Table Rocks Curriculum

Symbio!

Objective: Students will define and give examples of six basic types of ***ecological relationship***s and will play a game (similar to Bingo) to demonstrate and reinforce their knowledge. Students may also observe and record interactions between organisms in the field and conduct additional research.

Benchmarks Targeted: 2 and 3 (Grades 4-8)
Oregon Standards:

Subject Area: Life Science

Common Curriculum Goals: Diversity/Interdependence: Understand the relationships among living things and between living things and their environments.

Benchmark 2: Describe the relationship between characteristics of specific habitats and the organisms that live there.

Benchmark 3: Identify and describe the factors that influence or change the balance of populations in their environment.

Subject Area: Scientific Inquiry

Common Curriculum Goals: Forming the Question/Hypothesis: Formulate and express scientific questions or hypotheses to be investigated.

Benchmark 2: Make observations. Ask questions or form hypotheses based on those observations, which can be explored through scientific investigations.

Benchmark 3: Based on observations and scientific concepts, ask questions or form hypotheses that can be explored through scientific investigation

Common Curriculum Goals: Designing the Investigation: Design safe and ethical scientific investigations to address questions or hypotheses.

Benchmark 2: Design a simple investigation to answer questions or test hypotheses.

Benchmark 3: Design a scientific investigation to answer questions or test hypotheses.

Common Curriculum Goals: Collecting and Presenting Data: Conduct procedures to collect, organize, and display scientific data.

Benchmark 2: Collect, organize, and summarize data from investigations.

Benchmark 3: Collect, organize, and display sufficient data to support analysis.

Common Curriculum Goals: Analyzing and Interpreting Results: Analyze scientific information to develop and present conclusions.

Benchmark 2: Summarize, analyze, and interpret data from investigations.

Benchmark 3: Summarize and analyze data including possible sources of error. Explain results and offer reasonable and accurate interpretations and implications.

Length of Lesson: 30 minutes to 1.5 hours depending on whether the scientific inquiry is applied.

Materials:

- ✓ SYMBIO! Cards (provided)

- ✓ Poker chips or other item to mark "Bingo"-like squares
- ✓ Pens or pencils
- ✓ Journal for observations and illustrations

Key Vocabulary*: **amensalism, commensalism, competition, ecological relationship, mutualism, neutralism, parasitism, symbiosis, symbiotic relationship***

Background:

Ecology is the study of the connectivity of different factors included in an ecosystem. All organisms have ***ecological relationship***s that exist with other organisms within their habitat. These relationships between organisms are often necessary for the organisms' survival. ***Ecological relationship***s are classified according to the effect (positive **+** or negative **-**) on each of the organisms involved. ***Ecological relationship***s of the first three types in the following table can involve a particularly close dependence of at least one of the organisms upon the other. This extremely close ***ecological relationship*** is referred to as ***symbiosis***, which stems from the Greek *symbios,* which means "living together." The following table presents the six basic types of ***ecological relationship***s according to such a classification scheme:

Symbiotic	***Mutualism***	++ both organisms benefit
Symbiotic	***Commensalism***	+0 one organism benefits; the other is unaffected
Symbiotic	***Parasitism***	+- one organism benefits; the other is harmed
Non symbiotic	***Competition***	-- both organisms are harmed
Non symbiotic	***Neutralism***	00 neither organism is affected.
Non symbiotic	***Amensalism***	-0 one organism is harmed; the other is unaffected

Symbiotic Relationships:

Mutualistic symbiosis is when both organisms benefit from their association. An example of ***mutualism*** is the relationship between a flowering plant and its pollinators. The plant benefits by having the pollen from its flowers transferred to another flower of the same species so that it can reproduce, while the pollinator benefits from the pollen or nectar it collects.

Parasitic symbiosis is when one organism exploits the other. For example, the mistletoe that grows on oak trees at the Table Rocks is a ***parasite***; it sinks its roots into the oak and steals water and nutrients. The oak suffers from the association; a heavy mistletoe infestation can even kill the tree.

