Ecosphere Observation

This activity reinforces an understanding of the self-sustaining and cyclical nature of ecosystems and introduces matter and energy cycles through observation and prediction of a closed model of a freshwater pond ecosystem.

2nd-HS

An ecosphere with material collected from an urban park pond, including a group of aquatic freshwater snails, *Psudosuccinea columella.*

NJSLS Connections:

- **2-LS4-1**: Make observations of plants and animals to compare the diversity of life in different habitats.
- **5-LS2-1**: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- **5-PS3-1**: Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
- **MS-LS1-6**: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- **MS-LS2-3**: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- **HS-LS2-5**: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Learning Objectives:

- **Identify** groups of plants and non-vertebrate animals in a freshwater ecosystem
- **Create** a model to illustrate the cycles of matter and energy in a freshwater ecosystem
- **Predict** the impact of an organism group "disappearing" from the ecosphere to demonstrate understanding of the importance of photosynthesis and cell respiration in an ecosystem's matter and energy cycles


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Instructor Background

Through photosynthesis, plants are the source of almost all the energy present in all the levels in every ecosystem on Earth. They transform light energy from the sun into chemical energy stored as glucose in the plant. When an animal eats a plant, the chemical energy stored as glucose can be used by the animal to increase biomass (grow), move, and carry out biological functions.

Trophic level refers to an organism's position in a food web or energy pyramid. Plants and other photosynthetic organisms like cyanobacteria are considered producers. They may also be called autotrophs, meaning "self-feeding". Organisms that consume producers are primary consumers, organisms that consume primary consumers are secondary consumers, and so on. Some food webs or energy pyramids can have up to even four levels of consumers. Consumers can also be called heterotrophs, meaning "other feeding". Decomposers, like fungi, some arthropods, and some bacteria and protozoans, receive their energy by consuming dead and decomposing organic material.

In a closed ecosphere, the only outside input is the light from the sun. With this light, plants and algae in the ecosphere can perform photosynthesis and produce oxygen. The oxygen is consumed by animals like snails and crustaceans including daphnia, copepods, amphipods, and aquatic isopods. These animals produce carbon dioxide which is used by plants as another input of photosynthesis. Bacteria also consume oxygen and produce carbon dioxide as they feed on the decaying organic matter made up of animal waste and dead plants and animals. In doing so, they make the nutrients held in this decaying organic matter available to the living plants and algae in the ecosystem.

Ecosphere Observation

Supplies

- Ecosphere observation worksheet
- Ecosphere diagramming worksheet
- Writing utensils

If creating your own ecosphere:

- Glass jar with lid, with volume of at least 2L
- Shovels, nets, buckets, and other tools to collect ecosphere materials
- Full spectrum grow light or space on a sunny windowsill (not direct sun)

Preparation

Determine if you'd like to complete this activity using the linked videos or using your own ecosphere jars you have created ahead of time. If the timing of your program allows, you may venture into the field to create an ecosphere together with students and conduct your first observation a few days after the jar is created (to allow sediment to settle), and a follow-up observation after anywhere from a week to a year.

As a rule of thumb, jars for ecospheres should be at least two liters in volume. When creating the ecosphere, allow at least 2-3 inches of substrate at the bottom and at least an inch of air in the top of the jar. The jar should not be permanently sealed and should be shaped to allow access to the full interior of the jar, i.e. no necks that are too narrow. For best results, all materials and organisms going into the jar should be collected from the same water source.

Please do not allow vertebrate animals or animals bigger than a quarter into your jar. If you discover aquatic animals that undergo a terrestrial stage, such as insect nymphs, please release them. When finished with your experiment, please empty the contents of your jar back into the water body from which it was found.

Introduction

Show photos or videos of the ecosphere at the American Museum of Natural History linked in the Resources section and ask if anyone has ever seen or visited this exhibit before. Emphasize that this is a sealed tank. Ask questions to discuss: "How is this working?", "How are the animals still alive?". Contrast with fish tanks: most of them you have to clean the water, feed the fish, and otherwise maintain the tank.

Activity

Adapted from "Sealed Snails" hosted by The Wonder of Science by Paul Anderson, licensed under CC BY 4.0. https://docs.google.com/document/d/1rMEkaA9CSA7ppW6qG-RVRJyrdv36uEofkznuZksM94w/template/preview

1. If creating your own ecosphere, head out into the field to gather materials and build your ecosphere following the directions in the "how to make a successful ecosphere" video in the Resources section below. Keep the ecosphere in a sunny south-facing window (not direct sunlight as it may overheat) or under a full-spectrum grow light and give it at least a day or more for the sediment to settle and organisms to acclimate before making your Day 1 observation. If using the video as your model ecosphere, show the "creating a woodland pond ecosphere" video from the Resources below.

2. Distribute the Ecosphere Observation worksheet. Instruct students to illustrate a model of the ecosphere jar on Day 1, either using the ecosphere in the video or the ecosphere you made as a model. Students should label the components and organism groups in the jar and should also point out things like air bubbles or decaying vegetation. Remind them to be descriptive and use both numbers and text in their labels.

