SURVIVAL IN SPACE: A UNIT ON PLANTS

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This unit was used in a high school biology class as a way to motivate the students and add to their unit on plants. This unit can be adapted to any text, but it does take some planning and some imagination. The responses about the unit from the students will be varied -- but all will say "at least it was different" and many will thank you for it.

Unit Objectives

A. Observe properties of green plants.
B. Observe and know the functions of the different parts of · plants.
C. Gather and organize information on the life cycles and uses of different plants.
D. Choose and regulate variables needed for maximum plant growth.
E. Demonstrate the use of various plant propagation techniques, including ones using aseptic practices.
F. Demonstrate a closed biosystem with plants and animals.
G. Develop a plan (based on information provided and obtained) to provide food for 300 people after a two-month growth time.

Activity One -- Introduction to SPACE HAB ONE (SH #1)

[The following should be read to the students on the first day of the unit on plants. During this presentation, slides of a shuttle launch, the moon, space colonies, and space-related shots add a lot to get the students into the mood. Some of the slides should be artists' images of how the colony will look.]

For the rest of the unit on plants, you will imagine yourselves to be high school students twenty years into the future. You are the group of students from across the country who have won the contest to visit SH #1, the first large-scale space colony. We launch from Kennedy, traveling past the old space station and head for SH #1. Although the colony is not yet complete, the basic living sphere is finished except for radiation shielding; several of the agricultural rings are almost ready to plant. There are currently only 300 people at the colony and most are construction personnel who must get the sphere shielded before the surface can be planted and settled with colonists and their custom homes.

There are also other people in space, at Moon Base. They are continuing to mine the lunar soil for materials to finish SH #1 and build more solar power satellites -- like the two already beaming power to Earth. There are asteroid miners and a small base on Mars. To help feed all these people and the colonists yet to come, SH Ill has the Life Bank. The Life Bank contains the seeds", plant and animal tissue cultures, frozen embryos, and some frozen tissue samples from most of the living things -on Earth. Insects are the only major exception - - only useful ones have been stored as of yet. This is a very special facility with limited storage space and numbers of samples.

There is an emergency announcement from the communications room. [Either of the following may be used -- recorded, if you like, by someone else.} 1) Massive tectonic shifts dump California into the sea and earthquakes are set off around the world. With these come volcanic eruptions never seen or imagined by modern man. The accompanying tidal waves wreak havoc on all costal areas. As a result, the Earth is devastated and there is no place left to land or to launch space vehicles. Earth's first priority is the people still there. Or, 2) A computer malfunction causes the end of the world as we know it. The Earth is left in a nuclear winter.

In any case, you are now on your own in space and due to the lack of personnel trained in plant care and food production, you are elected to become those people. The construction workers will be busy trying to finish the radiation shielding around the sphere so it can be planted. There are computer tapes on plants and a botanist on the Moon who has been taking care of plant production. But the botanist is too disturbed by the loss of her family on Earth to be of any use at this time. You must rely on what is on the computer and intensely study plants. For your survival, you must:

1) know the physiology of plants to be able to get maximum growth in minimum time under controlled conditions;
2) know both plant reproduction and plant propagation in order to keep enough seeds, cuttings, . . . for future
3) know plant needs for light, temperature, and nutrients; and
4) know what plants are best for a vegetarian diet in order to know what to plant first. (Animals and their food needs can be considered later.)

We are informed that plants are an integral part of the finished SH #1 air and waste recycling program. Keep this in mind as you study plants. What plants will produce the most oxygen? What plants will we eat? (And later, what ones will we feed to the animals?) How will we be able to get a large number of plants from a limited number of seeds?

The head of SH #l suggests that we start with a basic botany course. The first step is 'to take a pretest to find out what each of you already knows about plants. [A textbook unit test with some added space-related questions could be used as the pretest. This should not be used for a grade, but can be given as a posttest at the end of the unit.] After taking the pretest, we will review it and see what topics need the most study.