Commensalistic symbiosis is when one organism benefits while the other is neither helped nor harmed. For example, moss growing on the bark of the oaks at the Table Rocks benefits by having a surface to grow on, while the oaks are not affected.

Non symbiotic Relationships:

Neutralism is a situation in which two organisms coexist without affecting each other. An example might be two bird species that share the same tree but rely on different prey,

and therefore have no impact on each other. Since the definition of ***symbiosis*** specifies a close ***ecological relationship***, ***neutralism*** is not a form of ***symbiosis***. It can be thought of instead as the absence of an ***ecological relationship***. However, since all organisms in an ecosystem are interdependent, even if indirectly, ***neutralism*** is rarely found in nature.

Amensalism is a relationship in which one organism is harmed while the other receives no biological benefit or consequence. For example, cows may trample streamside vegetation when they visit a stream to drink. The plants are harmed, but the cow gains no advantage from harming them. An ***amensalistic*** relationship does not involve an intimate dependence. Therefore, ***amensalism*** does not qualify as ***symbiosis***.

Competition is an ***ecological relationship*** in which both organisms suffer. For example, if two predator species compete for the same prey resource, or two plant species grow side by side and compete for limited nutrients, each species is impaired by the presence of the other. Direct ***competition*** can be difficult to observe in nature; when two organisms compete, typically one will displace the other, or the two will adapt to exploit different resources and thus avoid ***competition***. ***Competition***, like ***neutralism*** and ***amensalism***, is not a form of ***symbiosis***.

Procedure:

Preparation:
Ask students for examples of human interactions in which both partners benefit. Discuss situations in which each partner provides assistance or service in exchange for something received. In modern society many interactions of this nature involve the exchange of money, but encourage students to think of other cases in which money isn't involved. For example, a parent might cook dinner for a friend in exchange for that friend providing babysitting service for the evening. Explain that such mutually beneficial relationships occur frequently in nature as well as in human society. In nature, they are referred to as ***mutualism***. Introduce two or three examples of ***mutualism*** (see the SYMBIO! scenarios provided).

Next ask students for examples from human society of interactions in which one person gains at another's expense. When they have shared their thoughts, introduce the term ***parasitism*** and discuss some examples (see SYMBIO! scenarios). Last, introduce the term ***commensalism*** and discuss examples.

Referencing the example relationships you have already discussed, ask students what would happen to one partner if the other went extinct. In each case, one of the organisms involved depends heavily on the other and might not survive without it (in the case of ***mutualism***, this is true for both partners). Introduce the term ***symbiosis*** and emphasize to students that ***mutualism***, ***parasitism***, and ***commensalism*** are three different types of ***symbiosis***. Before introducing the other three types of ***ecological relationship***s discussed in the "Background," it may help to draw a table like the one in the "Background" on the board for students to see. Define and give examples of ***neutralism***, ***amensalism***, and ***competition*** as you fill in these terms in the table. Explain that these ***ecological relationship***s are not forms of ***symbiosis*** because they do not involve a close dependence.

Activity:
Pass out the blank SYMBIO! cards. Explain that the class is going to play a game that will reinforce their knowledge of the three types of ***symbiosis***, as well as ***competition*** and ***amensalism*** (***neutralism*** is not included). The game of SYMBIO! works like Bingo. First, have students fill in all the squares on their card randomly with the words ***mutualism***, ***parasitism***, ***commensalism***, ***competition***, and ***amensalism*** (have these terms written on the board for reference). Explain to the students that you will read various scenarios that describe actual ***ecological relationship***s in nature; their job is to decide which category each relationship falls under and place a poker chip on their card in one of the squares labeled with the appropriate term. If you have time beforehand, find photographs of each of the organisms described in the scenarios to show students as you read. When you play the game, be sure to read the scenarios in random order. When a student has filled five squares in a row (across, vertically, or diagonally,) that student may shout "SYMBIO!" (or "***Symbiosis***!"). Review with the class the scenarios you have presented, and make sure the winner has classified each one correctly. If the student has made a mistake, take the opportunity to review and clarify, then continue the game. If there are no mistakes, congratulate the winner and begin a new round.

