What Goes Around Comes Around!

Summary

The paths of water, carbon, and nitrogen are cyclic. In this lesson students will model the cycles of matter by creating an ecosystem in a jar. They will also give research-based oral presentations on the carbon, water, and nitrogen cycles.

Time Frame

3 class periods of 45 minutes each

Group Size

Small Groups

Life Skills

Thinking & Reasoning, Communication, Employability

Materials

- Computers with Internet access
- projector
- overhead
- library
- paper

Materials for making ecosystems in a jar:

- large glass jar with lid
- pond water or dechlorinated tap water
- gravel or rocks
- soil
- pinch of grass seeds and/or pinch of clover seeds
- mung bean seeds
- earthworms
- isopods
- mealworms
- crickets
- strands of Anacharis, Fontinallis, and/or foxtail
- duckweed
- black ram's horn snails
- guppies
- Daphnia

Background for Teachers

The sun provides the energy that drives the water cycle. Heat from the sun evaporates water from oceans, lakes, rivers, moist soil surfaces, the leaves of plants and from the bodies of other organisms. As water vapor cools in the atmosphere, it condenses and forms tiny droplets in clouds. When the clouds meet cold air, the water returns to the Earth again in the form of precipitation. The precipitation that falls on land may just evaporate again into the atmosphere or it may collect in streams and rivers that flow into the oceans. The precipitation may also soak into the soil. Water that soaks into the soil may be used immediately by plants or it may seep down through the soil and rocks until it reaches a layer of rock or clay where it can go no farther. This layer of underground water is

called ground water. Ground water may flow great distances underground and rise to the surface again, or it may be pumped up far from where it first entered the soil.
Carbon also cycles between the nonliving environment and living organisms. The earth's atmosphere is about 0.035 percent carbon dioxide. Carbon dioxide in the air or dissolved in water is used by photosynthesizing plants, algae, and bacteria as a raw material to build organic molecules. In effect, they trap the carbon atoms of carbon dioxide within the living world. Carbon atoms return to the pool of carbon dioxide in the air and water in three ways: 1. Cellular respiration. 2. Combustion or burning. 3. Erosion.
Organisms contain large amounts of nitrogen because proteins and nucleic acids are both nitrogen rich. The atmosphere is 79 percent nitrogen gas. Most organisms are unable to use the nitrogen gas that is so plentiful in the atmosphere. A few bacteria have enzymes that can bind the nitrogen atoms to hydrogen, forming ammonia. Nitrogen fixation occurs only in the absence of oxygen. Nitrogen fixation can only occur within swellings, or nodules, on the roots of beans, alder trees, and a few other kinds of plants. Lightning also fixes nitrogen, that is it makes it usable by living organisms.

Intended Learning Outcomes

- Make observations.
- Use references sources to obtain information.
- Make predictions.
- Identify variables.
- Plan investigation.
- Collect and record data.
- Analyze data and draw warranted information.
- Construct models.
- Understand science concepts.
- Use the language of science to communicate.

Instructional Procedures

1. Show the class a small log on which fungi are growing. Remind students that the fungi, as heterotrophs, digest the log to obtain the nutrients they need. However, as they do so, they also help to decompose the log and thus return materials to the ecosystem. Draw an analogy between the fungi and a person who recycles metal, glass, and plastic. Nature has recycled materials within ecosystems for millions of years. Humans have only recently recognized the importance of recycling materials.
2. Instruct students to make ecosystems in a jar. Ask the students to bring the materials or supply them for the students. Refer to the ecosystem throughout the lesson. If done right the ecosystem will last a up to a year or more. The single key is the size of the jar: the bigger the better. The students should have a design in mind when they construct their ecosystems, that is, they should have a purpose for everything the put into the ecosystem.
Each day the students should write down their observations of their ecosystems. Allow them to make adjustments in their systems for up to a week and then seal their ecosystems. Discuss the results of their experiences. If an ecosystem fails discuss why; also, if it works, discuss why. This activity will demonstrate the concepts being taught.
3. Form groups of six students. Each group of six will subdivide into three groups of two. Each group of two will decide which cycle (nitrogen, water, or carbon) they want to present to the others in their group. In the group of six each two will teach one cycle to the other four, thus all six members of the group will learn about the water, nitrogen, and carbon cycles. Present students with the following rubrics. Explain to the students that they will be assessing each other on BOTH their listening skills AND their presentations.

4. Allow students time to research and plan with their group. Students can make overheads, handouts, songs, presentations (Corel, PowerPoint, etc.), posters, brochures, videos. Let the students search the Internet for the cycles. They may use computers to put together their presentations. Encourage students to refer to their ecosystems in a jar in their presentations. They should use their ecosystems to illustrate how matter cycles.
6. Students give presentations. Each sub-group of two will take turns presenting their selected cycle to the other four in the group. They will grade themselves within their groups. The listeners should evaluate the presenters and the presenters should evaluate the listeners. Invite the groups that did an exceptional job to show the class what they did.
7. Lead a class discussion on each cycle. Correct any misconceptions. Discuss the cycles that are taking place in the ecosystems that they made. Direct the students to answer the following questions about their ecosystems:

- What happened to the organisms in your ecosystem?
- What are some possible causes of the changes in the populations you observed?
- Construct a food chain for the ecosystem you observed.
- What could be learned if more than one jar was set up in an identical manner?
- How does your ecosystem resemble a natural ecosystem? How does it differ?
- How did your observations compare with what you expected would happen? If the results differed from what you expected, explain what might have caused the difference.
- Make a drawing that illustrates how water cycled in your ecosystem.
- Make a drawing that illustrates how carbon cycled in your ecosystem.
- Make a drawing that illustrates how nitrogen cycled in your ecosystem.
- How would you modify the ecosystem if you were to repeat this investigation?
- What are the effects of certain abiotic factors - including temperature, light, and moisture - on the organisms in an ecosystem?
- How could a scientist set up an experiment to find out how certain pesticides or fertilizers might affect an ecosystem?

Extensions

Take a field trip to an undeveloped area and have the students diagram the various cycles found in the natural system.

Assessment Plan

1. Let students assess each other on their presentations using the rubrics provided.
2. Assess the students' answers to the questions about their ecosystems for accuracy and understanding.

Bibliography

Johnson, George Environmental Science (Holt Rinehart and Winston, 1996) Johnson, George Biology Principles and Explorations (Holt Rinehart and Winston, 1988)

Authors

TERRI LUSK