GROW FOR LAUNCH

RESOURCE PACK

PLANTS FOR SPACE
ARC CENTRE OF EXCELLENCE

Australian Government

LA TROBE UNIVERSITY

THE UNIVERSITY OF MELBOURNE

THE UNIVERSITY of ADELAIDE

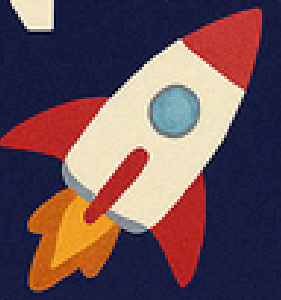
Flinders University

THE UNIVERSITY OF WESTERN AUSTRALIA

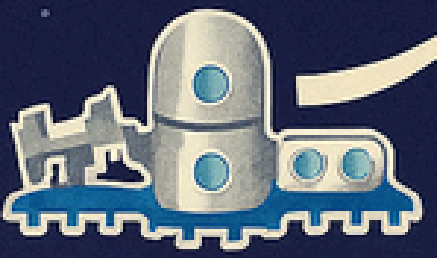
NASA'S PLAN

THE ARTEMIS MISSION

EARTH



LUNAR



THE GATEWAY

ISS

Growing food

Building materials

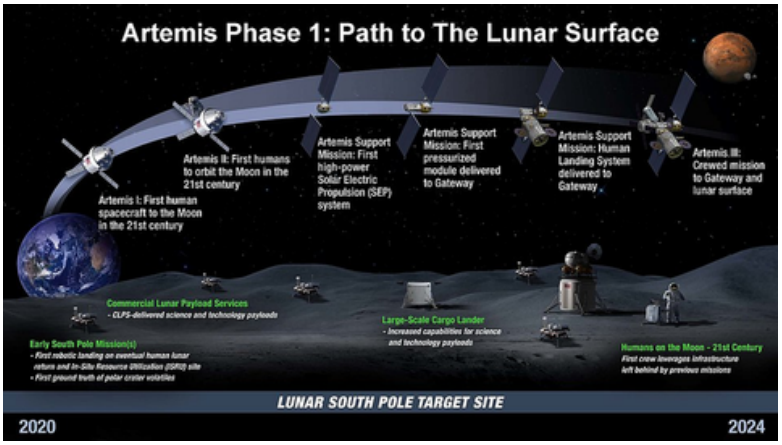
Living and working

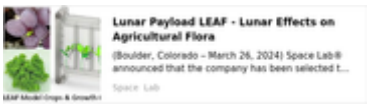
NASA'S ARTEMIS III MISSIOIN

The Artemis Accords are an agreement between more than 50 countries to work together to explore the Moon, Mars, and beyond peacefully and safely. It's like a big team promise to share science, help each other, and take care of space like we do with Earth.

This is important for astrobotany (space plants) because scientists all over the world will need to can share ideas about how to grow plants in space to help humans.

Working together helps us learn faster and grow better space gardens to feed astronauts and keep them healthy on their long journeys!





NASA's has a plan to get people back to the Moon! It's called "Artemis Phase 1: Path to the Lunar Surface."

First, special spacecraft and science tools are sent to the Moon to learn more about it.

Then, new parts like a space station called the Gateway and a landing system are sent up.

The big goal is Artemis III — the first crewed mission in the 21st century to land people on the Moon's South Pole!

Plant for Space and our partners will be landing plants on the Moon and testing to see how they grow compared to Earth!

Along the way, astronauts will practice living and working in space so they can stay safe, do science, and get ready for future missions—even to Mars!

WHY TAKE PLANTS TO SPACE?

O_2

Produce oxygen to breathe

Remove carbon dioxide

Provide fresh food

Help astronauts feel happy

In the future, plants might even make medicine for the Moon or Mars!

WHY TAKE PLANTS TO SPACE?

Humans need plants because they help us live and stay healthy!

