NSBRI TAP Classroom Activity

Title: **ECOSYSTEM MODULE**

Grade Level: 5-8

Content Area: Environmental and Space Science

National Science Content Standards:
Unifying Concepts and Processes
- Evidence, models, and explanation

Standard A. Science as Inquiry
- Abilities necessary to do scientific inquiry (Grades 5-8 & 9-12)

Standard C. Life Science
- Populations and ecosystems (Grades 5-8)

Behavioral Objectives:
- The student will use critical thinking and scientific problem solving to make informed decisions. The student is expected to: represent the natural world using models and identify their limitations.
- The student will identify relationship between organisms and the environment. The student is expected to identify components of an ecosystem.

Lesson Objective:
- In this lesson the student will explore an enclosed ecosystem using small fish. Research and good planning will be necessary for success and survival of the fish in the habitat. Students will compare the fish in the ecosystem to astronauts on board the International Space Station and the connection to long duration space flight.
- The student will research, plan, and develop a closed ecosystem where a small fish will survive for a two-week period.

Time:
- Four 45 minute class periods; Two 90 minute block periods

Materials:
1) Wide-mouth glass or plastic bottle (16 ounces/l pint). Note: a Gatorade bottle works nicely. Will need one per two person group.
2) Water from a creek (and any microorganisms that might be in it) is a good start for your ecosystem. Note: Bottled spring water will also work. Tap water will need to be dechlorinated.
3) One guppy, minnow, or Medaka fish per ecosystem

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4) Food sources for the fish
5) Gravel or sand
6) Elodea or Anacharis water plants
7) Any other necessary components for a successful ecosystem (brainstorm/research)

Procedure:

Pre-activity Preparation

The teacher will determine the type of fish. Guppies, Medaka fish, and minnows are good types of fish. Medaka fish are available from Carolina Biological. Locate a creek near your school where materials can be collected; arrange to go on a fieldtrip to a collecting site further from school; or have students bring in necessary materials. Note: If you are unable to go on a field trip some alternatives would be gravel from a nursery, Elodea for plants, water from the tap should be dechlorinated (the solution can be picked up at any pet store or grocery store that carries pet care products) or use bottled spring water. Note: Rinse the bottle but do not wash it with soap. Soap residue, especially from dishwashing soap, would become part of your guppy's ecosystem and could be toxic to him/her.

Activity

1) Research on the Internet and/or library the requirements for a self-contained ecosystem and the requirements needed for fish to inhabit it. Note: The student will need to research what type of plant life would be suitable for the habitat and what type of food will be available to the fish. Remember that once the habitat is sealed there is no going back to open it to feed the fish.

2) In groups of two build your ecosystem as directed by the teacher. On the data sheet record the components you used and the time and date your system was sealed.

3) After building your ecosystem, monitor it for two weeks. If the fish appear stressed prior to the two-week period, open the jar and remove the fish. The experiment will end at this point.

4) Make observations every class period and record the ecosystem's condition.

5) Measure the temperature of the water and any other instrument readings if available. Note: Students may want to brainstorm/research methods of adapting the habitat to obtain these readings while keeping the system closed.

6) Describe the color and other observable characteristics of the ecosystem's contents.

7) Enter this information in a notebook.

8) Each student should write a description of how the group's system was created and explain why certain components were included.

9) If the ecosystem failed, hypothesize and give evidence to support the hypothesis on what may have caused the failure.

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Data Sheet

Ecosystem Materials: Time and date habitat was sealed: _____

- Volume of bottle - (How much fluid capacity?)
- Plant life - (What type of plants did you include?)
- Food source - (What will the fish eat?)
- Type of fish - (What kind of fish did you use?)
- Type of soil - (What type of soil did you put in the bottle?)
- Source of water - (Where did your water come from?)

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Extension:

Examine the records and discuss the results of the closed ecosystems. Form one or more hypotheses to explain why some ecosystems lived longer then others.

- For each hypothesis:
    - Create two sets of 5-10 closed ecosystems where the sets differ in only one aspect (variable) chosen to test the hypothesis.
    - Observe the development of these ecosystems.
    - Determine if the hypothesis was correct.
    - Write a report describing the hypothesis, background information, experimental method, and results. Discuss the meaning of the results in the last section of the report

Resources:

A video of the first vertebrate mating in space-A Fish Story by Dr. Kenichi Ijiri, plus an explanatory booklet. Booklet and video may also be obtained from the following website:
http://130.69.100.13/SPACEMEDAKA/textE.html
Available on request:

(Mail) Radioisotope Center
University of Tokyo
Yayoi, Bunkyo-ku
Tokyp 113-0032, Japan
or
e-mail:
ijiri@ric.u-tokyo.ac.ip

Some helpful research sites:
http://lifesci3.arc.nasa.gov/SpaceSettlement/ – Website full of information on the settlement of space.
http://www.guppies.com/PAGES/facts.html – Excellent site to look at guppy information.
http://chamisa.freeshell.org/fish.htm – Good site on minnow characteristics.

