Hydroponic Germinator for Primary Grades

Objectives

Students will:

- Understand and build a hydroponic growing chamber.
- Understand and describe the life cycle of a plant.
- Examine and chart the life cycle of a hydroponically grown plant.

Suggested Grade Level

PreK – 2nd

Subject Areas

Life Science

Timeline

60 minutes, plus an additional two weeks for seeds to sprout

Standards

- K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.
- K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.
- 1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
- 2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.
- K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

21st Century Essential Skills

- Critical thinking/Problem solving
- Collaboration and Teamwork
- Carrying out investigations

Background

On a Lunar or Mars base, it will be essential to grow plants through various means. We cannot take all of the food that we need on a trip to the moon or Mars for all of the astronauts. Most of the food will be grown on the moon or Mars in greenhouses. There are two possible ways to grow plants for a moon or Mars colony. One way is with zeoponics. Zeoponics is a special type of soil that has all of the nutrients for the plants. Another way to grow plants is with hydroponics. This method of plant growing dates back to the ancient Babylonians and the Aztecs. Instead of putting the seeds in soil, they are grown by being suspended above a water-filled container.

Growing food for a Lunar or Mars base is going to be difficult. We need approximately 25 square meters of crops to keep one astronaut alive for the duration of their stay on the base. The atmospheric pressure is too low, and it is too cold to grow plants outside. We also can't take all of the soil we would need because it would be too heavy. The answer to this problem is hydroponics. The problem with hydroponics, though, is that the plumbing system will have to be very complex because the nutrients must be injected into the water solution.

Vocabulary

Hydroponics, chlorophyll, chloroplasts, photosynthesis

Materials

- 2-liter soda bottles (enough for each person or each group of students)
- Paper towels
- Radish or bean seeds (any seed will work, but these grow the fastest)
- Scissors or utility knife

Lesson

1. Start by discussing the parts of a plant.
    a. Roots-the roots anchor the plant to the soil and draw in water and nutrients for the plant
    b. Stems-the stem holds the plant upright, support the leaves so they can reach sunlight, and the stems contain xylem and phloem which carry water and food to other parts of the plant.
    c. Leaves-the leaves contain chlorophyll which makes food for the plant.
    d. Flowers-some plants grow flowers which attract animals and insects to help with pollination.
2. Discuss with the class how plants use water, carbon dioxide, chlorophyll and sunlight to make food in the process called photosynthesis.
3. Explain that water and nutrients are drawn up the roots and carried by veins called xylem into the plant's leaves.
4. Explain that in the leaves, sunlight is taken in by chlorophyll in the plant's chloroplasts. The chlorophyll, which gives plants their green color, converts light energy into chemical energy.
5. Explain that the water and nutrients are combined with sunlight and chlorophyll in the plant's chloroplasts. This is called photosynthesis. (This is a good time to discuss the transfer of energy from the sun to the plant, and then eventually to the humans that eat the plant.)
6. Explain that the nutrients are then carried out of the leaves by veins called phloem to the rest of the plant.
7. Discuss the life cycle of a plant.
    a. Seed - A plant starts as a seed.
    b. Germination - If conditions are right, germination will occur, and a root will emerge from the seed. Eventually, stems produce leaves for photosynthesis and more roots push down to anchor the plant and gather nutrients.

   c. Flowers - Flowers develop and produce pollen. Pollination occurs by animals, insects, or the wind carrying the pollen to another plant.
   d. Pollination - Reproduction occurs when eggs are fertilized by sperm. Seeds and a protective fruit develop.
   e. Seeds and protective fruit develop -The plant releases seeds, or the fruit is eaten, and the seeds are spread. If conditions are right, the seeds will germinate, and the cycle starts again.
8. Explain to students that plants are essential for survival. Not only do they provide oxygen, but they are also a food source for most animals. Ask students, "Can planets grow anywhere else in our solar system?" Answer: No; no other planet has the proper soil needed to grow crops. Ask, "So how can we grow plants on the moon or Mars when we build habitats there?" Answers will vary.
9. Ask students, "Is there another way to grow plants?" Answer: Yes. Define Hydroponics (growing plants with just water). Show examples or pictures of plants growing with just water. Explain to students that this is how NASA plans to grow crops on the moon and Mars.
10. Build the hydroponic germinator:
   a. Give each person or team a soda bottle. This could also be teacher-led.
   b. Cut the top off of the bottle about 3-4 inches below the mouth of the bottle using a utility knife. Make the cut about 1 inch below where the curved part of the bottle straightens out to become the sides of the bottle.
   c. Fill the bottom section of the bottle approximately 2/3 full of water.
   d. Turn the top section of the bottle upside down so the mouth of the bottle is pointing downward.
   e. Lay a soaked paper towel in the top section of the bottle to create a bed for the seeds.
   f. Lay several seeds in the paper towel seed bed.
   g. Cover the seeds with another soaked paper towel.
   h. Roll another paper towel and insert it into the mouth of the bottle from underneath. Make sure it is touching the seed bed and is sticking out from the mouth approximately 6 inches.
   i. Insert the top section of the bottle into the bottom section. Make sure the rolled paper towel touches the water in the bottom section. The water will be pulled up through the rolled paper towel and into the seed bed.
   j. Place the hydroponic germinator in sunlight. Refill water as needed.
11. Create a hypothesis (educated guess) for the experiment. This could be student or teacher-led. Ask students, "What do you think will happen? Will plants grow with just water?" The statement should look something like this: If we lay seeds on a bed of wet paper towels with no soil, then water will travel up the paper towels and the seeds grow into plants.
12. Record observations over the course of two weeks. After two weeks, analyze your results. Ask students, "When did the seeds start to sprout? What factors affected growth? What could you have different to improve growth?"
13. Formulate a conclusion. This could be teacher or student-led. Explain to students that the conclusion is a statement that explains the results of the experiment. Ask students, "What did we learn from this? Was our hypothesis

correct?" You should have a something like: "When we laid seeds on the wet paper towels, plants grew with just water."

Extensions

- Introduce phototropism to students. Observe how plants grow towards sunlight.
- Test how long a plant is able to grow without soil for nutrients.

Resources

Farming in Space: NASA's fast plants project at the University of Wisconsin-Madison.
https://www.nasa.gov/mission_pages/station/research/10-074.html

NASA Specialized Center of Research and Training in Advanced Life Support (ALS-NSCORT). This project is a very complex and intensive experiment that covers all areas of the life support systems involved in creating a Mars base.
http://www.alsnscort.org

Plant Observations