Scientific Inquiry:
Ask students to brainstorm some ***symbiotic relationships*** they think they might observe in nature. Then have them spend at least 30 minutes (either during class time or as a homework assignment) in an outdoor setting observing any organisms that seem to interact or coexist. During the exercise, students should record their observations and perhaps make illustrations of the organisms involved. They should also record information such as location, habitat type (woodland, grassland, riparian, etc.), weather, date and time of day, nearby man-made structures or human activity that might affect the ecology of the site, and size of the area in question. Based on their observations, students should form hypotheses as to what type(s) of ***ecological relationship***(s) might exist between the different organisms they observed. Have students share their observations and their hypotheses with the class. For each hypothesis proposed, engage the class in a discussion: Do they agree or disagree? Why?

Next, students might tally the different types of ***ecological relationship***s proposed and make a bar graph of the data. Do some types of relationships seem to be more prevalent than others? Why? Might some types of relationships occur more frequently? Or are they just easier to observe? Might the results be different if the exercise was performed in a different location or during different weather?

Adaptation:
Have students conduct research to find examples of each type of ***ecological relationship*** discussed in the lesson. In order to narrow the students' field of inquiry, you might direct each student to research just one particular type of ***ecological relationship***. Have students write SYMBIO! scenarios based on an example they discovered in their research describing the interaction without giving away which type of ***ecological relationship*** it is. Play SYMBIO! using these student scenarios instead of the ones provided.

Discussion Questions:

What are three examples of *symbiotic relationship*s you may see at the Table Rocks? Which type of *symbiosis* does each represent?
*Some common examples of **mutualistic symbiotic relationships** students may see could include a bee pollinating a flower, or observing lichen, which is a **mutualistic symbiotic** relationship between algae and fungi. A common **commensalistic relationship** that can be observed is lichen or moss growing on the trees. A **parasitic relationship** would be the mistletoe growing in the oak trees, or a tick getting on a person or other animal. **Amensalism** could be the students themselves hiking on the trails, and walking on or near the vernal pools of the Table Rocks, or other hikers that have picked flowers. **Competition** might be observed between squirrels and Acorn Woodpeckers wanting the same dietary supplement of acorns.*

Which type of *symbiosis* provides an adaptive advantage to both organisms involved (i.e., helps both partners survive or reproduce)? Which type of *symbiosis* gives an adaptive advantage to one of the organisms involved while harming the other?
***Mutualism** provides an advantage to both partners. **Parasitism** gives an advantage to one partner while harming the other.*

Why don't *parasites* usually kill their host?
If a parasite kills its host, it will die as well. Most parasites have evolved to exploit their host only as much as the host can withstand without dying (of course, the host's health, growth, and ability to reproduce may be compromised). Some parasites end up killing their hosts, but not before they (the parasites) have reproduced or moved on to a new host.

If the host organism in a *parasitic* relationship evolved a new defense against the *parasite*, how might this influence the evolution of the *parasite*?
The parasite would be under new selective pressure. It might evolve a resistance to the host's new defense, or it might become adapted to a different host.

If a plant species' primary pollinator went extinct, how might this affect the plant species (in both the short-term and long-term)?
In the short-term, the plant species' population would decline because it would not be able to reproduce as effectively. In the long-term, the plant might adapt to be more attractive to a different pollinator.

References:

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Mutualism. 2007. McDaniel College. 6 Feb. 2008 <http://www2.mcdaniel.edu/Biology/eco/mut/mutualism.html>.

Symbioses. L. Chinnery. 2000. Department of Biological and Chemical Sciences: University of the West Indies. 6 Feb. 2007 <http://scitec.uwichill.edu.bb/bcs/courses/Ecology/BL21B/symbioses.htm>.

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SYMBIO!

		SYMBIOSIS		

SYMBIO! Scenarios

Mutualism

- A special type of fungus called mycorrhizal fungus feeds off of the roots of oak trees. The fungus spreads out through the soil and helps the oak absorb water and nutrients. In return, the oak tree provides sugars, which it manufactures through photosynthesis, to feed the fungus.