Plants help create a healthy environment for astronauts, they:

- Produce oxygen to breathe and remove carbon dioxide from the air
- Provide fresh food filled with important vitamins
- They make medicines and materials
- Help astronauts feel feel happy when they see green leaves and bright flowers. and feel more connected to Earth

All very important for long space missions and for living on the Moon or Mars. And that's why we take care of plants on Earth—and want to grow them in space too!

PLANTS FOR SPACE
ARC CENTRE OF EXCELLENCE

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!

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

The Plants for Space team studies lots of things, like how plants grow, how to build special farming systems, how food affects our health and feelings, and even the rules about growing food in space.

MISSION BRIEF:

To grow plants for food, materials, and medicine to help humans live and be happy on the Moon!

Tasty food is one way to keep astronants happy and healthy. We aim to test how to grow the best food plants without soil, and then suggest a space food recipe for the journey!

PLANTS FOR SPACE 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

Vertical Farming and Automation

Plants Growth, Yeild, Efficiency

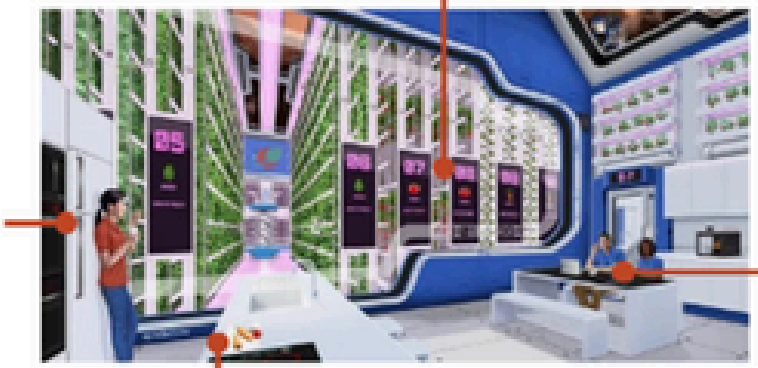
Plants

Food

Health and Nutrition

Good- Taste, Menu Fatigue and Storage

Plant and Food Processing and Preparation



People

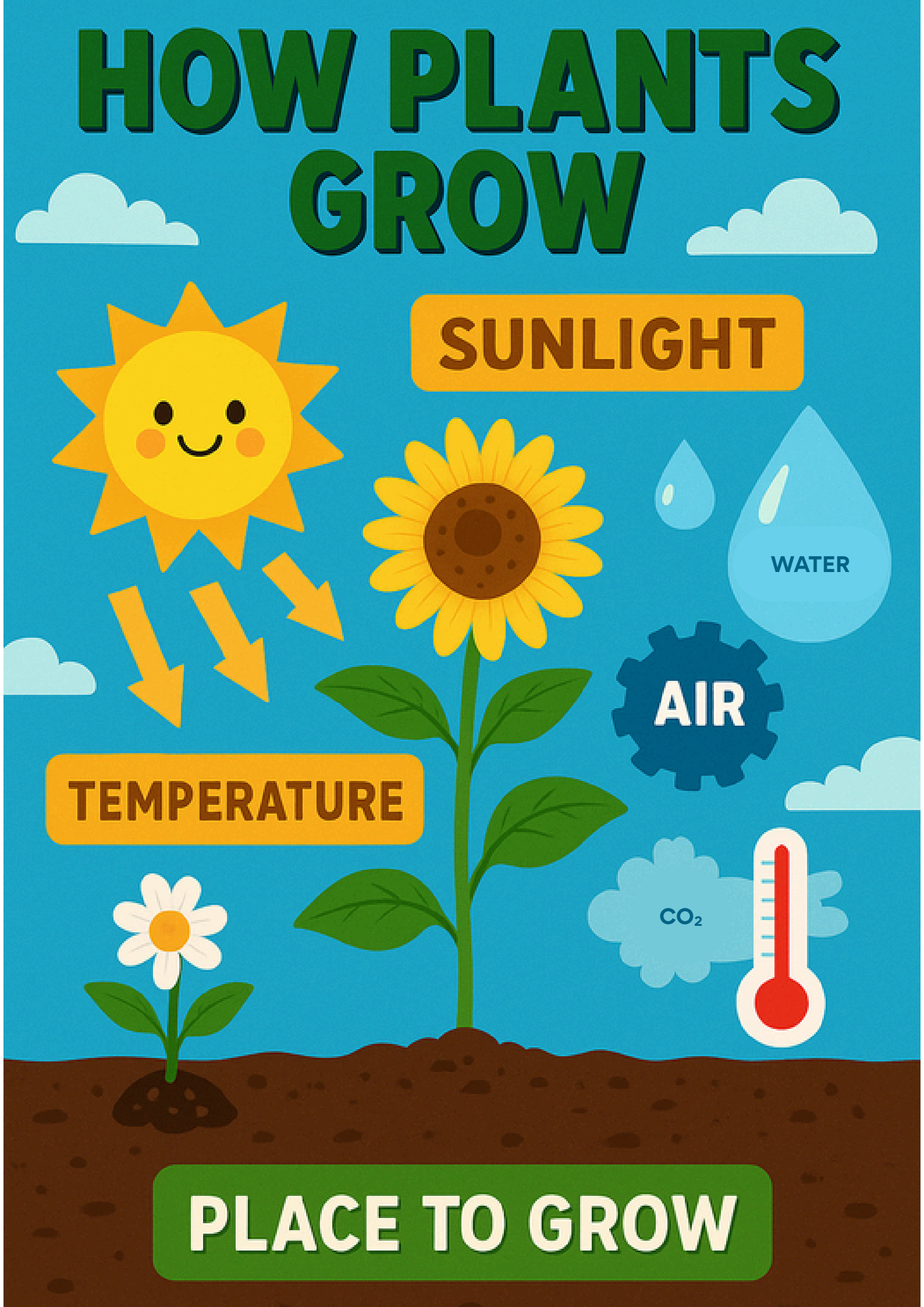
