

Symbiosis in Agriculture

Skills: Science, Language Arts

Objective: Students compare insect relationships according to their symbiosis class—parasitism, commensalism, mutualism.

Background

Symbiosis means living together. Any two different organisms that live together are symbiotic, whether they benefit one another, harm one another, or have no effect on one another. There are three forms of symbiosis: parasitism, commensalism, and mutualism.

- Parasitism—Parasite benefits; host is hurt
- Commensalism—One species benefits; the other is neither hurt nor helped.
- Mutualism—Both species benefit.

In agriculture there are many examples of symbiosis. People have mutualistic relationships with food crops and livestock. In the case of plant agriculture, farmers protect and fertilize crop plants for greater yields. This benefits the plants by making them stronger and helping them fight off competitor plants and insects. It also helps them survive as a species. The people who benefit by eating the crops also grow stronger and survive.

Insects like bees and wasps have mutualistic relationships with crops as they help with pollination in return for a source of pollen. Not all relationships between crops and insects are mutualistic though. Insects like the squash vine borer and the corn ear worm destroy their host plants in the process of drawing sustenance from them. In this case the relationship is parasitic.

Animal agriculture also provides examples of symbiotic relationships between animals and the people who care for them. Cattle, sheep and goats graze areas that are unsuitable for growing crops, transforming grass, which people cannot digest, into protein (meat) that people can eat. People do their part in this mutualistic relationship by protecting the animals from predators, by caring for the pasture land and by providing food when pasture is unavailable.

Background sources: “Animal Agriculture Symbiosis, Culture or Ethical Conflict?” *Journal of Agricultural and Environmental Ethics*, Volume 19, #1, February 2006; *World Book Encyclopedia*, 1998.

ACTIVITY 1: DISCUSSION

1. Write the words “symbiosis,” “parasitism,” “mutualism,” and “commensalism” on the chalkboard, along with the definitions included in the background.
—Students will write the vocabulary in their lab books or journals.

P.A.S.S.

GRADE 6

Science Process—2.1,2;
4.1,2; 5.2,3,4

Life Science—3.2; 4.1,2

Reading—1.1a; 3.1b;
5.1a,2a

Writing—1.2; 2.2d,7

Oral Language—1.1

Visual Literacy—3

GRADE 7

Science Process—2.1,2;
4.1,2; 5.2,3,4

Life Science—2.1,2; 4.2

Reading—1.1; 3.1; 5.1a,2a

Writing—1.2; 2.2b,8

Oral Language—1.1

Visual Literacy—3.1

GRADE 8

Science Process—2.1,2;
4.1,2; 5.2,

Life Science—3.1,2

Reading—1.1; 3.1; 5.1a,2a

Writing—1.2; 2.2d,8

Oral Language—1.1

Visual Literacy—3

Resources Needed

computer and/or library
access

Insect List
soil-searching wasp

brown fruit moth

Varroa mite

Acarina mite

African hive beetle

corn earworm

honey bee

stink bug

2. Use the background information and vocabulary to familiarize students with the concept of symbiosis and the examples of these relationships in agricultural production.
 - Students will discuss background and list additional examples of symbiosis in agriculture.

ACTIVITY 2

1. Make copies of the “Symbiotic Relationships in Agriculture” cards.
 - Cut the cards and place them in envelopes, 4-6 per envelope.
 - Divide class into groups of four and provide each group with one of the envelopes.
2. Students will read the descriptions and discuss the relationships in groups to determine if each relationship is symbiotic and, if so, if it is an example of a mutualistic, parasitic or commensalist relationship.

ANSWERS: 1. Not technically symbiotic. Organisms are in competition for the same resource—water. 2. commensalist. 3. mutualist. 4. mutualist. 5. parasitic. 6. parasitic

3. Students will discuss their answers as a class.
4. Discuss the following: Can a symbiotic relationship change from mutualism to commensalism or parasitism? (e.g., overgrazing grass, killing beneficial insects in the attempt to protect plants from destructive insect)
5. Hand out copies of the Symbiosis Lab Questions for students to answer in writing.

