



# GROW FOR LAUNCH



## 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.

Plants for Space (**P4S**) is funded through the Australian Research Council and

**P4S** partners include The University of Adelaide, The University of Western Australia, La Trobe University, The University of Melbourne, Flinders University, University of California, Berkeley, University of California Davis, University of Wisconsin-Madison, Rice University, University of Cambridge, University of Nottingham, Research for Agriculture, Food and Environment - INRAE, ETH Zürich, Vertical Future, Space Lab, Gaia Project Australia, Australian Plant Phenomics Network, The Andy Thomas Space Foundation, Dr Joanna McMillan, The Victorian Space Science Education Centre (VSSEC), One Giant Leap Australia Foundation, South Australia Botanic Gardens, South Australian Space Industry Centre (SASIC), Defense Science and Technology Group, Department of Primary Industries and Regions, South Australia (PIRSA), NASA, Australian Space Agency (ASA), Axiom Space, Yuri, Twist Bioscience, BioPlatforms Australia, Australian Genome Research Facility, Saber Astronautics, FOODiQ, National Imaging Facility.

These materials have been developed by the P4S Education and Engagement team with consultation with the P4S researchers, education providers and classroom teachers. LISAF and Melb Uni Botany Foundation. Plants for space would like to thank the following people for helping support Grow for Launch



## Contact Information

Email: [p4s\\_admin@adelaide.edu.au](mailto:p4s_admin@adelaide.edu.au)

Socials:



## Creative commons



Attribution-NonCommercial (CC BY-NC)



# 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



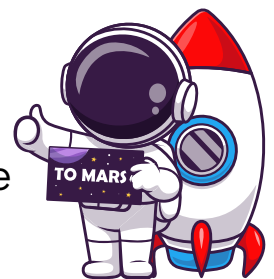
Designing new plants with almost no waste in controlled environments



Making healthy, tasty, plant-based food for astronauts and for people on Earth

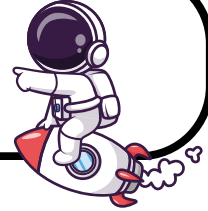


Helping kids and adults learn skills to get ready for jobs of the future



**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.



### Food Sensory Test

Food gives us lots of joy and helps us thrive. Taste is very important but we use other senses to enjoy food. Complete a food sensory test to help think about what make food enjoyable.



### Space Cook

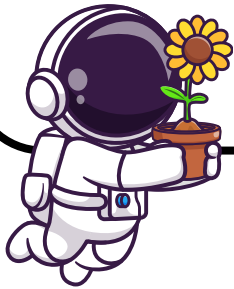
Using what you have learned during this mission to come up with a plant based recipe that is inspired by space. Maybe you want to make a super nutritious salad or a joyfull cake.



### 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 Challenge!

# 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.

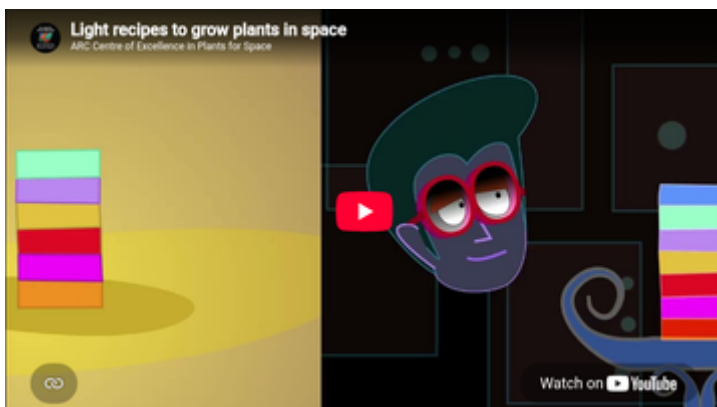
**Growing Plants on Earth:** <https://tinyurl.com/pv6xmje>



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



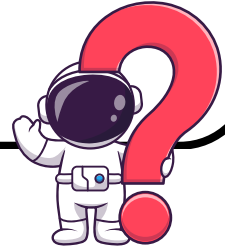
**Light recipes and plant growth:** <https://tinyurl.com/yc74tv73>



**Autonomous agriculture:** <https://tinyurl.com/4hc7nmtm>



# PLANT GROWTH EXPERIMENT



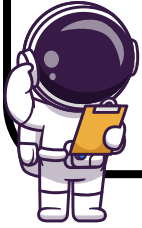
Your first mission task is to grow two plants using hydroponics. One plant will be grown in just tap water the other with nutrients added to the water.

