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**Y7**

 Ecosystems beyond Earth • Lesson 1 • Dining in space

**Lesson 1**

**Launch**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth/lesson-1-dining-space](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth/lesson-1-dining-space?utm_source=docx&utm_medium=lesson_1&utm_campaign=EBE) |

# Lesson overview

This lesson introduces the necessity of obtaining energy through food and explores the conditions experienced by astronauts.

## Key learning goals

Students will:

* identify the source of energy in a food chain.
* explore the conditions experienced by astronauts on the International Space Station (ISS).
* taste-test a variety of foods.
* identify the considerations of nutritionists when planning trips to the ISS.
* evaluate the effectiveness of a food test by examining the potential bias of participants.

Students will represent their understanding as they:

* complete a food chain with correctly drawn arrows.
* record the results of a food test.
* evaluate the effectiveness of the food test by identifying any outliers and explaining how bias or assumptions may have influenced the result.

## Assessment advice

In the Launch phase, assessment is diagnostic.

Take note of:

* students’ ability to explain the movement of energy through food chains.
* students’ understanding of bias and assumptions.
* students’ understanding of the conditions in space.

## List of materials

**Whole class**

* **Ecosystems beyond** **Earth Resource PowerPoint**
* An area for food-tasting, which should not be a laboratory. If required, use the school lunch area for testing.

**Each group**

* **Australian food web Resource** **cards** (retain for use in later lessons)
* Paper plates
* Samples of small leafy foods, for example lettuce varieties, kale, coriander, basil and beetroot

**Each student**

* Individual student notebook
* **Testing food preferences Resource sheet**
* Optional: Water bottle

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Elicit** | 10 minutes | Small group |
| **Anchor** | 10 minutes | Whole class |
| **Experience and empathise** | 30 minutes | Individual/Small group |
| **Connect** | 10 minutes | Whole class |

# Launch

## Elicit • Earthbound ecosystems

Divide students into groups. Provide the **Australian food web Resource cards** to each student group.

Students should select one plant card, and then select an animal that eats the plant.

Discuss how the animal might be growing and needs to move to find food or escape being eaten. Discuss how energy is transferred from the plant to the animal so that it can do these actions.

**Potential discussion prompts**

* *Why does the animal need to eat the grass?*
	+ To get energy for moving, growing.
* *How can we show the movement of energy from the plant to the animal?*
	+ Drawing an arrow from the plant to the animal (the direction the energy flows).
* *Does the animal get eaten? What eats the animal you have chosen?*

Each team then selects a second animal that eats the first animal.

Discuss how some of the energy is transformed into movement and all the processes that are needed to keep it alive. The teams continue to select cards to add to their food chain until they cannot go any further.

✎ STUDENT NOTES: Draw the food chain.

Each team mixes the animal cards, and this time start with an animal. Use the notes to identify where the animal’s energy comes from.

✎ STUDENT NOTES: Draw the food chains that are created, including the direction which the energy flows (from the plant to the animal).

Describe the importance of plants in harnessing energy for all other animals on Earth.

## Anchor • Conditions in space

**Pose the question:** *What if you were on the International Space Station? Where do astronauts get their energy?*

(Slide 3) Discuss how food is currently sent to the International Space Station by rocket, and that Earth could not sustain this for longterm settlements on the Moon or Mars.

**Potential discussion prompts**

* *What do astronauts eat?*
	+ They eat a variety of food that is often dried. The mass of water adds to the overall mass of a rocket, so astronauts want to minimise this. Water is added to food at the International Space Station (ISS). More information can be found in the NASA video [Surprisingly STEM: Space Food Scientist](https://plus.nasa.gov/video/surprisingly-stem-space-food-scientist/).
* *Do astronauts grow food on the International Space Station?*
	+ Astronauts are experimenting on the types of food that can be grown on the ISS.
* *Could astronauts grow any food on the space station, or are there limitations?*
	+ Limited space in an enclosed environment means astronauts cannot grow anything too tall (like corn or tomato vines). Most often they grow greens like lettuce.
* *What are conditions like on the International Space Station?*
	+ There is very little gravity (microgravity), and similar oxygen content in pressurised air (21%). Oxygen is delivered to the ISS or generated by splitting water into oxygen and hydrogen. Water is recycled.

## Experience and empathise • Astronaut lunch

Many students may have limited experience with different food varieties. This routine is designed to increase students’ exposure to food types and greens in particular.