ACTIVITY 3: A FLOWER AND A MOTH

1. Hand out copies of the story included with this lesson.
2. Students will read the story independently, in pairs, or in groups.
3. Students will list the symbiotic categories.
4. Students name symbiotic relationships found in the story.
5. Students will describe the symbiotic relationships.

Mutualism —plant and animal (yucca plant and yucca moth: Each needs the other to survive.)

—animal and animal (aphid and ant: Ant protects aphid from the ladybugs and also eats caterpillars that eat the aphids’ food. Ant gets sweet honeydew from the aphid.

Parasitism—animal to plant (aphid and yucca plant: Aphids suck juice from the plant and causes plant leaves to turn yellow and curl downward.)

ACTIVITY 4

1. Divide students into research groups to study insects which play a role in agriculture.
 - Students select one or more of the insects listed at left or choose other insects to research, using an online search engine or library reference sources.
 - Before research begins, students predict the insect’s symbiotic relationship with agriculture.
 - Students identify the insect’s symbiotic relationship with agriculture. Is the relationship harmful or beneficial to agriculture?
 - Students organize data about each insect in a class or an individual

chart.

2. Discuss ways insects, other animals, or plants could show mutualism as a benefit to agriculture.
6. Students write a poem (cinquain, diamante, etc.) or draw a cartoon illustrating the researched insect's symbiotic relationship with agriculture.

Extra Reading for Students

Brett, Jan, *Honey . . . , Honey . . . , Lion!* Putnam Juvenile, 2005.

Facklam, Margery, *Partners for Life: The Mysteries of Animal Symbiosis*, Little Brown, 1989.

George, Jean Craighead, *Cry of the Crow*, HarperCollins, 1988.

Hauth, Katherine B., *Night Life of the Yucca—The Story of a Flower and a Moth*, Harbinger House, 1996.

MacLochlan, Patricia, *Caleb's Story*, HarperTrophy, 2002.

Silverstein, Alvin, *Symbiosis*, 21st Century, 1998.

White, E.B, and Garth Williams, *Charlotte's Web*, HarperCollins, 2006.

Extra Reading for Teachers

Burger, William C., *Flowers: How They Changed the World*, Prometheus, 2006.

Burger, William C., *Perfect Planet, Clever Species: How Unique Are We?* Prometheus, 2002.

Jackson, Louise E., *Ecology in Agriculture (Physiological Ecology)* by, Academic, 1997.

Vocabulary

commensalism—a relation between two kinds of plants or animals in which one obtains a benefit (as food) from the other without damaging or benefiting it

fauna—the animals of a specified region or time

flora—the plants of a specified region or time

mutualism—association between different kinds of organisms that benefits both

organism—an individual living thing that carries on the activities of life by means of organs which have separate functions but are dependent on each other

proboscis—a tubular or snoutlike organ, as of some insects, worms, and mollusks

parasitism—a close association between living things of two or more kinds of which one is a parasite obtaining benefits from the other which is a host and is usually harmed in some way

symbiosis—the living together in close association of two different kinds of organisms.