People's Experience and responses

What is legal and right

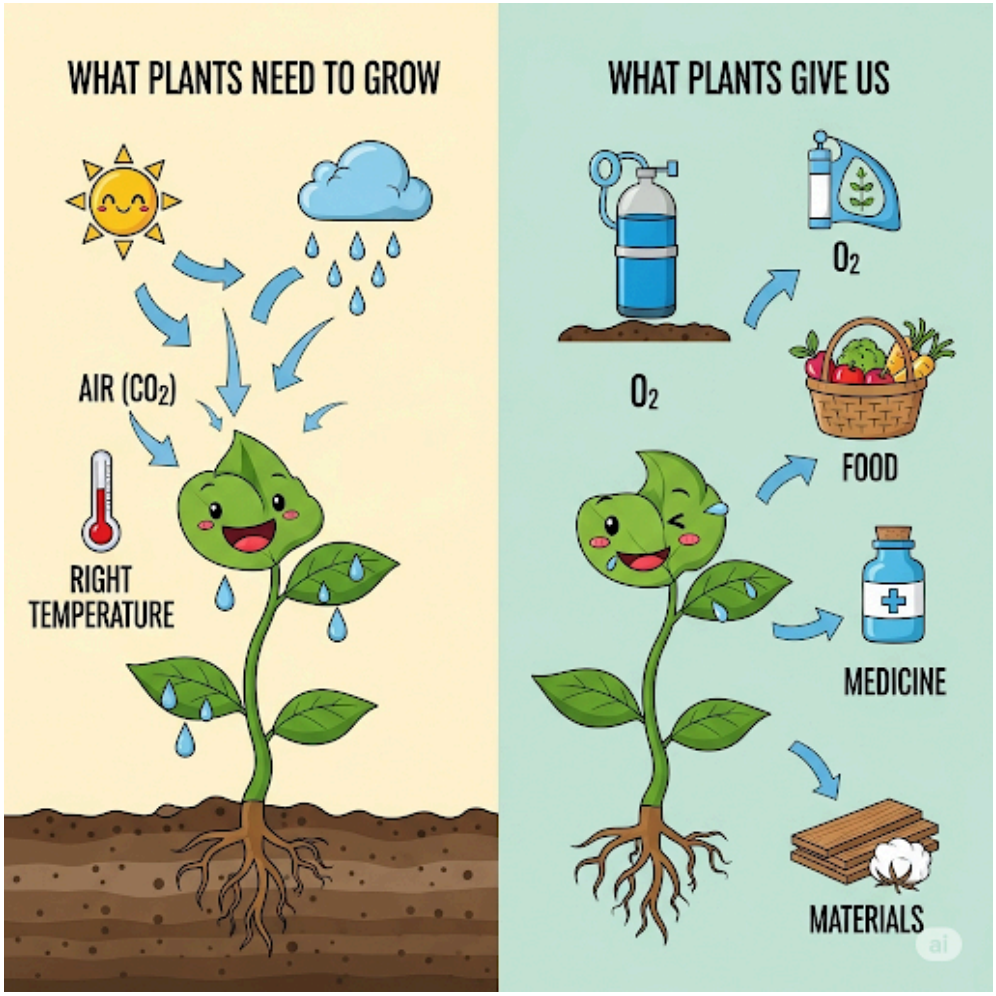
Products

Bio-Molecule Production

Future / Novel Foods


HOW PLANTS GROW
SUNLIGHT
WATER
AIR
TEMPERATURE
CO_2
PLACE TO GROW

HOW PLANTS GROW AND WHAT THEY GIVE US



Plants need things to grow. They need:

- Light to make their food,
- Water to drink,
- Air (especially carbon dioxide).
- The right temperature-not too hot or too cold
- A place to grow, like soil or water with nutrients.

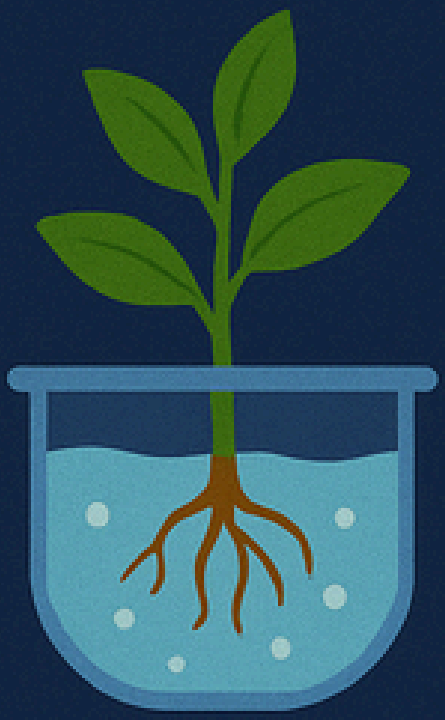
With all these things, plants can grow healthy and happy!

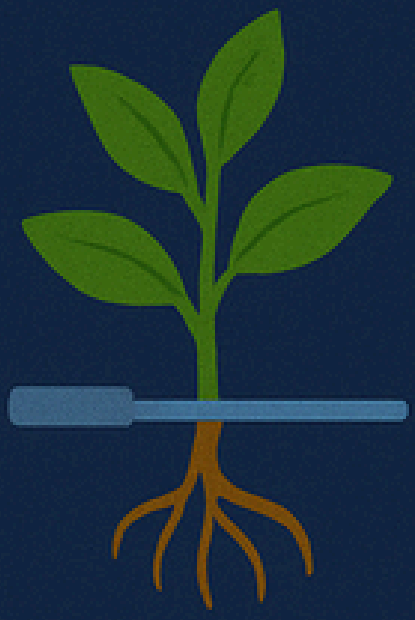
Plants make oxygen gas and food medicine and materials humans need here on Earth and in space!