## 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



## 2 Bottles

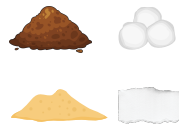


Not included.

You will need minimum 2 bottles cut in half or containers to grow seeds



## Substrate(s)



Not included.

You will need to select or make at least 1 “space” substrate to grow the seeds e.g sand, stones, cotton wool, paper, bark, soil, etc. or mixtures



## Seeds



Provided are a number of coriander seeds



## Tweezers



Used to sow the seeds



## Dropper



Used to water seeds and make up the nutrient solution



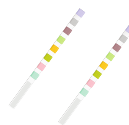
## Nutrients



This is a mixture of nutrients that plants need such as Nitrogen, Potassium, and phosphate.



## 2 Test Strips



These test strip measure different chemical nutrients are in the water

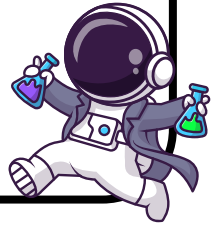


## Mission Sticker



Your very our mission sticker

# AVA EXPERIMENT METHOD



## Step 1

### Materials check

At least two growth chambers (e.g. 2 litre bottle ),  
growth substrate, seeds, tweezers and test strip, nutrient



## Step2

### Prepare Growth Chamber

Cut the 2 litre bottles into two pieces about half way up.  
Alternatively you can use a plastic containers



## Step 3

### Prepare Substrate

Select or Create a substrate mix that the plants will be  
able to grow and thrive in.

Example growth substrates are: Agar, sand, peat, gravel,  
soil or a mixture.



## Step 4

Add your substrate to your two containers

## Step 5

Add several seeds to your substrate in the containers



**Note 1:** The challenge of growing plants in space is giving the plants the right amount of water, the right substrate and the right amount of nutrient. The substrate the plant grows in can help.

**Note 2:** you can set up multiple substrates to test, but up set two at a time to compare different nutrient conditions.

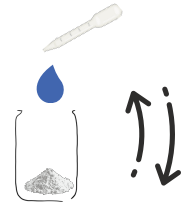
# AVA EXPERIMENT METHOD



## Step 6

### Dilute Nutreints

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

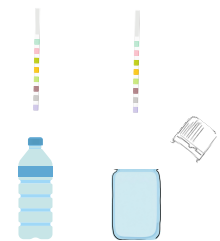


**Warning: Wash immediately if undiluted nutrients contacts skin**

## Step 7

### Test nutrients

- Dip test strips into 1) the tap water used to dissolve nutrients and 2) nutrient solution for 30 seconds
- Remove test strips and DO NOT shake off extra water
- Wait 30 seconds - the colours change might change



## Step 8

### Analyse the nutrients

- Compare the colours on the test strips to the the **Nutrient Analyzer** on the Mission Report (next page) to see how nutritious the two samples are
- Record results in the “Nutrients in water” table in the Mission Report (next page)



## Step 9

### Water the substrate and seeds

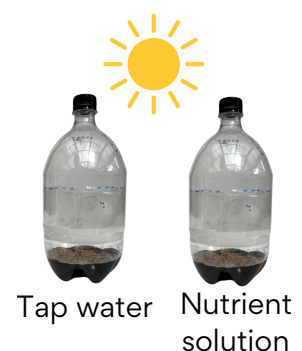
- Add ~100ml tap water into one container and label it
- Add ~100ml nutrient solution to the other container and label it