3. Invite students to imagine what the jar may look like in 1 month/6 months/1 year (if using the video) or in a predetermined amount of time (if using a homemade ecosphere) into the future. Ask students to predict what will happen to the overall jar ecosphere and to each plant and animal group and illustrate their ideas within the "Prediction" section of the worksheet. As before, use labels and be descriptive. Students may share their predictions with a partner, group, or the class.

4. Show the completed ecosphere jar you created ahead of time or use the same ecosphere you made with the class after waiting for the predetermined amount of time. If using the video, show the corresponding video linked below of the ecosphere after 1 month, 6 months, or 1 year.

5. Instruct students to observe, illustrate, and label a model of the ecosphere jar in the "Outcome" section of the worksheet and write a response as to the accuracy of their prediction.

6. Discuss: "Was your prediction correct?", "How did the living things in the ecosphere survive?", "What does this tell us about the ecosystem in our jar?".

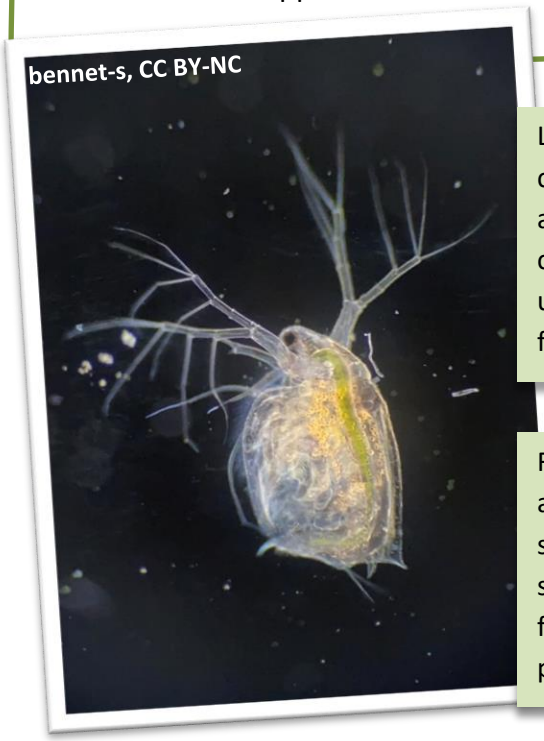
Extension: If the timing of your program allows, permit students to make daily or weekly observations of the ecosphere and record in a journal, or take photos to monitor changes.

Ecosphere Diagramming Worksheet

For older students, option to complete the Ecosphere Diagramming worksheet. Students will diagram the food web (4th and 5th grade) and/or map cycles of matter and energy transfer (middle school and high school).

Discuss their diagrams and ask about the role of cell respiration and photosynthesis in the facilitation of these cycles:

- What if the plants in the tank disappeared?
- What if [animal group] disappeared from the ecosphere?
- What would happen if we put in too many plants?
- What would happen if there were too many [animal group]?



Left: *Daphnia*, also called water fleas, are small crustaceans ubiquitous in freshwater ponds

Right: Ostracod, also called seed shrimp, another small crustacean found in woodland ponds

Materials

- Ecosphere observation worksheet https://www.canva.com/design/DAGADiWmyUc/m4W6x1WTL6Pq1PXl3-DZOg/edit?utm_content=DAGADiWmyUc&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

- Ecosphere diagramming worksheet https://www.canva.com/design/DAGAErlhJ78/-9c_tdEs4LYlDjThIf6qVg/edit?utm_content=DAGAErlhJ78&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

Resources

American Museum of Natural History ecosphere:

- Brief article: https://www.amnh.org/exhibitions/permanent/the-universe/planets/the-search-for-life-in-the-universe/ecosystem-sphere
- Video (watch on mute, the narration is irrelevant): https://www.youtube.com/watch?v=TV5vqENm3J8&ab_channel=ChuspinSpain

Information on nutrient and energy cycling in ponds and closed ecosystems:

- https://extension.psu.edu/pond-ecology
- https://home.howstuffworks.com/closed-terrarium.htm
- https://www2.nau.edu/lrm22/lessons/bottle_biology

Videos

- How to make a successful ecosphere https://www.youtube.com/watch?v=2vm8fqqJpZM&ab_channel=LifeinJars%3F
- How ecospheres work https://www.youtube.com/watch?v=K0ImENkmIBo&ab_channel=LifeinJars%3F
- Creating a woodland pond ecosphere https://www.youtube.com/watch?v=40O1LeIFuc4&pp=ygUXd29vZGxhbmQgcG9uZCBlY29zcGhlcmU%3D
- Woodland pond ecosphere after one month https://www.youtube.com/watch?v=yhSNpb7Epqw&pp=ygUXd29vZGxhbmQgcG9uZCBlY29zcGhlcmU%3D
- Woodland pond ecosphere after six months https://www.youtube.com/watch?v=LiR3eyR1Kf8&pp=ygUXd29vZGxhbmQgcG9uZCBlY29zcGhlcmU%3D
- Woodland pond ecosphere after one year https://www.youtube.com/watch?v=L0GEy-MEwhc&pp=ygUXd29vZGxhbmQgcG9uZCBlY29zcGhlcmU%3D