

Source: Developed by Dr. Carol Landis. Math, Science, and Technology Education Section, Ohio State University, Columbus, Ohio. Used with permission.

10. “YOU SCRATCH MY BACK AND I’LL SCRATCH YOURS”

That old saying was used to refer to an informal agreement. It usually meant, “I’ll do this for you, if you’ll do that for me.” Actually, that kind of a relationship exists between many different kinds of living things. Such a “mutualistic” relationship exists where two different organisms benefit from living closely with each other. **Can you think of some examples?**

For example, bees get nectar from flowers. While the bee gets the food it needs, some of the pollen from the flower gets caught on the bristles on the bee’s body. The pollen is carried to the next flower the bee visits and may be transferred. This can pollinate the flower. Another example, from the ocean, can be seen by watching a fish called a goby (go’-bee). Gobies are small fish that set up “cleaning stations” where they pick particles and small parasitic living things out of the mouths and gills of larger fish (like groupers). The goby stays by a certain place—its “station.” The grouper swims to the cleaning station and stops there, holding its mouth open. The grouper does not close its mouth or try to eat the goby. Both organisms benefit; the goby gets a “free meal” without having to find food, and the grouper gets rid of some pesky parasites.

Background Information

Some corals and a certain group of algae have a mutualistic relationship as well. Scientists don’t understand all of the factors that are important in this relationship. However, it is well established that certain kinds of brownish algae called “zooxanthellae” (zo’-uh-zan-thell’-ee) can live inside the body of some kinds of corals. The algae live in the lining of the “gut” of each of the coral polyps (paul’ips).

During the daytime, the algae carry on photosynthesis, just like plants, to produce their food and provide energy and materials for their other cell processes. The algae use carbon dioxide and give off oxygen during photosynthesis. While in the polyp, the algae get a protected place to live, a constant source of carbon dioxide, ammonia, and other substances for photosynthesis. Meanwhile, the polyp uses the oxygen given off by the algae and the sugars produced through photosynthesis. This process is called cell respiration. **What is one exchange that occurs in this mutualistic relationship?**

The algae provide oxygen to the coral polyps, which give off carbon dioxide used by the algae. Likewise, polyps use the sugars produced by the algae as food and give off nitrogen compounds that are used by the algae.

Materials

- 20 waxed paper sandwich bags, or translucent plastic cups
- wrapped caramel candies, or butterscotch lifesavers
- a yellow circle made of posterboard labeled “Sun”
- student chairs
- a blanket
- a ball of yarn, or a roll of string

Role Play -- Round 1: PHOTOSYNTHESIS

Set several chairs (10-20) close to each other and all facing the same direction. One student should sit in each chair. Ask the students to move their chairs close together. Each student will hold a bag/cup with about a half dozen yellowish-brown candies in it. Each bag/cup now represents a coral polyp with algae in it, and the whole group of students represents a colony of coral. The set of chairs represents the stony structure which we often call “coral” which is the basis of the larger structure known as a “reef.”

Select a student to be the “Sun” and give him/her the yellow circle of posterboard to carry. Have this student walk around the set of chairs, making a complete circle. Because the Earth spins, we see the Sun in the daytime, but not at night. As the person representing the Sun moves in front of the chairs and becomes visible to the students seated in them, the seated students should shake their “polyp” bags/cups with the “algae” in them to represent the chemical activity of photosynthesis. Since photosynthesis requires sunlight, the shaking should cease when the Sun goes behind the chairs. At this time (i.e., night), the students should wave their arms (“tentacles”) above their heads, as if they are gathering food particles from the “water” and placing them into their mouths.

Note: The teacher should point out that the notion that the Sun moves across the sky is an historic misrepresentation of the astronomical phenomenon of day and night. To better represent what really happens, the student representing the Sun should stand in one place while the set of chairs revolves and spins around him/her. This is obviously impractical! A teacher-demonstration using a “lazy Susan” and a flashlight may be useful before the Role Play.

Role Play -- Round 2: EFFECTS OF EXTREME TEMPERATURES

Have the students remain in the chairs, as in Round 1, but this time ask a student to stand by the chalkboard and write a different number (water temperature) on the board at 15 second intervals. Have another student assist by timing and keeping track of which temperature is next. Begin with 26° C and increase the temperature by one degree every 15 seconds until the temperature is 32° C. When the temperature reaches 30°, have half of the students empty out most of their “algae” candies and just move their bags/cups once as the Sun passes in front of them. ***How do the “corals” look now?***

They are less colorful and the algae within them are less active.