HYDROPONICS & AEROPONICS

HYDROPONICS

Plants grow with their roots in water that contains dissolved nutrients





AEROPONICS

Plant roots are misted with a nutrient solution in the air

Benefits:

- Use less water than soil-grown plants
- Can be grown in a limited space

Benefits:

- Require less water and fertilizer
- Let astronauts monitor plants easily

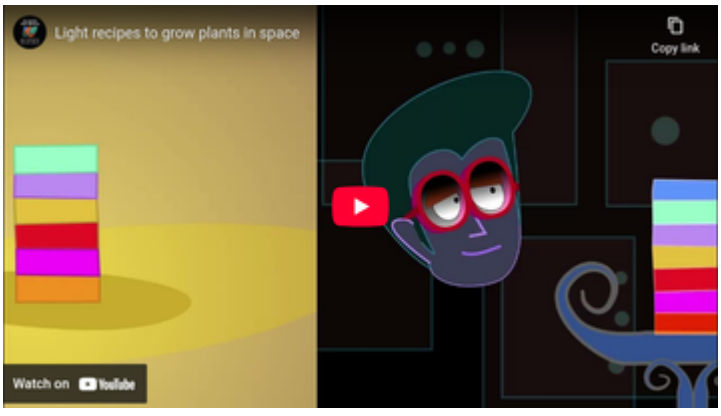
GROWING PLANTS IN SPACE

Growing plants in space is hard! we have to give the plants just the right amount of light water, nutrients and air. And there is no soil in space! so we can't grow them in soil!

Vertical farms are indoor farms that grow plants on shelves stacked on top of each other. the farmer can control all the things plants need to grow in sustainable ways and produce more food than traditional farming. Vertical farms on Earth might be a great way of testing how we might do it in space.

Hydroponics is a way of growing plants without soil. Instead, the plant roots sit in a solution of water and nutrients.
Why it's great for space:
Uses much less water than soil-based growing — perfect for saving resources in space.
Can grow in small, controlled environments like space stations.

Aeroponics grows plants with their roots hanging in the air. The roots are sprayed (or misted) with a nutrient-rich solution.
Why it's great for space:
Needs even less water and fertilizer than hydroponics.
Makes it easy for astronauts to check and monitor plant health.



What makes a great Space plant?

Tomato

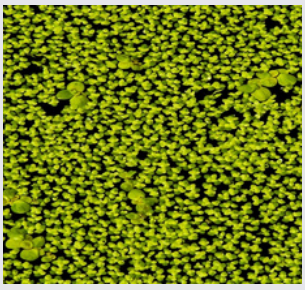
Been to Space

- Sweet and juicy Very
- nutritious
- Small varieties available

Leafy greens

Been to Space

- Crisp and crunchy
- Easy to grow
- Almost entirely edible



Duckweed

Been to Space

- Grows super fast
- Packed with protein
- Whole plant edible

Strawberry

Preparing for lift-off

- Tastes delicious
- Small compact plant
- Grows from seeds or cuttings

Images from Unsplash.com. Tomato: Leilani Angel; Leafy greens: Gabriel Mihalcea; Duckweed: Lucas van Oort; Strawberry: Josh Withers

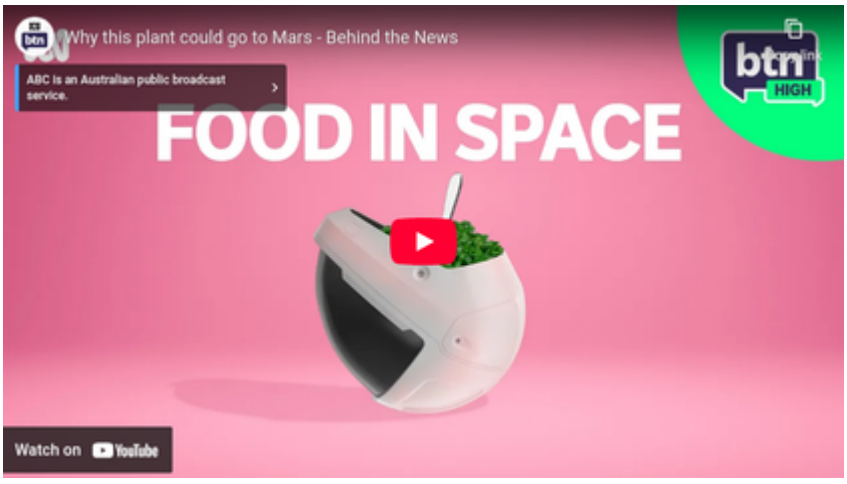
WHAT PLANTS HAVE BEEN TO SPACE?

