Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

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Relatives

Adapted by Duc Tran and Laura Sanders, Environmental Science Institute, February 2011
Source: "It's All Relative" by Al Janulaw from the University of California Museum of Paleontology, May 2004
http://www.ucmp.berkeley.edu/education/lessons/its_all_relative.html

Grade Level: 3 – 5

Time: 1-2 class periods

Sample TEKS:
§112.14. Science, Grade 3: 1B, 2C, 2D, 2F, 3D, 9A
§112.15. Science, Grade 4: 1B, 2C, 2D, 2F, 3D, 10A, 10B
§112.16. Science, Grade 5: 1B, 2F, 2G, 3D, 9A

Overview: Students will find pictures of living things and arrange them in collages, categorizing them according to which organisms they *think* are closely related.

Note to Teachers: The central idea to be conveyed to students is that we often compare and classify organisms by their appearances (morphology). Looks can be deceiving. In deciding which organisms are most closely related, students will make some decisions with which you may not agree, but keep in mind that this exercise is about students learning about the process of classification, so the product does not need to be perfect for the lesson to be successful.

Teachers can use this activity to introduce the theory of evolution, Darwin, and his works**.** They can introduce the concept of phylogeny (and how scientists use it to investigate the origins of species). Teachers can refer to this website for more information on phylogeny:
http://evolution.berkeley.edu/evosite/evo101/IIBPhylogenies.shtml.

Objectives:
Students will:
- Categorize living things and how they are related.
- Compare and contrast similarities and differences among fossils and living organisms.
- Explore the theory of evolution and the study of phylogeny.

Materials:
- Engagement: *Are They Related?* PowerPoint Slide Show
- Exploration:
  - Numerous magazines containing pictures of animals, fossils, etc. (i.e. *National Geographic*)
  - Scissors
  - Glue
  - Plain paper
- Elaboration: Scientific papers and other resources to research organisms

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Advance Preparation: Teacher should start collecting magazines and other necessary materials a few weeks before starting the activity.

Procedure: This activity can be done independently or in groups of two.
Today's lesson is about how scientists work to find out which living things are related to each other, and the class will have an opportunity to do what scientists do.

Engagement – *Are They Related?* Power Point Slide Show

1. Slide 2 – Tell students: *"Humans (all vertebrates) and octopuses have developed camera eyes with lenses (as opposed to eyes that act as concave mirrors or pinhole cameras). Knowing that they have similar eye structures, would you guess that humans and octopuses related?"* Allow students to discuss and explain their thoughts and ideas. Older students can read the journal article cited for the evolution of these eye similarities for exposure to scientific publications.
2. Slide 3 – Explain: *"No they are not related because they developed this evolutionary adaptation independently of one another. You might have already guessed that we are not related based on other attributes, but it is important to note similarities and differences between organisms when deciding who is related to whom. "*
   Note the difference between where the retina and nerve fibers are between the two eyes. Note that only the human eye has a blind spot. Further background information is included in the slide notes, such as, "This difference may be accounted for by the origins of eyes; in cephalopods they develop as an invagination of the head surface whereas in vertebrates they originate as an extension of the brain."
3. Slide 4 – Challenge the students: *"Now let's compare snails to octopuses. What do we know about them? Do they both have eyes? Yes, but snail eyes are at the end of eyestalks on their head or below tentacles, and snail eyes only detect the difference between light and dark… Snails have shells, and octopuses do not. Octopuses are not found on land… Are snails and octopuses related?"* Allow students to discuss and explain their thoughts and ideas.
4. Slide 5 – Explain: *"Yes, the snail and octopus are distantly related because they both belong to the same animal group called the Phylum Mollusca."*

Exploration - Distribute the materials for the exploration activity. Tell students: *"Now you will become scientists and group the animals based on their structures the way you think they are related. You can do this by cutting out pictures of ten different living things and group them on your desks. Be ready to explain your methods – how and why you have decided to group them the way you have."*

1. Patrol the room, keeping kids on task, and asking how they made their decisions. (Note: Students may surprise you with how reasonable their explanations are, even if you think their ideas do not conform to up-to-date science.)
2. Have students glue their aggregations on white paper (as collages) and label the groups whichever way they choose.
3. Have students share their collages with the class.

Elaboration - Students should do further research to determine the validity of their "classification" schemes. One way this could be accomplished is to pick an organism or two and research more about them to see if they are truly related. The paper or fact sheet could address characteristics such as:

- Geographical distribution and Habitat
- Appearance, Size
- Diet – what it eats and how it obtains food

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- Interaction with its ecosystem with the living and non-living environment

An example might include the following:

Octopus Fact Sheet

Adapted from Sources: Young People Trust (http://www.ypte.org.uk/animal/octopus-common-/148), Earth Life (http://www.earthlife.net/inverts/mollusca.html), and Wikipedia (http://en.wikipedia.org/wiki/Evolution_of_the_eye).

