Designing and Assessing a Vertical Hydroponic Garden

Growing Plants in Space

Background Information

There's no question about it — plants are vital to our very existence. They provide us with food, oxygen, and shelter. But have you ever stopped to think about how these benefits would translate beyond our planet?

Plants provide:

Food

Currently NASA compares its food system for astronauts to a picnic because space travelers must pack everything they consume. Their meals include few if any fresh fruits and vegetables due to limited room and rapid spoilage. But as we use the International Space Station, and someday have an outpost on the moon and colonies on Mars, we'll need a renewable food source that will be more economical than "packing groceries." Besides, fresh produce provides nutrients, flavor, texture, and variety to meals that break the monotony of packaged foods.

Air

Plants use carbon dioxide (CO_2, produced by astronauts) and produce oxygen (O_2, consumed by astronauts) through the process of photosynthesis. They also remove chemical pollutants from the air. Plants would improve the air quality inside spacecraft.

Water Purification

It costs about $22,000 per kilogram to ship objects into space! This makes water a very expensive commodity, so creating a way to reuse water would be very beneficial. Plants can

play a role because they produce pure water in the process of transpiration. Scientists are developing techniques to irrigate plants with wastewater— such as that from washing — and then recapture the purified water given off during transpiration.

Waste Recycling

Scientists are also investigating ways to recycle human waste and inedible plant matter to provide nutrients for plants. This is an important element for creating a self-contained ecosystem.

Table A: Think About It

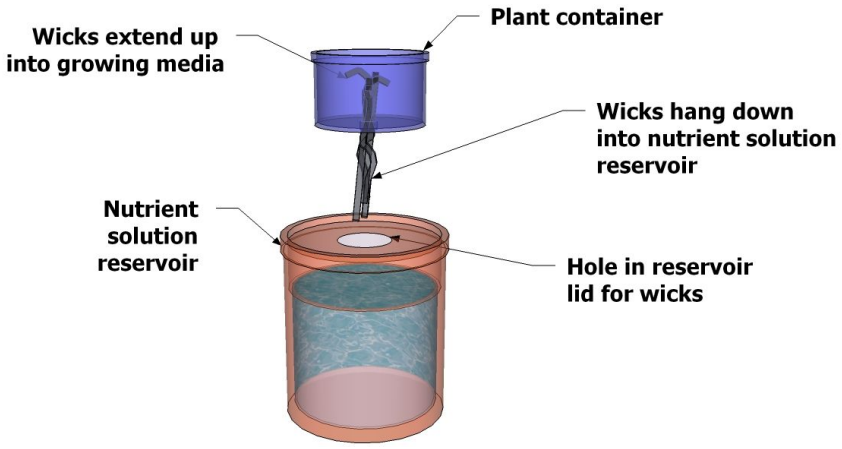
Let's consider some of the difficulties astronauts face when trying to accommodate plants with the things they need to grow. You may use your lab partners or your favorite search engine to aid in your responses. Water has been completed as an example.

Plant Need	Importance to Plants	Difficulty in Space
Water	It is a reactant for photosynthesis. It carries nutrients from growing media into the plant. Transpiration (water loss through stomata) allows for circulation.	There is no water cycle in space. It is very expensive to send heavy materials into space.
Air		
Light		
Medium and Nutrients (N, P, K, Ca, Mg, Fe)		

Your mission:

Design and build a lightweight, soilless vertical system that can support 1 plant.

Basic Wick System Components:



Basic Materials:

- 2 Liter Soda Bottle with Cap
- Nylon String
- Lightweight Growing Medium (Coconut Coir and rock wool)
- Masking Tape / Spray adhesive
- Butcher's Twine/Paper Clips
- Scissors
- Aluminum Foil / Spray Paint (optional)
- You may add to this list as your design calls for

Your Building Plan: Wick System Building Plan

Various Drip System Designs to Inspire You

** The key here is to embrace the STEAM concept and focus on upcycling and repurposing materials. You are encouraged to sketch and label your design and then evaluate it in Table B on the following page.

Table B: Evaluate it

Consider the plant needs from Table A. Using your knowledge of plant anatomy, explain what part of the plant is responsible for acquiring the needed resources from the environment in Column A. Next, discuss what components of the hydroponic setup will allow for the acquisition of these materials in an extraterrestrial growing location in Column B.

Plant Need	Part of Plant Anatomy Responsible	Hydroponic/Classroom Resource
Water		
Air		
Light		
Nutrients		
Medium	This will be some variety of traditional soil.	

Record Data:

Use the table below to record system data to compare your design to traditional soil. Make copies of page 5 as needed to complete your research.

Date:	Hydroponic System	Soil
Temperature		
pH		
# of Leaves		
Plant Height		
Volume of water used to date		
General Appearance		

Date:	Hydroponic System	Soil
Temperature		
pH		
# of Leaves		
Plant Height		
Volume of water used to date		
General Appearance		

Data Analysis:

Use the data you collected to compare the success of your design to that of traditional growing, the designs of others, and the larger classroom system.

1. Create line graphs that allow you to visualize the data patterns for temperature, pH, plant height, and leaf numbers. Each graph should have the date of recording on the x-axis as well as a key that identifies the data for your design, soil, and the large classroom system. Be sure to include appropriate titles and axis labels with units.

2. Based on your results from your line graphs, which growing method appeared to be the most stable in terms of temperature and pH? Why do you feel this was so?

3. Based on your results from your line graphs, which growing method was most successful in terms of supporting a plant?

4. Which of the growing methods were the most efficient in terms of water usage? Use quantitative data to justify your response.

5. Compare your data analysis to that of your classmates. Share your results on FlipGrid and compare them to what others are reporting.

6. What flaws do you feel were a part of your design? If you were to redesign your growing system, what accommodations would you make to account for these errors?