NASA has grown...

🥬 Lettuce 🥦 Kale
🌶️ Peppers 🌱 Microgreens
🥕 Radish 🍓 Strawberries 🍅 Tomatoes

These are picked and eaten by astronauts! Yum!

What plant would YOU grow on the Moon and why?
Taste? Vitamins? Easy to grow? something else?



Growing Plants in Space

As humans explore space, we will want to bring plants for both aesthetic and practical reasons. We already know from our pioneering astronauts that fresh

NASA / Apr 9, 2019

POPULAR FOODS IN SPACE!

FREEZE-DRIED FRUITS

strawberries, bananas

Portable, sweet, and tasty

Warm and comforting

REHYDRATABLE SOUPS AND STEWS

Heat processing

TORTILLAS

Nuts and Trail Mix Cashews, almonds, dried Truits.

SPACE ICE CREAM

novelty item

SPACE ICE CREAM

Novel :y item

REHYDRATED BEVERAGES

Pouches. tea. fruit drink

PACKAGED CANDY AND CHOCOLATES

Enjoyed. But have short shelf-life

REHYDRA-TABLE EGG AND BREAKFAST ITEMS

Tèxture unusual on space flisht

Used in wraps or sandwiches

FRESH OR EATH

Enjoyed, but have short shelf-life

Foods Astronauts Have Eaten in Space

1. Freeze-Dried Fruits
Strawberries, peaches, bananas, apples
Popular because they're sweet, portable, and retain flavor well.

2. Rehydratable Soups and Stews
Chicken noodle, vegetable, beef stew
Warm and comforting, generally liked.

3. Thermostabilized Entrees (Heat-Processed Meals)
Beef stew, chicken curry, pasta dishes
Popular but sometimes taste a bit "processed".

4. Tortillas (Used Instead of Bread)
Used for sandwiches, wraps
Very popular because they don't create crumbs.

5. Nuts and Trail Mix
Cashews, almonds, dried fruits
Liked for snacks but can be messy in zero-G.

6. Space Ice Cream (Freeze-Dried Ice Cream)
Novelty item, more for fun than nutrition
Mixed reviews: some like it, others find it dry and crumbly

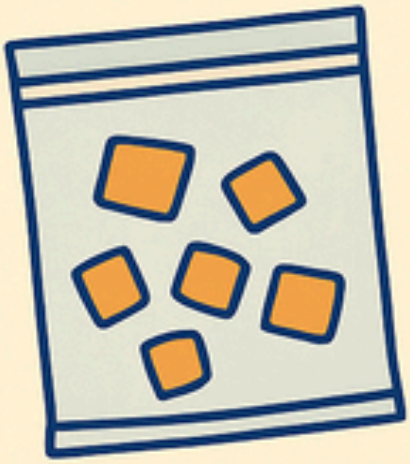
7. Packaged Candy and Chocolates
Mars bars, M&Ms
Generally liked, but sometimes avoided to reduce crumbs

8. Rehydratable drinks
Coffee, tea, fruit drinks
Essential and generally well-liked

9. Fresh Foods (On Short Missions or ISS Resupply)
Apples, carrots, salad greens
Enjoyed for freshness but limited shelf life

10. Rehydratable Eggs and Breakfast Items
Scrambled eggs, oatmeal
Mixed reviews; some find texture unusual

How is Food Cooked in Space?



Freeze-dried or dehydrated

In space, there's no stove because it's a zero-gravity, oxygen-rich environment.

So, instead, they add water to rehydrate this freeze-dried food.

Pah to rephy ted

Then they heat it using a special oven.

No pots or pans needed!

FOODS IN SPACE

How is Food Cooked in Space?

In space, there's no stove because fire is dangerous in a zero-gravity. So, astronauts don't "cook" food like we do on Earth. Instead, their food is:

- Pre-cooked or processed on Earth to make it safe and easy to eat.
- Freeze-dried or dehydrated to remove moisture, making it lightweight and long-lasting.