(Slide 4) Explain that because of microgravity an astronaut needs to exercise for two hours each day to prevent muscles from wasting away. Less gravity also means that their muscles do not need to work very hard (not need as much energy). A typical astronaut needs:

* Male: 10,800-14,800 kJ each day
* Female: 8,000-10,800 kJ each day

The food needs to be planned six months in advance by nutritionists.

**Pose the question:** W*hat things do the nutritionists need to consider?*

✎ STUDENT NOTES: Brainstorm what affects whether you like food.

Most students’ suggestions can be categorised as taste, texture, and appearance.

(Slide 5) Explain that students will need to test the different food varieties that could be supplied to the ISS or grown on the ISS.

Provide students with the **Testing food preferences Resource sheet**.

Explain how students need to score each food (1 for extreme dislike-10 for extreme like) for appearance, colour, smell, flavour and texture. Encourage students to not share their results until the discussion at the end to avoid bias from the results of other class members.

Explain that bias is a decision based on prior experience or other people's opinions rather than this tasting experience.

**Food tasting**

1. All participants should wash their hands.
2. Place each food sample on a paper plate.
3. Students should score the colour, appearance, colour and smell for each food.
4. Students should taste the food (if safe) to record the taste and texture of each food.
5. If there is a strong opinion for or against the food, students should record their reasoning in the comments.
6. Students should use their water bottle to cleanse their palette between tasting if required.

(Slide 6) Discuss the most and least popular foods. Evaluate the effectiveness of the food tests.

**Potential discussion prompts**

* *Did everyone score the food the same value for the colour or appearance? Why or why not?*
* *What kinds of things may have affected the way everyone viewed the food?*
* *What does it mean when we say someone is ‘biased’?*
	+ They may already like or not like the food, based on prior experience.
* *How could this affect the result?*
	+ It means that people will push their score more to the ends—either a 1 or 10—rather than the middle.
* *What could be one way we could remove possible bias from the class results?*
	+ Remove the extreme results from either end.

✎ STUDENT NOTES: Complete the **Testing food preferences Resource sheet**.

## Connect • Working in space

**Pose the question:** *How old will you be when NASA will have people starting settlements on the surface of the Moon (2026) or Mars (2035)?*

Compare the settlement of the Moon or Mars to research stations in Antarctica. Antarctica is a reasonable comparison to make as it is isolated and help cannot arrive immediately in the middle of winter. This means they need to be self-sufficient in all things.

(Slide 7) Brainstorm the variety of professions that will be needed on the Moon or Mars:

* Welder
* Plumbers
* Electricians
* Doctors
* Engineers
* Climatologists
* IT officers
* Geologists
* Mechanics
* Chef
* Operation coordinator
* Psychologist
* Pilot

Watch the video [ARC Centre of Excellence in Plants for Space - Launch](https://www.youtube.com/watch?reload=9&v=rUVpu7wr7D4) (3:03).

Explain that in this sequence, students will be designing a plant-growing pod that will allow the first settlements on the Moon or Mars to grow their own food.

### Reflect on the lesson

You might:

* research show long it takes to travel to the ISS, the Moon, and Mars.
* research the conditions on the ISS.
* ask students to record the food they eat/need for 24 hours.

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**Y7**

 Ecosystems beyond Earth • Lesson 2 • Tracking energy

**Lesson 2**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth/lesson-2-tracking-energy](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth/lesson-2-tracking-energy?utm_source=docx&utm_medium=lesson_2&utm_campaign=EBE) |

# Lesson overview

Students examine the challenges of comparing and measuring plant growth. They plan an experiment that examines the energy needs of a plant, using coloured light.

## Key learning goals

Students will:

* examine how to observe a plant.
* identify independent, dependent and controlled variables.
* plan a reproducible experiment to test the relationship between coloured light and plant growth.

Students will represent their understanding as they:

* draw a diagram of their observations of a plant.
* plan and conduct a safe, reproducible experiment to test the relationship between coloured light and plant growth.
* select and construct appropriate representations to organise data and information.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* representations of flows of energy in an ecosystem.
* planning and conducting safe, reproducible investigations to test relationships.
* selecting and constructing appropriate representations to organise data and information.

**Potential summative assessment**

Students working at the achievement standard should:

* represent flows of energy in ecosystems.
* plan and conduct safe, reproducible investigations to test relationships.
* use equipment to generate and record data with precision.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth?tabIndex=2) for further information.