- Bees collect pollen from camas flowers to feed their young. When a bee visits a flower, some pollen gets stuck to its hairy body. When it visits the next flower, that pollen may rub off and pollinate the flower, thus allowing the camas to reproduce.

- A certain kind of bacteria lives in the intestines of many animals on the Table Rocks (including humans!). The bacteria have a safe place to live and plenty to eat; in return, they help the animal digest its food.

- The fuzzy, grayish-green lichen that grows on the oaks of the Table Rocks is not one organism but two, an alga and a fungus living together. The fungus gives the lichen its shape and protects the algae cells within it from drying out. The algae cells live inside the fungus, performing photosynthesis to provide food for themselves and for the fungus.

- The Native Americans' use of fire to manage the oak savannah plant community provided the oak trees with soil rich in nutrients. The trees don't have to compete with other vegetation for food and water after a fire, and in turn the oak trees produce lots of acorns providing the Native Americans with plenty to collect and harvest for food.

- Many different types of lichen grow on oak trees. Some types of lichen help enrich the soil the trees grow in by acting as nitrogen fixers, meaning they help add nitrogen to the soil. Nitrogen helps plants to grow. The trees support the lichen, which in turn enrich the soil when they fall to the ground and decompose or when rain water flows over them leaching out the nitrogen.

- Squirrels love to eat acorns. They collect and gather as many as they can and will bury them in the dirt for future use. With so many acorns buried in the dirt, squirrels often forget where they have placed them. In turn, they help oak trees by planting next year's crop of trees.

Parasitism

- Mistletoe grows from the branches of the oak trees at the Table Rocks. The mistletoe sinks its roots into the oak, stealing water and nutrients. The oak suffers and can even die from a heavy mistletoe infestation.

- Ticks attach themselves to humans and other animals, feeding on their host's blood. They can harm their host not only by stealing blood, but also by transmitting bacterial infections.

- The oak gall wasp lays its eggs within the bark of an oak tree. The eggs release a chemical that causes the oak to form a spongy growth called a gall. When the eggs hatch, the wasp larvae develop within the gall, protected from predators, munching away at the gall tissue. The oak wastes energy forming a growth that does it no good.

- Fleas bite mammals such as deer, squirrels, and people. They harm their host by sucking their blood and sometimes transmitting infection.

- Tapeworms live inside the intestines of mammals at the Table Rocks (including humans!). They will soak up the nutrients that have been pre-digested by their host through their skin. The host suffers from being deprived of nutrients.

- Instead of raising its own young, the cowbird lays its eggs in the nests of other birds. An unsuspecting mother bird will spend all her energy providing food for the demanding cowbird chick while her own chicks starve.

- The roots of the Indian paintbrush flower penetrate the roots of neighboring plants, stealing nutrients from the plants that they could have used to grow.

Commensalism

- A bird called the Oak Titmouse nests in cavities in trees that grow on the Table Rocks. It can't peck out a cavity of its own, but instead nests in old woodpecker cavities that have been abandoned. The Oak Titmouse depends on the woodpecker for safe, cozy nest sites, while the woodpecker neither benefits nor is harmed by the Oak Titmouse using the abandoned cavities.

- A fairy shrimp cyst in the mud at the bottom of a vernal pool gets stuck to the leg of a duck. The duck flies away and lands in another vernal pool where there aren't any fairy shrimp, transporting the cyst to new habitat and thus allowing the fairy shrimp species to colonize new territory. The duck gains nothing by transporting the cyst.

- Moss grows on the bark of the oak trees at the Table Rocks. It does not harm the tree, but benefits by having a place to grow where no other plants can.

- Several types of lichen grow on the bark of the trees and shrubs of the Table Rocks. The lichens are photosynthetic; they make their own food. They take nothing from the plants they grow on, but they benefit by having a place to grow.

- Houndstongue, which grows in the woodlands of the Table Rocks, produces a seed covered with little hooks that can stick in the fur (or clothing!) of a passing animal. The animal is neither helped nor harmed, but the houndstongue benefits by having its seed dispersed to new territory.