To eat, astronauts add warm water to rehydrate these foods. There are no pots, pans, but there is plastic waste packets.

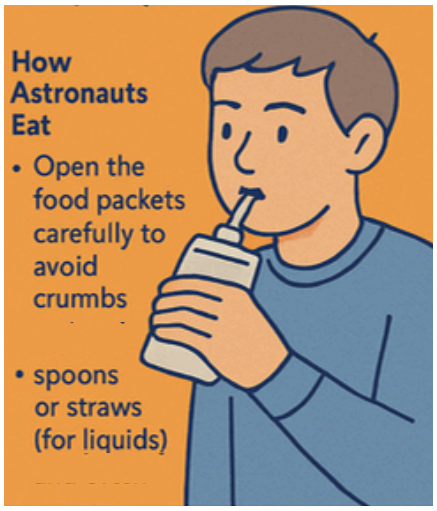
Cooking and eating Equipment in Space:

Food Warmer

Astronauts put their sealed food packages in the warmer to
heat them up. It's like a mini oven with warm plates to gently
heat food packets.

Water Dispenser and Rehydration Station

Provides hot and cold water in special bags.
Astronauts add water to freeze-dried or dehydrated foods to
"cook" or soften them.
No Microwaves or Toasters because of
fire risk, these common Earth appliances aren't used in space.



Utensils

Forks, knives, and spoons are magnetic or have velcro to stop them floating away.

How Astronauts Eat

They open the food packets carefully to avoid crumbs floating away (crumbs can be dangerous in zero-G). Use reusable containers or special bags to hold food.

They eat using spoons or straws (for liquids) and often drink from pouches.

CREATE YOUR ASTRONAUT DINNER! – RECIPE MAKER FOR KIDS

1. Imagine You're an Astronaut!
Where are you? (The Moon, Mars, or a Space Station)
What kind of food can you take with you? (Think about no fridge, limited space, or special space food!)

2. What Do You Want to Eat?
Choose a type of meal:
Breakfast 🥓
Lunch 🥪
Dinner 🍽️
Snack 🍎
Drink 🥤
What is your favorite food or something new you want to try?

3. What Ingredients Will You Use?
Pick 3–5 ingredients that you think would work well in space.
Ingredients can be fresh, dried, powdered, or freeze-dried (like astronaut food).

4. How Will You Make It?
Think about simple cooking or preparation steps astronauts could do in space.
Can you mix, heat, freeze, or just eat it as it is?

5. What Does Your Meal Look Like?
Draw or describe the colors, shapes, or fun space names you want to give your dish.

6. Why Is This a Good Astronaut Meal?
Does it give energy?
Is it healthy?
Can it last a long time in space?
Is it easy to eat in zero gravity?

Example Template (You can fill it out or draw pictures!)
Step Your Idea!
1. Where are you in space? e.g., Mars Base
2. Meal type Dinner
3. Ingredients e.g., freeze-dried chicken, rice, space cheese, powdered veggies
4. How to prepare Mix the freeze-dried chicken and rice with water, heat in space oven
5. What it looks like Orange and white chunks, looks like a space stew
6. Why astronaut food? Gives energy, easy to eat, lasts long

Create Your Sci-Fi Story: Astronauts and Food! – Story Maker for Kids

1. Start Your Story in Space!
Where is your story set? (Space station, spaceship, another planet, moon base...)
Who are the astronauts? (Names, how many, any special powers or pets?)

2. What's the Food Problem or Adventure?
Do they run out of food?
Are they growing strange space plants?
Is there a mystery about alien food?
Or maybe the food has magical or futuristic powers?

3. What Cool Space Food Do They Eat?
Describe the astronaut meals — are they freeze-dried, glowing, or maybe taste like anything they want?
Is there a new food invention?

4. What Happens in the Story?
What problem or challenge do the astronauts face with their food?
How do they try to solve it?
Do they have friends or robots helping them?

5. How Does the Story End?
Do they fix the problem?
Do they discover a new food from aliens?
What lesson did the astronauts learn about food or teamwork?