## List of materials

**Whole class**

* Ecosystems beyond Earth Resource PowerPoint
* Sticky notes
* Whiteboard to write on (with associated markers)
* Display plant e.g. lettuce seedling (also used in Lesson 3)

**Each group**

* 8 long skewers
* Masking or sticky tape
* Coloured cellophane (red, blue, and green)
* Well-lit area
* Water
* Seedling lettuce plants or duckweed plants (minimum 2/group)
* Soil or water for the plants to grow in
* Small containers to hold the seedlings (i.e. egg cartons)
* Dish to contain water under the plants

**Each student**

* Individual notebook
* Testing plant growth Resource sheet

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-orient** | 5 minutes | Whole class |
| **Question** | 5 minutes | Whole class |
| **Investigation** | 30 minutes | Small group  |
| **Integrate** | 10 minutes | Whole class |

# Inquire

## Re-orient

Recall the previous lesson, focusing on what we know about the requirements of sending astronauts to the Moon or Mars.

Watch the video [Off limits: Space food - Find out what astronauts eat in space](https://www.youtube.com/watch?v=fgM9Y4MQC6o) (3:36).

Discuss the importance of food to supply us with the energy that we need to move, repair tissue/muscles, and grow.

## Question • What do plants need?

Discuss the challenges of supplying food to astronauts when they are further away from Earth (such as on the Moon and Mars).

(Slide 9) Recall food chains all start with a plant and that plants need sunlight.

**Potential discussion prompts**

* *What foods do astronauts need?*
	+ A variety of different foods and fibre so they stay healthy and fit for space.
* *Where are we/humans located in a food chain?*
	+ We are omnivores that eat plants and other animals. Therefore, we are second or third (trophic level) on the food chain.
* *What is at the start of all food chains?*
	+ Plants.
* *How do plants get their energy?*
	+ Sunlight.
* *Does the International Space Station (ISS) have natural light?*
	+ No. It uses artificial light.

**Pose the question:**  *Does it matter what colour of light the plants are exposed to?*

Explain that students will be testing this during the teaching sequence.

**Pose the question:** *How do we know if a plant is growing well under coloured light?*

## Investigation • Plant growth experiments

Display a plant for students to observe.

✎ STUDENT NOTES: Draw a diagram of the plant.

Discuss the importance of drawing what they see rather than what they expect to see.

**Potential discussion prompts**

* *How many leaves does your plant have?*
* *What shape are the leaves?*
* *Do they have smooth edges or bumps/serrated edges?*
* *Is there a vein/xylem down the middle?*
* *Are there smaller veins coming off a central vein?*
* *Is the leaf one colour or darker in some places?*
* *How are the leaves attached?*
* *What labels or measurements does you picture need?*

(Slide 10) Brainstorm all the ways a plant can be measured. Options include the number/colour/length/height/width of leaves and number/length/depth/width of roots.

✎ STUDENT NOTES: Record ideas.

(Slide 11) Brainstorm all the things/variables that may change the way a plant will grow. Record each variable on a sticky-note and display on a board or window. Make sure ‘coloured light’ is included.

Discuss the meaning of an independent variable and move the sticky-note with ‘coloured light’ to one side. Label it ‘independent variable’.

Discuss what would be the most reliable way to measure plant growth (dependent variable).

Students are likely to suggest using plant height as a way to measure plant growth. However, when lettuce leaves grow in green light, they will initially grow taller in an attempt to reach light with greater energy, before withering. For this reason height is not a good choice of dependent variable.

**Optional:** Different student groups may decide to measure different dependent variables.

Group the remaining variables as ‘controlled variables’. Discuss how it is easy to make assumptions about the controlled variables (e.g. assume that the temperature near windows is the same as the temperature in the centre of the room).

**Potential discussion prompts**

* *What does the word ‘controlled’ mean?*
	+ To make sure that each plant is in the same conditions except for the one change that we make (independent variable).
* *Why is it important to keep the conditions between all the plants the same (except for the independent variable)?*
	+ So we know that the variable that we select is the one that caused the change.
* *How can we control the variables we have identified?*
* *How could we measure these variables to ensure that one plant does not have different conditions from other plants?*

✎STUDENT NOTES: Record the different variables and how they will be controlled in the **Testing plant growth Resource sheet** (Slide 12). Plan your experiment and consider any possible risks involved.

Allow students time to set up their experiments. Consider:

* using the skewers and masking tape to make a pyramid scaffold for the cellophane. If this is done carefully, the pyramids can be stored and reused in the following years.
* using double layers of cellophane (especially the green) provides for more thorough filtering of the light reaching the leaves of the plants.

## Integrate • Flow of energy in space

Discuss why it is important to make initial measurements of the plants. Confirm with the students what dependent variable(s) they will be measuring in a reproducible way.