Things to Remember

1) Constantly remind the students that time is limited; i.e., How many days have you been on SH #1? What are the survival deadlines for planting, harvesting, and replanting?
2) Constantly remind the students that all the other people are depending on them for food; it means Life or DEATH!!!
3) Constantly remind the students of the limited resources both in food and in seeds.

Activity 2. Growth Variables

Description: Students will observe demonstrations at learning centers to take note of results.

Objectives: 1. Compare the effects of various growth hormones on growth and development.
2. Define tropism and explain how phototropism and gravitropism occur.
3. Explain the advantages of growing plants in: 1) soil and 2) water (hydroponics).

Materials: Various plants, plant hormones, soil, pots, light sources, box with light-proof lid, Petri dishes, and hydroponics kit.

Suggestions: Set up several leaning stations.
1. Effects of plant hormones -- use plants of one kind and age; treat each sample group with a different hormone.
2. Gravitropism -- use germinating seeds, sprouts, and plants placed at various angles in a dark box.
3. Soil vs. water (hydroponics) -- use two types of plants in each medium planted on the same day.
4. Phototropism -- use plants in a dark box with a light source on the side.

Students should record data, write a conclusion, and discuss findings for each learning station.

Discussion: 1) How will the space colony environment affect phototropism and gravitropism in plants?.
2) Which growing medium (soil or water) should be used on SH #1 in relation to limited space, replacement of nutrients, and control of rate of plant growth?

Activity 3. How Much of What Kind?

Description: Through brainstorming in small groups, students will develop an experiment to determine the photoperiod and the light requirements for a plant.

Objectives: 1. Design an experiment to determine the maximum hours of light needed by the plant.

2. Design an experiment to determine what light wavelengths are used by plants.

Materials: Text and related materials.

Suggestions: 1. In groups, have students brainstorm to design two experiments; they should be written out completely with purpose, materials list, and procedures.
2. Each group should chose one design and prepare it as a demonstration for the class.

Activity 4. Cloning

Description: Students will practice aseptic techniques of cloning.

Objectives: 1. Describe cloning using aseptic techniques.
2. Give examples of different cloning techniques.

Materials: Depending on your budget, purchase basic plant tissue culture kits or use materials as listed in a lab manual cloning experiment.

Suggestions: 1. Follow procedures in the kit or lab. manual. (A demonstration using slides or video may help.)
2. Stress the need for cleanliness.
3. Have the students do ten replications each if possible.
4. Observations should be made every three days and a final report should be completed in two weeks.

Discussion: 1. How would cloning help the people on SH #1 survive?
2. What is the advantage (or disadvantage) for SH #1 of making many replicants from one plant?

Activity 5. Propagating Plants

Description: Students will observe plants being propagated in a greenhouse setting.

Objectives: 1. Describe one vegetative propagation technique and give an example of its use.

Materials: All you need is a place to go a local greenhouse, conservatory, or university that has a variety of propagation techniques in use.

Suggestions: 1. Have the person in charge explain to the class the techniques in use.
2. Back at school, if possible, allow students to try cutting, layering, grafting and runners.

Discussion: 1. How would these techniques help life on SH #1?

Activity 6. Biocycles

Description: Students will create and observe small micro-climates using terrariums.

Objectives: 1. Explain the hydrologic cycle and its importance to life.
2. Diagram the oxygen cycle using plants and humans.
3. Describe briefly a closed system that should work to supply air and water for humans using plants.

Materials: Terrariums, tops, plants, soil, sand, small lizards, certain (safe) bugs, . . . , and bulletin board display of cycles.