6. Add Fun Details!
What do the spaceships or space kitchens look like?
What sounds, smells, or colors do the food have?
Are there funny or exciting moments?

Example Story Plan (You can fill this in or use it as a guide!)
Step Your Idea!
1. Setting and characters On Mars base with astronaut Mia and robot Zip
2. Food problem or adventure The food machine broke and no one can eat!
3. Space food description Freeze-dried pizza that tastes like real pizza
4. Story events Mia and Zip fix the machine with alien help
5. Ending Food machine works again and they throw a party!
6. Fun details The pizza glows green and floats in zero gravity

CABBAGE INDICATOR

The water test strips used in this kit are colour indicators to measure how much of something is in a liquid. You can make your own indicator using red cabbage. It changes colour to show if something is an acid or a base. This is called pH.
You can make your own Red Cabbage pH indicator

What You'll Need:

- ¼ of a red cabbage chopped
- Hot water
- Large bowl and spoon
- A strainer or sieve
- Clear cups or jars
- Spoon or stirrer

For testing:

- Vinegar
- Lemon juice
- Baking soda mixed with water
- Dishwashing liquid
- Tap water
- Other liquids from your kitchen (milk, soda, juice)

Instructions:

1. Make the cabbage indicator

- Chop up ¼ of a red cabbage into small pieces (ask an adult for help).
- Put the cabbage into a bowl.
- Add about 2 cups of hot water.
- Mash and stir the cabbage for a few minutes until the water turns purple.
- Strain the liquid through a sieve into another container.

Test different liquids:

- Pour a small amount of the cabbage juice into several clear cups or jars.
- Add a different liquid to each cup — just a few drops or a spoonful.
- Stir gently and watch the colour change.

What the Colours Mean:

- Red or pink = acid (like vinegar or lemon juice)
- Purple = neutral (like water)
- Blue, green, or yellow = base (like baking soda or dishwashing liquid)

What's Going On?

Red cabbage contains a natural chemical called anthocyanin. It changes colour depending on whether it's in an acid or a base.

"SIMPLE SEEDS" AUSTRALIAN VIRTUAL ASTRONAUT CHALLENGE

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

- Share any images or updates of your project on LinkedIn and Instagram using @Magnitude.io, @ARC Centre of Excellence in Plants for Space, @Australian Pastures Genebank, and @AVA Challenge.

AVA AUSTRALIAN VIRTUAL ASTRONAUT

PLANTS FOR SPACE
ARC CENTRE OF EXCELLENCE

Celebrate Science Week with Plants For Space

P4S

Which plants can Astra the Astronaut grow on her spaceship?

Astra

Glossary 

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

- **Experiment**: This is like a special test we do to find out something new! We ask a question and then try to find the answer.
- **Hydroponics** (Hi-dro-PON-iks): This is a cool way to grow plants WITHOUT soil! Instead of dirt, the plants grow in water that has special food mixed in. "Hydro" means water!
- **Nutrients** (NOO-tree-ents): These are like the special food or vitamins for the plant. In hydroponics, we mix these into the water so the plant has everything it needs to grow big and strong.
- **Germinate** (JER-min-ate): This is when a seed "wakes up" and starts to grow a little root and shoot. It's the very beginning of a new plant!
- **Solution** (So-LOO-shun): In hydroponics, this means the water with all the plant food (nutrients) mixed into it.
- **Measure**: This means to find out how big or how much of something there is. We might measure how tall our plants get!
- **Observe** (Ob-ZERVE): This means to look very carefully at something and notice what's happening. We observe our plants to see how they are growing.
- **Hypothesis** (Hy-POTH-e-sis): This is your best guess about what you think will happen in the experiment. It's an idea you want to test!
- **Results**: This is what actually happens in your experiment. What did you find out?

Thank you for participating in Plants for Space National Science Week Grow for launch program. Grow For Launch is generously sponsored by a National Science week grant.

Further resources can be found on the Plants For Space Education and Engagement webpage

https://plants4space.com/public-programs/education-and-engagement