GROW FOR LAUNCH

AUSTRALIAN VIRTUAL ASTRONAUT

Australian Government
Australian Research Council

PLANTS FOR SPACE
ARC CENTRE OF EXCELLENCE

Acknowledgments

Plants for Space acknowledges the Traditional Custodians of Country and their deep ongoing relationship with the Land. We pay respect to Elders past, present and future.

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Creative commons

GLOSSARY 

When learning about space and plants there are a lot of new words. Here are some new words you will find out about while doing Grow For Launch.

Germination:
When a seed starts to grow into a plant. It's the first step when a seed sprouts roots and shoots.

Hypothesis:
A smart guess or idea you can test to see if it's true. Scientists make a hypothesis before doing experiments.

ISS (International Space Station):
A big space station that orbits Earth where astronauts live and do science experiments.

Observation:
Watching something carefully to learn about it. Scientists make observations during experiments.

Substrate:
The surface or material that something grows on or lives in, like soil.

WHAT IS PLANTS FOR SPACE?

Plants for Space is a big team of scientists from five Australian universities, plus space companies, farming experts, the Australian Space Agency, and even NASA!

We are all working together to figure out how to grow plants for food and other important stuff so people can live in space for a long time without needing so many deliveries from Earth. What we learn can help make food and farming better and kinder to the planet here on Earth.

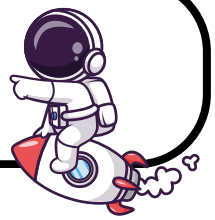
The Plants for Space team studies lots of things, like ways of growing plants in without gravity, how farming robots might help, how food affects our health and feelings, and even the rules about growing food in space.

OUR MISSION

- Making useful things with plants whenever we need them when far from earth
- Designing new plants with almost no waste in controlled environments
- Making healthy, tasty, plant-based food for astronauts and for people on Earth
- Helping kids and adults learn skills to get ready for jobs of the future

Watch the video here: https://tinyurl.com/pv6xmje

MISSION BRIEF



Your missions:

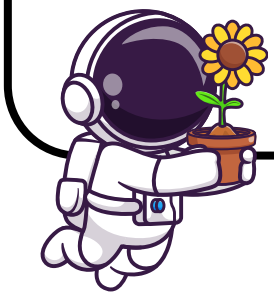
Plant Growth Experiment

The substrate free growth experiment will test how plants grow in just tap water and how they grow when extra nutrients are added to the water.

AVA Challenge

Think about the plants you will need to bring with tyou to the moon, the foods and flavours that are important to you. Use this knowledge, and your experience with growing plants hydroponically in your ideating for growing plants on the Moon in the Australian Virtual Astronaut Change!

GROWING PLANTS IN SPACE



Why Grow Plants in Space?

On long space missions astronauts will need fresh food for nutrients - these fade in packaged food over time. Caring for plants can also lift spirits during long, lonely missions. The goal is for astronauts to grow their own food on the Moon, Mars, or space stations. Plant can also be used for materials and medicine in space.

Growing plants in space comes with many challenges. On Earth, gravity helps roots grow down and light helps stems and leaves grow up. Plants floating in zero gravity grow differently and can become stressed. To help plants grow the best in space the temperature and humidity needs to be controlled. Special energy-saving LED lights are used. Since soil is heavy and hard to use in space, astronauts grow plants using hydroponics (in water) or aeroponics (with mist). Plans for Space scientists are working out the best mix of nutrients and light so plant grow quickly and so they are more nutritious

On the ISS, astronauts use the Veggie System with LED lights and rooting pillows to grow lettuce, mustard greens, and even flowers. They also use closed-loop systems, which recycle water, air, and nutrients even the carbon dioxide from astronauts' breath!

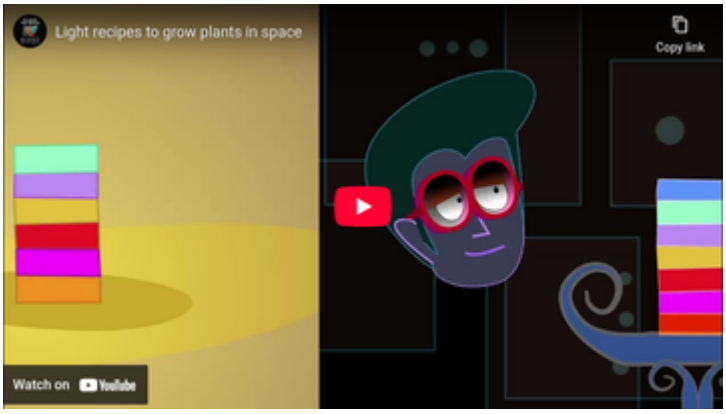
The researcher at Plants for Space are researching how to change plants so they can grow better in space, like a small miniature tomato plants, sweeter strawberries with less roots, and event leaves that make medicine.

