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Hydroponic Germinator

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

5th -8th

Subject Areas

Life Science

Timeline

60 minutes

Standards

- 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-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

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 can not 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 zeponics. Zeponics 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.

Revised: May/2019

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Vocabulary

Hydroponics, zeaponics, 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
 - b. Germination
 - c. Flowers
 - d. Pollination
 - e. Seeds and protective fruit develop
 - A plant starts as a seed.
 - 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.
 - Flowers develop and produce pollen. Pollination occurs by animals, insects, or the wind carrying the pollen to another plant.

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- Reproduction occurs when eggs are fertilized by sperm. Seeds and a 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.

Building the hydroponic germinator:

1. Give each person or team a soda bottle.
2. 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.
3. Fill the bottom section of the bottle approximately 2/3 full of water.
4. Turn the top section of the bottle upside down so the mouth of the bottle is pointing downward.
5. Lay a soaked paper towel in the top section of the bottle to create a bed for the seeds.
6. Lay several seeds in the paper towel seed bed.
7. Cover the seeds with another soaked paper towel.
8. 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.
9. 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.
10. Place the hydroponic germinator in sunlight.
11. Explain that the seeds will sprout after a couple of days. When this happens, remove the top paper towel so the seedlings can receive sunlight.
12. Repeat the above steps for a soil only germinator, zeolite/soil germinator, zeolite/water germinator.

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>

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Plant Observations