- The Blue-gray Gnatcatcher builds its nest in the protective cover of a thick patch of buckbrush. The bird safely raises its young in its hidden nest while the buckbrush neither benefits nor is harmed.

- Ignoring the "No Dogs" sign at the trailhead, someone takes their dog, unleashed, for a walk on Lower Table Rock. The dog runs through the brush, and seeds from star thistle attach to the dogs fur. Further up the trail the seeds fall off and this noxious weed is able to contaminate a new area. The dog and its owner continue their walk unharmed.

Competition

- Two flower species on the Table Rocks rely on bees as pollinators. But it's been a very cold spring, and frosts have killed most of the bee population. Neither plant is able to get all its flowers pollinated, because there simply aren't enough bees to serve both of them.

- In the mixed woodland at the Table Rocks, many species of trees grow side by side, and they all need the same resources: sunlight, water, and nutrients from the soil. Neither tree is able to grow as fast as it might if it had more space.

- The Acorn Woodpecker and California ground squirrel populations have grown to large numbers, and not enough acorns are available for both populations to store for the winter. Both find as many acorns as they can, but neither has enough.

- In the oak savannah at the Table Rocks, several species of birds all nest in tree cavities. However, there aren't enough cavities to accommodate them all! Some individuals of each species are unable to reproduce because they can't find a nest site.

- The Anna's Hummingbird and the Rufous Hummingbird both like to feed from the same types of flowers. When a male hummingbird finds a good patch of flowers, he'll defend it from other hummingbirds. But there aren't enough patches of flowers at the Table Rocks for all the hummingbirds, so some have to leave and look for flowers elsewhere.

- The lack of fire on the Table Rocks has left the buckbrush and manzanita tough and hard. The homeowners around the Table Rocks are happy there has not been any fire but the buckbrush and manzanita have grown very dense and thick. With the lack of fire to crack open their seeds, and little space or sunlight to grow, neither plant is able to sprout new plants.

- A rattlesnake and a gopher snake both spot a Western fence lizard looking very tasty, sunbathing on the lava rock at Table Rocks. They both try to grab the lizard, but end up fighting each other trying to get to it first, giving themselves away to the sunbathing lizard. The Western fence lizard gets away and both snakes are left hungry.

Amensalism

- An elk goes to a vernal pool to drink. On its way, it tramples some vegetation that grows alongside the vernal pool. The plants are damaged, while the elk gains no benefit and suffers no harm.

- A student goes off the trail during a hike at the Table Rocks. He steps on some flowers, crushing the developing seeds and preventing the plant from reproducing. Fortunately, Laurel prevents the student from stepping in poison oak, and the student returns to the trail unharmed. The flower seeds are damaged, while the student does not biologically benefit from their actions.

- Ignoring the signs that say "No Off-Highway Vehicle Use" on the Table Rocks, Damiana decides to ride her 4-wheeler on top of one of the Table Rocks. The tires tear up the vegetation and displace soil. Two years later, you can still see the swirl marks of the tires where no plants grow. Damiana receives no biological benefit from this behavior.

- Molly carves her name into a madrone tree. Wood-eating insects and disease can invade the tree more easily where her name is carved. Molly does not biologically benefit from her actions.

- A town decides to pave over a vernal pool to build a shopping center. The unique species that lived there no longer have a home. The people of the town do not biologically benefit, nor are they harmed.

- While hiking Upper Table Rock, Joe decides to ignore the "No Dogs" signs and brings his two black labs for a hike. At the top his dogs start to chase a Killdeer, a bird that builds its nest on the ground. After the exhausted bird escapes, in addition to finding food for its babies, it must now find more food for itself to make up for the energy lost getting away from the dogs. The dogs continue on their walk, and received no benefit from the chasing the Killdeer.

- Gwyn loves horses and she loves the Table Rocks. One day she decides to ignore the "No Horses" sign at the base of the trailhead on Lower Table Rock and goes for a ride. While she is admiring the view from the top, her horses trample a patch of dwarf woolly meadowfoam. The rare plants are destroyed but Gwyn and her horses are free to finish out their day.