Work by Plants for space might make farming more sustainable by using less water, and help create delicious and nutritious future foods! Cheese made from duckweed, and new flavours, and food that stores even better.

Growing Plants on Earth: https://tinyurl.com/pv6xmje

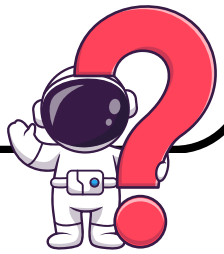
Effect of gravity on plants grow: https://tinyurl.com/wx2b3y53

Light recipes and plant groth: https://tinyurl.com/yc74tv73



Autonomous agriculture: https://tinyurl.com/4hc7nmtm

PLANT GROWTH EXPERIMENT



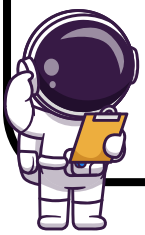
Your first mission task is to grow two plants using hydroponics. One plant will be grown in just tap water the other with nutrients added to the water.

What plants do you think will grow best?

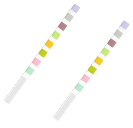
What you think will happen is your Hypothesis. You will test your hypothesis with the experiment.

To do this:

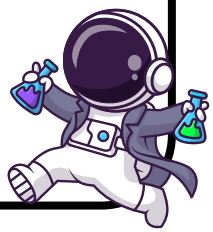
- Read about growing plants in space
- Follow the **Experiment Method** to test your hypothesis.
- Record everything you do. Use the **Mission Report** to record your hypothesis and data
- Use your data to see if your Hypothesis is correct
- Log your data with Grow For Launch Mission Control



GROW 4 LAUNCH!
CLASS DEMO KIT

☐	**3 Bottles**		Not included in the kit you will need to find 3 used bottles with wide openings (34mm)
☐	**Seeds**		Provided are a number of coriander seeds
☐	**1 Tweezers**		Used to set seeds in the Gyrosnaps
☐	**3 x Gyrosnap**		Gyroflex are a substrate-free reusable plant growth system
☐	**3x Hydrogel**		Hydrogel will take up water to make a gel, help seeds germinate and will biodegrade
☐	**1 Dropper**		Used to water seeds while germinating
☐	**Nutrients**		This is a mixture of nutrients that plants need such as Nitrogen, Potassium, and Phosphate.
☐	**3 Test Strips**		Measure different chemicals adn nutrients found in water
☐	**Mission Sticker**		Your very our mission sticker

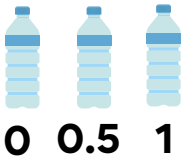
EXPERIMENT METHOD



Video demonstration ofo experiment set up: https://tinyurl.com/24fmcfzj

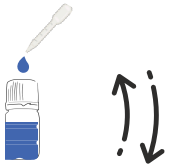
Step 1

- Materials check
- Collect two wide mouth plastic bottle about 250 - 300ml in size
- Label your bottles: **0, 0.5,** and **1**



Step 2

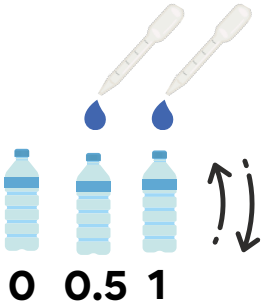
- With the dropper, fill the nutrient vial up with warm tap water and shake until all nutrients are dissolved



Warning: Wash immediately if undiluted nutrients contacts skin

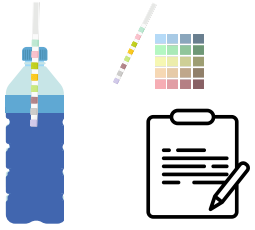
Step 3

- Add 0.5ml nutrients solution to the bottles labeled **0.5**
- Add 1ml nutrients solution to the bottles labeled **1**
- Fill both bottles to the same level with tap water
- Shake well (careful not to spill any!)



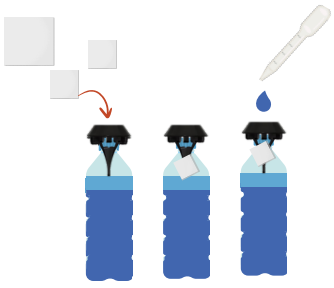
Step 4

- Dip a test strip into the **0** bottle for 2 seconds
- **Remove** test strips (**DO NOT** shake off extra water)
- Wait 30 seconds
- **Repeat** for 0.5 and 1 samples
- **Compare** to the test strips to the the test analyzer on the “Mission Report” page to see how nutritious the two samples are
- **Record** results in the “Nutrients in water” table in the “Mission Report”



Step 5

- Add a piece of hydrogel between the two flat flaps of each of the Gyrosnaps.
- Place one Gyrosnap in the each of the bottles.
- Use the dropper to add water onto the hydrogel.
- Wait 1 min until soaked. Add more water if needed.