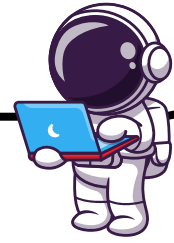
## Step 10

### Seal Growth Chamber

- Seal growth chamber (you can use sticky tape if you want)
- Add additional water as needed (don't let it dry out) and make sure you add the same volume to each container!
- Place in well lit area



# MISSION REPORT



## Hypothesis:

(Circle what your hypothesis is)

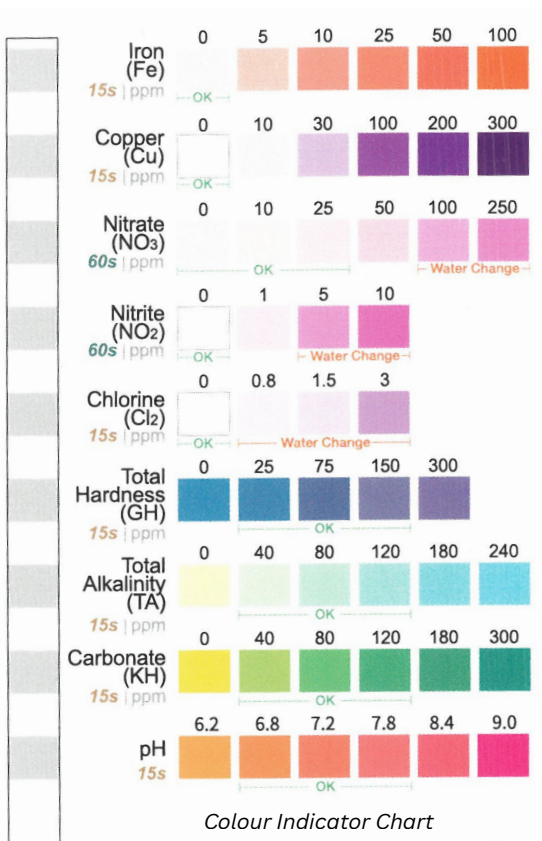
1. The plants that grow best will be in just tap water.
- or
2. The plants that grow best will be in nutrients solution.

Do you have any other Hypothesis or predictions about how the plants will grow? which substrate will be best?

## Water Test Results:

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

## Nutrient Analyzer



| Nutrient         | Tap Water | Nutrient Solution |
|------------------|-----------|-------------------|
| Iron (Fe)        |           |                   |
| Copper (CU)      |           |                   |
| Nitrate (NO3)    |           |                   |
| Nitrite (NO2)    |           |                   |
| Chlorine (CL2)   |           |                   |
| Total Hardness   |           |                   |
| Total Alkalinity |           |                   |
| Carbonate        |           |                   |
| PH               |           |                   |

# Plant Growth Results

| Day |   | Shoot<br>height<br>(cm) | Root<br>length<br>(cm) | Numb<br>er of<br>leaves | Health<br>score<br>(0-5) |
|-----|---|-------------------------|------------------------|-------------------------|--------------------------|
|     |   |                         |                        |                         |                          |
| 0   | N |                         |                        |                         |                          |
|     | W |                         |                        |                         |                          |
| 2   | N |                         |                        |                         |                          |
|     | W |                         |                        |                         |                          |
| 4   | N |                         |                        |                         |                          |
|     | W |                         |                        |                         |                          |
| 6   | N |                         |                        |                         |                          |
|     | W |                         |                        |                         |                          |
| 8   | N |                         |                        |                         |                          |
|     | W |                         |                        |                         |                          |
| 10  | N |                         |                        |                         |                          |
|     | W |                         |                        |                         |                          |
| 12  | N |                         |                        |                         |                          |
|     | W |                         |                        |                         |                          |
| 14  | N |                         |                        |                         |                          |
|     | W |                         |                        |                         |                          |

# **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 by showing people their results and coming up with a conclusion.

Look at your 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 writing and making Space food recipes too!)