The octopus is an invertebrate animal (it has no backbone) and belongs to the phylum (group) Mollusca. Its closest relatives are the various species of squid and cuttlefish. Snails and slugs are distant relatives of the octopus.

Description: Bag- shaped body, with bulbous head and eight tentacles. Skin color varies to match the environment.

Size: Length: up to 3m, though commonly smaller

Weight: up to 25kg. Females mature at 1kg, males at 100g.

Habitat: Octopuses can be found throughout the world's temperate oceans. They live in holes or rock crevices in shallow water. Sometimes the octopus digs a nest in gravel, or uses tentacles to construct a "fortress" out of rocks on the sea bed. These can often be identified by piles of discarded shells lying in the entrance.

Hunting for food: The octopus hunts at dusk. Crabs, crayfish and bivalve molluscs (two-shelled molluscs such as cockles) are preferred, although it will eat almost anything it can catch. It is able to change color to blend in with its surroundings, and jump upon any unwary prey that strays across its path. The prey is paralyzed by a nerve poison, which the octopus secretes, and the octopus is able to grasp its prey using its powerful tentacles with their two rows of suckers. If the victim is a shelled mollusc, the octopus uses its small teeth to punch a hole in the shell before sucking out the fleshy contents.

Mothering: The female lays clusters of up to 200,000 grape-like eggs inside her nest. She then guards them for four to eight weeks, depending on water temperature, continually touching and cleaning them as she circulates fresh water over them. The eggs hatch into larvae, which look like tiny adults, but which are only 3mm in length. These float in the sea with plankton before coming to rest on the seabed. They grow to maturity in about two years. In the meantime, their mother may well have died from exhaustion, as many female octopuses never recover their strength after going six weeks without food whilst guarding their eggs.

Enemies and Self-defense: Dolphins, sharks, moray and conger eels will all feed on octopuses. The octopus has a number of clever ways to defend itself from attack. The octopus swims head-first, and in times of danger can expel water through the end of its mantle, propelling it like a jet through the water. It can squeeze its body through tiny gaps to shake off predators, but more importantly, it is able to 'disappear' in order to escape detection. It does this by changing the color of its skin to blend perfectly with its surroundings. By concentrating and diluting the colored pigments in its skin, it can even produce stripes or strange patterns which seem to change its shape. Finally, it can squirt ink into the water to hide itself, in the same way that it does when hunting for food. At the same time it releases a substance which numbs the attacker's sense of smell, so that the octopus can escape undetected. If at any time the octopus damages a tentacle during a fight, it is able to quickly grow a new one!

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Phylum Mollusca: From the Latin, *Molluscus,* meaning "soft of body."
After the Arthropods, the Molluscs are the most successful of the animal phyla in terms of numbers of species. There are about 110,000 species known to science most of which are marine. They occupy a vast range of habitats however both aquatic and terrestrial, from the arctic seas to small tropical streams and from valleys to mountainsides.

Molluscs show a wide degree of adaptable variability in form, though their bodies are all bilaterally symmetrical and can be divided into two functional regions, and they use gills for gas exchange. They have an open circulatory system with a heart and aorta. Most species secrete a shell of some sort; these shells are long lasting and have been collected.

For thousands of years, some of these shells, and the pearls which come from oysters, which are also molluscs may be among the earliest forms of money.

Comparing the eyes of cephalopods and vertebrates: `
Humans (all vertebrates) and octopuses have developed the camera eye with lenses (as opposed to eyes that act as concave mirrors or pinhole cameras). However, they developed this evolutionary adaptation independently of one another.

The eyes of many taxa record their evolutionary history in their imperfect design. The vertebrate eye, for instance, is built "backwards and upside down," requiring "photons of light to travel through the cornea, lens, aqueous fluid, blood vessels, ganglion cells, amacrine cells, horizontal cells, and bipolar cells before they reach the light-sensitive rods and cones that transduce the light signal into neural impulses – which are then sent to the visual cortex at the back of the brain for processing into meaningful patterns." This reduction in efficiency may be countered by the formation of a reflective layer, the tapetum, behind the retina. Light which is not absorbed by the retina on the first pass may bounce back and be detected.

The camera eyes of cephalopods, in contrast, are constructed the "right way out", with the nerves attached to the rear of the retina. This means that they do not have a blind spot. This difference may be accounted for by the origins of eyes; in cephalopods they develop as an invagination of the head surface whereas in vertebrates they originate as an extension of the brain.