

Biosphere

Background

If you look into a terrarium, you can see a mini-biosphere. There are soil and rocks on the bottom of the glass tank, and possibly a pool of water. There is air appropriate for the life inside, and the glass container's inhabitants have food to eat. Each of these elements interact and are able to sustain themselves for long periods of time. Although they are in miniature, these elements closely resemble those of Earth's biosphere. Our biosphere consists of the air we breathe and the ground we walk on. Life in the biosphere lives on the surface, in the air, and in its waters.

Our planet is unique in its capacity to support a wide variety of life. Almost anywhere you go, life can be found, be it in salty, -45°C (-23°F) ponds in Antarctica to the 90°C (194°F) hot springs at Yellowstone National Park. However, elsewhere in the Solar System, no traces of life have been found. This is probably because, despite life's apparent versatility, surface conditions on the other planets are simply too extreme. Nowhere else in the Solar System is there a comparable atmosphere, either in density or in composition. Nor is there (at the time of this writing) definitive proof of the presence of liquid water on any planet. It appears that Earth is the sole possessor of the "just-right" conditions necessary to support living organisms.

Today, life flourishes on Earth in a carefully maintained balance between organisms and the planet. For example, plants require light from the Sun, nutrients from soil, and carbon dioxide from the atmosphere for energy. As a byproduct, they release oxygen into the atmosphere, providing animals with the air that they require for their survival. As a result, the atmosphere maintains stable amounts of each gas, ensuring enough for both forms of life. The biosphere is riddled with such examples of mutually beneficial relationships.

Topic

Biosphere

Objectives

Students will:

- Construct a balanced biosphere.
- Explain the basic elements required to sustain life.

Overview

Earth is the ultimate biosphere, literally a "life ball." It holds and sustains all life known to humanity. As men and women look to traveling and living beyond the protective envelope of our atmosphere, they see conditions that cannot sustain life as we know it.

Key Question

What are some examples of the way the Earth maintains a life-friendly environment?

Key Concepts

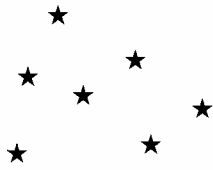
- The Earth is a unique place that supports a wide variety of life forms.
- The Earth's biosphere is a complex system that maintains a balanced, life-friendly environment.
- A biosphere is successful when it is self-enclosed, and able to function efficiently over a long period of time.

Materials & Preparation

Each team will need:

- Data and observation sheet
- Measuring cups and spoons
- Assorted soils and sand
- Fertilizer
- Seedlings
- Small living organisms (such as insects)
- Water
- Clear plastic tape
- Lamp
- Two 2-liter bottles

1. After discussing the background and purpose of this activity, divide the class into cooperative teams of four. Assign the following roles within each team:



- **Soil Specialist:** person who studies condition of soils
 - **Botanist:** person who studies plants
 - **Science Specialist:** person who coordinates interaction between all aspects of the biosphere, including soil, plants, water, and light
 - **Animal Specialist:** person who studies animals
2. Have teams brainstorm and list all of the elements needed to create a balanced biosphere.
 3. Distribute the Student Worksheets. Students are responsible for reading and sharing the data contained on their worksheets. Have students log their shared information on their worksheet.
 4. Each team should decide, based on the recommendations given on the Student Worksheets, the following: Best soil mixture, amount of each soil type, optimal lighting (direct Sun, shade, artificial light), optimal amount of water prior to sealing, and the kinds and amounts of plants and animals. **Each biosphere must include plants and animals.**
 5. After each team has discussed and decided on the content of its biosphere, let each student build his or her own biosphere according to the team plan. The biosphere must be completely sealed with clear tape. **Once the biosphere is sealed, it cannot be opened again.**
 6. Each biosphere should be set under the lighting conditions chosen by the team.
 7. Have students label their biospheres with their names, names of their team members, date, and time sealed.
 8. Assign students to complete data and observation sheets daily, or on a basis that works best for your class.

Management

- **Seedlings:** About two weeks prior to the activity, sprout seedlings for use in the

biospheres. Successful biospheres have been made using mung, radish, and peanut plants, as well as simple garden weeds. Seedlings can be purchased at a local garden center.

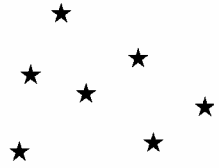
- **Soil material:** Collect a variety of soil materials, such as vermiculite, permiculite, cinder, gravel, sand, silt, and clay. If possible, obtain information about each type of soil and provide it to the students so that they are better able to make decisions about appropriate soil types.
- **Animals:** Students should collect live critters such as caterpillars, ants, worms, etc. to live in the biosphere. We recommend that your students collect critters on the day the biospheres are completed to ensure that they are well cared for. Most pet stores sell a wide variety of live insects and worms.
- **Biosphere:** Use two 2-liter plastic bottles. Remove the labels. Cut off the top 8.5 cm from the first bottle. Then, cut the second bottle 7.5 cm from the bottom. Students will take the two pieces and put together as in diagram A. Have enough materials for each student to make one biosphere.

