LEVEL:
TIME: 20-35 minutes
SUBJECT: Biology/ Genetics
CONCEPTS: DNA, relatedness, genetics, phylogenetic tree

LEARNING OBJECTIVES

- All living organisms have DNA.
- Genes are specific sequences of DNA.
- Organisms share commonalities in DNA & genes.
- The more DNA/ genes that are shared between 2 organisms, the more closely related they are.
- Scientists use phylogenetic trees to map the genetic relationships between organisms.

MATERIALS

- Phylogenetic tree poster
- "dna-bar-codes.jpg" - 2 copies
- Pictures of zebrafish, chicken, human, mouse, and frog
- Foam core
- Scissors
- Glue
- Velcro dots

BACKGROUND INFORMATION

- DNA is a molecule that contains an organism's genetic information.
- An organism's genome is made up of its own unique DNA.
- Scientists sequence an organism's DNA to determine its genome.
- Scientists then compare the newly sequenced genome (or portion of genome) to another organism's genome.
- By observing commonalities between the organisms' genomes, scientists can determine how closely related the 2 organisms are.
- Phylogenetic trees are not 100% concrete entities. They are constantly changing or being rearranged as new data is discovered. There is no consensus on what the "roots" of the phylogenetic tree look like since there has been much gene transfer among the prokaryotes and archaea.
- Time is represented by distance on phylogenetic trees. The larger the distance between 2 branching points on the tree, a longer amount of time has elapsed.

SET UP

1. Hang up the phylogenetic tree poster on a bulletin board or blackboard so that it is visible to the entire class.
2. Place Velcro dots on the following branches: fish, amphibian, bird, and 2 dots on the placental mammal branch.
3. Next you will need to make the foam animal cut outs. Glue the pictures of the various animals to the foam core. Allow to dry. Cut out around the animals. Cut out and glue the appropriate DNA bar code to the back of its representative animal. (Leave enough room to place a Velcro dot on the same side as the DNA barcode.) After the DNA barcode has dried, place a Velcro dot on cutout. (on barcode side)
4. You will also need to print out copies of the barcodes, glue them to foam core, and place Velcro dots on the back. Make sure to place Velcro dots on the poster next to the animal they will represent (zebrafish: Ray-finned Fishes, frog: Amphibian, chicken: Birds, mouse: Mammals, human: Mammals).

ACTIVITY

1. As class begins, ask the students to take a look at the phylogenetic tree. Ask the students if they know what the diagram is? Etc…

- Let your student know that:
  - DNA is a molecule that contains an organism's genetic information.
  - An organism's genome is made up of its own unique DNA.
  - Scientists sequence an organism's DNA to determine its genome.

2. Next, explain that the spiral is a graphic representation of the genetic relationships between organisms. Remind students that:

- All organisms descend from one single-celled ancestor, "**LUCA**."- **L**ast **U**niversal **C**ommon **A**ncestor.
- All organisms have DNA and some genes- specific sections of DNA, are shared across all of the kingdoms.

3. Explain how time is represented on the tree- (by concentric rings, oldest at the center to most recent near the outside) Make sure that students are aware that:

- These new animals evolved from previous groups, but they still share some DNA and are still related.
- Branching points represent the appearance of a new group of animals.

4. Make sure to point out examples of relatedness:

- Ex. A human is more closely related to a mouse than to a fish.

5. Explain to students that geneticists sequence an organism's genome and then compare it, or parts of it, to other animals' genomes. When they compare the two genomes, they use the similarities and differences between the two to determine the relatedness of the two animals.

- Two genomes that have a lot of similarities are closely related.
- Two genomes that have a lot of differences are distantly related.

6. At this point, bring out the DNA barcodes you created earlier. Here you can use a story to help the students visualize the process of creating a phylogenetic tree. Your story can be original or follow a format similar to the one below:

<u>Story</u>
"Yesterday I was preparing for our lecture on phylogenetic trees and I wanted to sequence the DNA of some common animals and see how they were related. I extracted DNA from a fish, a frog, a chicken, a mouse, and a human. I put them into my sequencing machine in my home laboratory and this (hold up barcodes) is what my sequencing machine gave me. These barcodes must represent each of these animals' genome. Well, I made a terrible mistake when I put the DNA samples in my machine- I forgot to label which sample belonged to which animal. Now we must use this phylogenetic tree that we have to determine which DNA barcode goes with each animal."

7. At this point, you can allow students to work in groups or as a whole class to determine where the DNA barcodes go. If students are having problems, you can direct them with questions or clues like:

- If two animals are closely related, will they be close together or far apart on the tree?

- If two animals are closely related, will their DNA barcode be similar or different?
- If two animals are members of the same group, (ex: mammals) will their DNA barcodes be more similar or different?
- If two animals are distantly related, will their DNA barcodes be similar or different?
- If two animals are distantly related, will they be close together or far apart on the tree?
- Let's compare these two DNA barcodes to find similarities/differences.
- Etc…

8. After allowing students adequate time to make their predictions on where the DNA barcodes will go, as a class come up with a consensus as to which DNA barcodes should go where.

9. After placing the barcodes, you can continue your "story" from before:

<u>Story, Part 2:</u>

"Luckily, I had some extra DNA samples from the animals I tried to sequence last night. This time I labeled my samples and sent them through my sequencing machine. Here are my results!" At this point you can flip over the animal cutouts you have placed on the tree. The correct barcodes will be displayed on the back of the animal.

10. Compare the students' placement of the barcodes with the correct placement. Did your students have the correct placement? If not, you can ask them some of the questions found in step 7 to help them understand why they may have gotten the answer wrong.