Symbiotic Relationships in Agriculture

<p><u>1. Red Cedar and Pasture</u> In areas where red cedar is not controlled, the grass frequently disappears, erosion starts and gullies begin to form. Red cedar survives drought conditions by drawing water away from grass.</p> <p>Is this a symbiotic relationship? If so, is it parasitic, mutualistic or commensalist?</p>	<p><u>2. Cows and Egrets</u> The Cattle Egret is often seen in the company of cattle, horses and other grazing animals. The grazers stir up insects, which the egret then eats.</p> <p>Is this a symbiotic relationship? If so, is it parasitic, mutualistic or commensalist?</p>
<p><u>3. Cattle and Grass</u> When cattle are properly grazed they aerate the soil with their hooves, allowing more oxygen to enter the soil and helping grasses and plants grow better. If soil isn't aerated, it develops a hard crust, which decreases the amount of water and nutrients it can absorb. Grazing cattle also press grass seed into the soil and provide natural fertilizer in the form of manure. When cattle graze they reduce the length of the grass. This helps reduce the spread of wildfires.</p> <p>Is this a symbiotic relationship? If so, is it parasitic, mutualistic or commensalist?</p>	<p><u>4. Mycorrhizal Fungi and Plants</u> Plants photosynthesize and provide carbon to mycorrhizal fungi in return for nutrients that the fungi take up from the soil. Mycorrhizal fungi help plants get nutrients by extending plant root systems beyond low nutrient zones into places where more nutrients are available. Fungal hyphae are often much smaller in diameter than roots, which allows them to access nutrients and water in smaller soil pores. Finally, fungi have higher surface-to-volume ratios than roots, which increases the rate at which nutrients are absorbed.</p> <p>Is this a symbiotic relationship? If so, is it parasitic, mutualistic or commensalist?</p>
<p><u>5. Southern Green Stink Bug and Cotton</u> The southern green stink bug feeds on cotton with its piercing-sucking mouth parts. Salivary fluid is pumped down the salivary duct and liquefied food is pumped up the food canal. The stink bug feeds on all plant parts but prefers growing shoots and developing fruit. Attached shoots usually wither and may die. Young fruit growth is retarded, and the fruit often withers and drops from the plant.</p> <p>Is this a symbiotic relationship? If so, is it parasitic, mutualistic or commensalist?</p>	<p><u>6. Wasp and Stink Bug</u> Stink bugs lay their eggs in masses. There are several species of very small wasps that take advantage of this by searching for stink bug egg masses and laying their own eggs inside the individual stink bug eggs. The larvae complete their development inside the eggs.</p> <p>Is this a symbiotic relationship? If so, is it parasitic, mutualistic or commensalist?</p>

Symbiosis: A Flower and a Moth

In late May, after the rains fall, a plant with clusters of waxy, bell-shaped flowers emerges from the desert. As bats catch insects by the millions and owls search for mice, which search for seeds, the yucca flowers open.

A small silver-white yucca moth enters the yucca flower petal, folds her wings and rests. A male moth mates with the female and flies away.

The female moth recovers the golden pollen from each of the six stamens that circle the broad pistil in the center of the flower. She works the pollen into a ball approximately the size of her head. She carries this ball under her neck and flies into the night.

The moth is guided by the fragrance and whiteness of the waxy flowers. She must visit hundreds of flowers and plants while eluding the bats, which are also busy at night. She inserts her proboscis deep into young blossoms and lays eggs at the base of the pistil.

She packs a hunk of pollen into the tip of the pistil. As she moves up and down the pistil, she repeats her egg-laying, pollen-packing action. She must work quickly, because she lives for less than a week.

From each minute grain of pollen, a tube grows to reach an ovule in the chamber, which will house the moth's eggs until they hatch. Only yucca moths bring the pollen that the yucca plant needs for the ovules to become seeds that will grow into young yuccas. The yucca seeds are the only food that the moth's young will eat.

During the day, others will visit the yucca plant. Aphids suck juice from new blooms, while ants milk the aphids for droplets of sugary honeydew. As the sun heats the desert, and the yucca petals droop, the yucca's pistils swell with growing seeds. If the aphids, weather, or mule deer don't destroy the blossoms, the moth's eggs will hatch in about a week.

The moth's young eat some yucca seeds, but hundreds more of the seeds survive. In four to eight weeks, the full-grown larvae bore through their seed-pod caves, lower themselves to the ground on silk threads and burrow down to weave sticky cocoons.

Through the fall, the open yucca pods are shared with mice and ants. In the winter these same empty pods are capped with snow.

If no rain has fallen by May, the yucca moth will not appear. The yucca plant will not bloom. Instead, it will wait until the following spring, when the rains return. The stiff yucca leaves funnel water to its roots and also shade the wet roots when the sun returns. Soon the yucca plant will bloom, and during the night, a yucca moth will find it.

(Text adapted from *Night Life of the Yucca, The Story of a Flower and a Moth*, by Katherine B. Hauth.)

List the three kinds of symbiosis.

Which of the three kinds of symbiosis are represented in the story above?

Explain the symbiotic relationships.