Reflection & Discussion

1. Are some of the biospheres doing better than others? Why?
2. What factors may have led to the success or failure of the biosphere?
3. How might biospheres help us understand the Earth and its unique biosphere?
4. What other benefits might there be in studying closed biospheres?

Transfer/Extension

1. Look for examples of research being done in closed environments, such as Bioplex at Johnson Space Center, and write a report about them.

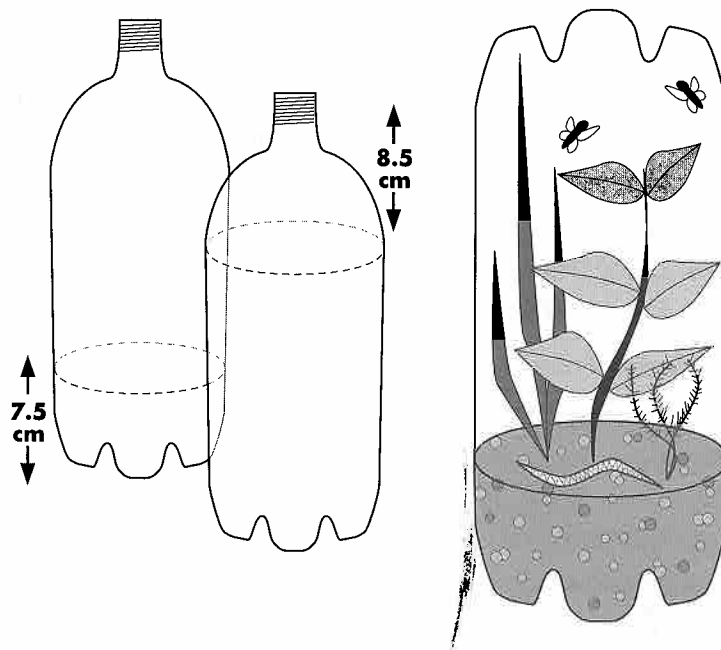


Biosphere

Student Procedure

1. Fill out the "Materials Used Data Sheet" with your team's choice of soil mixture, type and number of seedlings and other organisms, optimal lighting conditions, and the optimal amount of water to add to the biosphere before sealing. Remember that you are trying to create a living system that will remain balanced over a long period of time.
2. Obtain a pre-cut plastic bottle from your teacher and build your personal biosphere following the team's recommendations.
3. Seal your biosphere with clear plastic tape. Once the biosphere is sealed, no air or other materials can go in or out. After the biosphere is sealed it cannot be reopened.
4. Label the biosphere with your name, the names of your team members, and the date and time the biosphere was sealed.
5. Set your biosphere under the lighting conditions chosen by your team.
6. Fill in the "Biosphere Observation Sheet" as directed by your teacher.

Diagram A



Soil Specialist

Recommendations: Soil supplies water, nutrients, and gases, as well as structural support to plants. The ideal soil for a biosphere should hold moisture and nutrients while letting excess water drain to make room for air. There are many types of soil.

Considerations: When mixing and layering soil, you need to consider the following questions.

- How well does it hold water?
- What is the nutrient content?
- Does it provide structural support for plants?
- How well does it drain excessive water?

Botanist

Recommendations: You should try to find a hardy plant that still may survive in less-than-perfect conditions. Also, if plant-eating animals are being placed in the biosphere, it may be helpful to provide a variety of plant species so that you can better ensure that there will be an acceptable food supply. Garden weeds may work well. Other specific types of plants may be included.

Considerations: For the plants above and for any other plants, you need to consider the following questions.

- What is the best soil type for this plant?
- How much water does the plant require?
- What are the best lighting conditions?
- How tall and fast will the plant grow?
- Will the animals eat this plant?

Science Specialist

Recommendations: A balanced biosphere should provide soil, light, oxygen, water, and food for living organisms.

Considerations: When working with your team, you should consider the following questions.

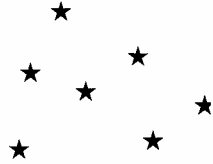
- Are there enough nutrients in the soil for all the plants?
- Is there enough water?
- Is the lighting condition appropriate?
- Does the biosphere include food for the animals in amounts that will be supportive, not destructive?

Animal Specialist

Recommendations: There are a wide variety of animals you can use in your biosphere. However, each animal has its own needs in terms of diet and environment.

Considerations: For the animals above, or any others you choose, you need to consider the following.

- What does the animal eat?
- Where do they live?
- What kind of climate are they used to?
- Does the animal need shade or direct sunlight?



Biosphere

Materials Used Data Sheet

Name: _____

Date: _____

| Soil Material | Amount Used—Explain Why |
|---------------|-------------------------|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

| Seedlings and Animals | Amount Used—Explain Why |
|-----------------------|-------------------------|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

| Lighting Conditions—Explain Why | Amount of Water Added—Explain Why |
|---------------------------------|-----------------------------------|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

Date and Time it was sealed: _____