Suggestions: 1. In groups, have students plan what kind of micro-climate they want to make and how to make it.
2. Students are encouraged to read about micro-climates and look at the bulletin board displays on the hydrologic, nitrogen,

and oxygen cycles. *[Additional texts or other related material may also be helpful.]*

3. Students are to build micro-climates that will be sealed for more than two weeks. *[Supply students with as much material as possible to build their micro-climates. Explain that any kind of micro- climate can be created in SH #1, from tropical rain forest to desert, depending on the types of plants and amounts of materials started with.]*

4. A detailed report and team presentation are due at the end of the unit. Students are to describe how the micro-climate was constructed and to discuss the success (or breakdown) of any cycles that may have occurred.

Discussion: 1. How would the various cycles operate of SH #1?
2. How would the plants grown for food be included in each cycle?

Activity 7. Plant Selection

Description: Students will work in teams to choose plants to grow for food crops to feed 300 people.

Objectives: 1. Choose plants from seed catalogs to grow food for 300 people.

Priority One: Food -- Choose plants that will provide a balanced diet continually. Plan for future seed gathering or alternate propagation techniques.

Priority Two: Oxygen and waste management -- Choose plants that will provide the most oxygen while using the most carbon dioxide; these plants must recycle human wastes.

Priority Three: Environmental -- Select plants that will give SH #1 an Earthlike appearance. Remember SH #1 is bare right now.

Materials: Seed catalogs, nutrition books, and space colony plans (Space Studies Institute).

Suggestions: 1. Have students read articles on vegetarianism. *[The vegetarianism article can come from any nutrition or health text.]*
2. In teams, give the students an outline of what to look for in plants for food crops.
3. Remind students of where they are in simulation -- SPACE -- and of earlier work on criteria for plant selection.
4. Provide students with these assumptions: a) unlimited area; b) any number of plants; c) plants must provide a balanced diet; and d) controlled environment allows controlled seasons.

Discussion: 1. What seed selections are best for each priority level? The selections may overlap, that is fine. [You can send away for seed catalogs from the companies listed in the "Sources."]
2. What are the reasons for your choices?
3. List the name of the plant, days until maturity, growth medium, and needs: shade vs. sun, temperature, .
4. Present team choices and explain them. {Combine all choices to make a master list to be used in Activity 8.}

Activity 8. How Will Your Garden Grow?

Description: Students will be given specific plans of a space habitat and materials related to Controlled Environmental Agriculture (CEA).

Objectives: 1. Outline the techniques you would use to grow plants in space.
2. Describe advantages and disadvantages to raising plants under ideal conditions such as in a space habitat.
3. Develop specific ideas of how to grow the crops selected in Activity 7 and identify possible problems.

Materials: Master list from Activity 7, plans for a space habitat (Space Studies Institute), and information from EPCOT Center (the Land exhibit on CEA).

Suggestions:
1. In teams, study the space habitat plans and brain- storm ideas for growing plants in the habitat.
2. Select and develop the best idea.
3. Prepare a short report about this technique, stating which plants would be used, what additional materials are needed, amount of light, photoperiod,
4. Present team idea to the class.

Discussion:
1. Was sufficient time allowed to clone enough plants?
2. Was ample time planned for the plants to mature and/or produce food?
3. Did all the colonists die?

Sources

Seed Catalogs (all will send in quantity, if number requested):
W. Atlee Burpee Co./300 Park Ave./Warminster, PA 18974
Piedmont Plant Co./P.O. Box 424/Albany, GA 31703
Earl May, Seed and Nursery L.P./Shenandoah, IA 51603
Park Seed Co./Cokesbury Road/Greenwood, SC 29647-0001
Gurney Seed and Nursery Corp./110-T Capitol/Yankton, SD 57079

Miscellaneous:
Space Studies Institute/P.O. Box 82/Princeton, NJ 08540
National Space Society/922 Pennsylvania Avenue, S.E./Washington, DC 20003
The Planetary Society/65 North Catalina Avenue/Pasadena, CA 91106
EPCOT Center/Walt Disney World/Lake Buena Vista, FL 32830 any NASA Center

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