Explain that the loss of algae is often referred to as “coral bleaching” since the corals look lighter than normal in color. The polyps are still alive, but they do not benefit from the interactions with the algae at this time. If the polyps were to lose all of the algae, their tissue would be completely transparent and would look white because of the background color of their stony cup. (If photographs of bleached coral are available, show these to the class.) Bleaching also occurs at times when the water temperature is unusually low, when the oxygen level is too high, when the water becomes too salty, when too many particles are floating in the water making it less clear, when the amount of different wavelengths of light changes, or when corals become diseased. Scientists are still learning about the combinations of factors that contribute to coral bleaching. ***What might cause the water to be less clear?***

This can occur when sand is stirred up from the bottom, or because of silt and mud washing off the land into the ocean.

Now have the student at the chalkboard successively decrease the temperature by one degree every 15 seconds until it reaches 26° again. As the temperature goes under 30° C, the “bleached” corals can add “algae” to their “polyps” and, when the Sun shines on them, shake their bags/cups as before.

Explain that the algae remaining in the polyps can reproduce and restore themselves to their normal numbers inside the coral polyps once conditions become favorable again. This can occur within days of the bleaching event. Scientists have learned that corals often recover from bleaching events that last several weeks, or longer. However, the longer the corals remain bleached, the less likely they are to recover. Prolonged periods of bleaching, without recovery, will ultimately lead to the death of polyps.

Have the group do another round where the temperature stays high and the polyps do not recover all their algae, and therefore die. Use string or yarn to rope off and cover the surface of the chairs where the coral died, representing filamentous algae that cover the surface of the coral skeletons in the absence of living polyps.

Role Play -- Round 3: EFFECTS OF LACK OF SUNLIGHT

This time, block the light from one section of the reef. Place a movable chalkboard or a blanket between the path of the Sun and the "reef" to prevent sunlight from reaching the algae. **Can you predict what might happen to the reef?**

The algae do not receive any sunlight, so they cannot carry out photosynthesis. (Algae, like plants, need adequate sunlight to thrive.) The coral polyps do not receive food and oxygen from the algae and also lose their ability to gather food.

What are some things that might block the light from the algae?

A coating of sand and silt covering the corals blocks the sunlight. Also, garbage bags, clothing and other things that are lost or tossed overboard from ships can get tangled and caught on the reef.

Remove the object shading the coral. **How might the corals respond to increased sunlight?**

The corals may recover if the algae are able to sufficiently reproduce.

Decide as a group whether or not the affected coral polyps will recover. Consider how long the sunlight was blocked, and how long the polyps showed the effects of bleaching. Enact re-exposure to sunlight.

Explain to students that the effect of severe shading on coral varies, depending on whether sunlight is blocked due to suspended sediments in the water, or whether an object (marine debris) rests on the surface of the coral. In the latter case, the algae cannot photosynthesize productively, moreover the polyps cannot feed by gathering particles from the water. **What will undoubtedly happen to polyps that are shaded and also unable to feed from the water?**

They will die.

Summary

The close association of algae and coral polyps is not completely understood. Scientists have known for a long time that algae live inside the coral polyps, and that they carry on photosynthesis and respiration in a mutualistic relationship. More studies will help us to better understand the processes and the interactions between these different organisms. Coral reefs provide nutrition and a place to live for many kinds of organisms. Some factors that cause stress for the organisms of the reef include: increased water temperature which can make the water more salty by evaporation, increased silt and other things that cover the reef's surface, and changes in the amount and kinds of energy that are received from the Sun. Because coral reefs are important parts of the marine ecosystem, and recent changes that can be seen are hard to explain, scientists will continue to study the organisms and conditions that are associated with coral reef systems. We are conscious about the impact of a variety of human activities on the complex system of living things, in the oceans and elsewhere.

Review

1. What kind of relationship exists between algae and coral polyps in reefs?
2. What does each of the organisms gain from this relationship?
3. List some factors that affect the ability of the algae to survive.
4. Explain how corals feed.
5. What are some examples of human actions that interfere with the normal processes of coral reef communities?
6. What are some ways that we can reduce the stresses on the reefs?
7. What are some factors that we cannot control?

Glossary

Calcification: The hardening of tissue from the addition of calcium carbonate and other calcium-based compounds (examples: formation of coral reefs and bones of humans and other mammals).

Coral polyp: A single coral animal with a cylindrical body and tentacles. Many polyps form a colony. Over many years, a large colony can produce a structure called a reef.

Organism: Any living thing (examples: fish, butterfly, horse, or human).

Parasite: An organism that lives on or in another one and damages or weakens the host (examples: tapeworms, fleas, tooth decay bacteria, etc.).

Photosynthesis: A chemical reaction by which plants and algae use energy from sunlight to produce sugar. This reaction uses carbon dioxide and gives off oxygen.

Respiration: The process of using oxygen and giving off carbon dioxide, as part of the chemical reactions in cells.

Correlation to National Standards from McREL (<http://www.mcrel.org>) :

Life Sciences

5. Understands the structure and function of cells and organisms
6. Understands relationships among organisms and their physical environment

Geography

7. Knows the physical processes that shape patterns on Earth's surface