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Background Information:

*Note: This information should be given to the students prior to beginning the activity in order for them to be knowledgeable about the abiotic and biotic factors in the ecosystem.

When astronauts are aboard the International Space Station they live in a self-contained Habitat Module. This module provides for all of their physical needs. Food, water, and oxygen to breathe are present in adequate supplies. The astronauts are sheltered from the outer space environment and they have just enough room in which to work and to relax. Living things such as plants and animals in the environment are called biotic factors. Nonliving things in the environment, such as soil, water, temperature, air, light, wind, and minerals are abiotic factors. Living (biotic) and nonliving (abiotic) factors interact and function as an ecosystem. An ecosystem is a biotic community interacting with the abiotic parts of its environment.

However, as we move toward exploration of space or the building of colonies, logistical requirements for resupply of life sustaining materials become a severe limitation. This is due to high financial cost associated with propelling supplies over a great distance. In these cases the deployment of more sophisticated systems for the purification and replenishment of air and water, the production of food, and the treatment of onboard wastes are required. Regenerative Life Support is the discipline dealing with the development of the physico-chemical and bioregenerative systems, which are required to accomplish this task.

Orbital space settlements will be located between the planets. While the Sun will provide ample reliable energy, there are essentially no material resources in the immediate vicinity. All materials will need to be transported from Earth, the Moon, the asteroids, comets, or other planets and their moons. Thus, the space colony designer may assume ample energy but must conserve materials. Therefore, the life support system of the colony should recycle all materials. Since we would prefer a life support system consisting primarily of plants, animals, and single-celled organisms, our life support system may be described as an ecosystem. Because our space colony's ecosystem does not import or export materials, we call it a closed ecosystem.

You and your partners will build an "ecosystem module" for a guppy. Other fish such as the shiner minnow or Japanese Medaka (a type of minnow) may also be used. Guppies are small minnow-like fish that are normally kept in aquariums. Humans and other animals have basic needs. Food, water, shelter and space must be in an arrangement that makes it possible for an animal to survive. Different kinds of animals need different kinds of food, water and shelter and different amounts of space. A limiting factor is something that affects the survival of an animal or a population of animals. Inadequate food and/or shelter are two examples of what are called limiting factors. Consider this as you decide what would make a suitable ecosystem for your guppy. Plants produce oxygen and use carbon dioxide. You and your partners will decide the quantity and type of other organisms to add to your bottle. Consider how much food each organism that you add will need to survive. Too much food, plants, or oxygen-users can be just like pollution, and create a toxic environment for your guppy. In order for a healthy environment to exist there must be a balance of its components.

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Student Assessment (Student Copy)

Title: **ECOSYSTEM MODULE**

1. If bios means life, define biotic factors. Give an example in your ecosystem.

2. If an a in the front of the word makes the word opposite of what it means, define abiotic. What is an example of an abiotic factor in your ecosystem?

3. Explain a limiting factor. Give an example.

4. Define ecosystem.

5. How is the guppy ecosystem similar to the space shuttle/International Space Station ecosystem?

6. What is a bioregenerative system? Why is it important to understand how a system like this works? (Especially, in the case of long duration space)

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Student Assessment

Title: **ECOSYSTEM MODULE**

1. If bios means life, define biotic factors. Give an example in your ecosystem.

   Ans: A biotic factor is a living factor. Example in ecosystem- fish, plant

2. If an a in the front of the word makes the word opposite of what it means, define abiotic. What is an example of an abiotic factor in your ecosystem?

   Ans: Abiotic means non-living. Example in ecosystem– water, air etc.

3. Explain a limiting factor. Give an example.

   Ans. A limiting factor effects the survival or growth of a species population. Ex. Inadequate food, water or shelter

4. Define ecosystem.

   Ans. An ecosystem is a biotic (living) community interacting with the abiotic (nonliving) parts of its environment.

5. How is the guppy ecosystem similar to the space shuttle/International Space Station ecosystem?

   Ans. In the guppy ecosystem the system is enclosed in a container. The ecosystem must provide everything the guppy needs for survival. Food, water, shelter and space must be in an arrangement that makes it possible for an animal to survive

   Astronauts aboard the International Space Station live in a self-contained Habitat Module. This module provides for all of their physical needs. Food, water, and oxygen to breathe are present in adequate supplies. The astronauts are sheltered from the outer space environment and they have just enough room in which to work and to relax.

6. What is a bioregenerative system? Why is it important to understand how a system like this works? (Especially, in the case of long duration space)

   Ans. **Bioregenerative** is a process whereby organic products are regenerated from base materials (waste or elemental organic) strictly by biological means. In the case of a space colony or a trip to Mars it would not be feasible to resupply the astronauts from earth. Therefore, they would need regenerative methods to resupply their food, air, and water.

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