Step 6

- Use tweezers and place three seeds onto the wet gyroflex
- Top up the bottles with more water so that the level is just below the seeds.

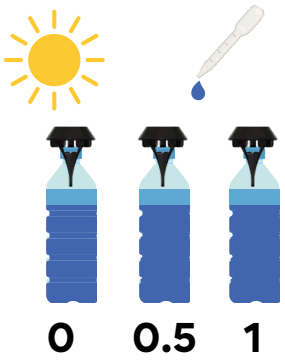
(Germinating seeds need to be kept wet but not underwater)

Note: Seeds can take up to 7 days or longer to germinate

Step 7

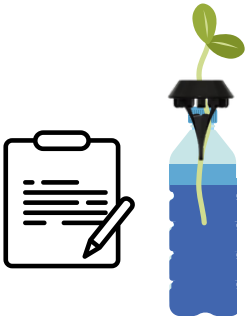
- Place bottles in sunlight and wait for them to grow.

Note: Add a few drips of water to the seeds each day to keep them wet but no under water!



Step 8

- Lets plants to grow for 14 days after germination
- Record every two day
  - How tall the sprout is
  - How long the roots are
  - How many leaves there are
  - How healthy the plant looks on a scale of 1 to 10 (1 being very sick looking 10 being very healthy looking)



Step 9

- Based on your observations complete the **Mission Report**

Extension: What better than water?
What other substrates might work?

1. Collect Materials

- Growth chamber
- Growth substrate
- Water
- Seeds

2. Prepare Growth Chamber

- Use any clear container that can hold growth medium and house plant up to 20 cm tall and can be sealed. e.g. 2 Liter bottle, storage container, large glass container.

3. Prepare Substrate and Plant Seeds

- Create a substrate mix that the plants will be able to grow and thrive in without adding additional water or nutrients.
- Example of growth substrates are: Agar, Sand, peat, gravel, soil or a mixture.
- Add seeds!

Note: The challenge of growing plants in space is giving the plants the right amount of water. The substrate the plant grows in can help.

4. Seal Growth Chamber

- Seal growth chamber
- Once sealed nothing can be added during the mission.
- Place in well lit area

5. Record and Analyse

- Record the growth substrate used, amount of water added, location in the world, and position and orientation in e.g south facing window.
- Record the growth of plants and observation very few days

MISSION REPORT

Hypothesis:

(Circle what your hypothesis is)

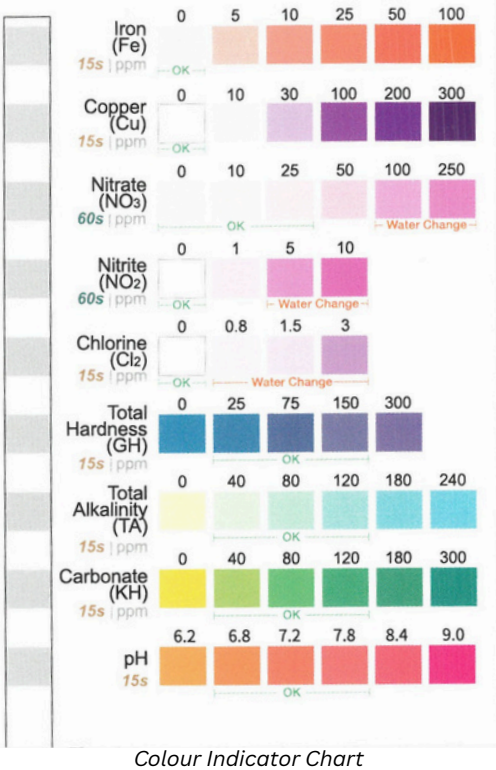
1. The plants that grow best will be in just tap water.

or

2. The plants that grow best will be in water and nutrients.

Do you have any other Hypothesis or predictions about how the plants will grow?

Water Test Results:
Use the test colour indicator chart to determine the nutrient levels. Record the data from water test strips in the table.



Colour Indicator Chart

Nutrients in Water

Nutrient	Water	Water + Nutrients
Iron (Fe)		
Copper (CU		
Nitrate (NO3)		
Nitrite (NO2)		
Chlorine (CL2)		
Total Hardness		
Total Alkalinity		
Carbonate		
PH		

Plant Growth Results

Day		0		2		4		6		8		10		12		14	
		W	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N
Shoot height (cm)																	
Root length (cm)																	
Number of leaves																	
Health score (0-5)																	

Plant Growth Debrief

Scientists love to tell others about what they found out, how their finding might help people or what their findings might mean for the future. This is done my showing people their results and coming up with a conclusion.

Look at you results and determine if one plant grew better than the other.

Do these results match your Hypothesis?

You can share your results, a space food recipe, or a plant/science inspired space story!
Here: (there is helpful advice on story writting and making Space food recipes too!)