**Potential discussion prompts**

* *What type of measurements or observations will you make?*
* *Will your data be quantitative (numerical) or qualitative (descriptions)?*
* *How will you record your data?*
* *What headings might you need in your table?*
* *What units will you use when measuring?*
* *If all leaves are different lengths to start with, how could you show any change? How could you show this in your table?*

✎ STUDENT NOTES: Draw up a table for the initial measurements of the plants.

(Slide 13) Discuss how energy cannot be created or destroyed, but it could be difficult to reuse or lost to the system.

✎ STUDENT NOTES: Record the pathway/transfer of energy on the ISS.

Depending on students’ prior knowledge, they may omit the type of energy (text in red).



**Potential discussion prompts**

* *Where do the plants get the energy to grow?*
* *Where does the light energy come from?*
* *What about the ISS, where does its energy come from?*
	+ The ISS has solar panels to capture sunlight. This light energy is transformed into electrical energy for the LED lights, which convert it back to light energy for the plants.
* *If the astronauts get their energy from eating the plants, where does their energy go?*
	+ The energy is transferred to movement/kinetic energy, and thermal/heat energy. This helps to heat the air in the ISS.
* *Where does the heat energy go?*
	+ The ISS has a cooling system to remove the thermal/heat energy from the inside of the ISS through radiation.

Optional: Watch the video [How do you grow plants in space? | BBC News](https://www.youtube.com/watch?v=vv6ATRPUjrI) (4:19).

### Reflect on the lesson

You might:

* watch the video [Bean Time-Lapse - 25 days | Soil cross section](https://www.youtube.com/watch?v=w77zPAtVTuI) (3:09) and describe the growth of the seed at Day 1, 4, 7, 9, and 12.
* re-examine the intended learning goals for the lesson and consider how they were achieved.
* discuss how students were thinking and working like scientists during the lesson. Focus on the planning of reproducible experiments.

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**Y7**

 Ecosystems beyond Earth • Lesson 3 • Matter matters in space

**Lesson 3**

**INQUIRE**

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# Lesson overview

Students use secondary data to generate a column graph comparing the portions of different plants that are edible. They examine the recycling of matter on the International Space Station.

## Key learning goals

Students will:

* identify that the portion of a plant that is edible will vary between plants.
* use percentages to compare the portion of plants that are edible.
* use secondary data to explore the recycling of matter in the ISS environment.
* use argumentation skills to make a claim supported by evidence and reasoning.

Students will represent their understanding as they:

* use secondary data to generate a graph.
* use secondary data to identify plants that would be suitable to grow on the ISS.
* use argumentation skills to justify their decisions.

## Assessment advice

In this lesson, assessment may be formative.

Feedback might focus on:

* understanding of the recyclability of matter in an ecosystem.
* the ability to use software to organise data.
* the ability to assess the reliability of second-hand data.
* the ability to use evidence and reasoning to support a claim.

**Potential summative assessment**

Students working at the achievement standard should:

* represent flows of matter in ecosystems.
* identify considerations for the use of secondary data.
* select and construct appropriate representations to organise data and information.
* use spreadsheets to aid the presentation and analysis of data.
* process data and information and analyse to describe patterns, trends and relationships.
* identify evidence to support their conclusions and construct arguments to support or dispute claims.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth?tabIndex=2) for further information.

## List of materials

**Whole class**

* Ecosystems beyond Earth Resource PowerPoint
* Edible plant (lettuce seedling) with roots, from the previous lesson—as a demonstration or for use in individual teams
* Cutting board
* Knife
* Scales

**Each group**

* **Edible plant Data resource**
* Access to spreadsheet software (i.e. Excel)

**Each student**

* Individual notebook
* **Selecting plants Resource sheet**

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-Orient** | 5 minutes | Whole class |
| **Inquire** | 5 minutes | Whole class |
| **Investigate** | 30 minutes | Individual |
| **Investigate** | 20 minutes | Individual |

## Inquire

## Re-orient

Allow students time to make observations and measurements of their plants.

Discuss any differences that are observed, focusing on any biases that students may have towards the effect of a particular colour of light.

Recall the different ways that plants can grow, including number of leaves, thickness/length/width of leaves, and the height of the plant.

## Inquire • What is edible?

Discuss the type of growth that is needed (many leaves with crispness) and the limitations of plant growth (height and plant waste) on the ISS.

**Potential discussion prompts**

* *How much food needs to be grown on the ISS?*
* *How many different foods do you think they will need to grow to meet the nutrition needs of the astronauts?*
* *How big are the growing areas on the ISS? Will this affect the types of plants that can be grown?*
* *How much of a plant can be eaten?*
* *What happens to the rest of the plant?*

✎ STUDENT NOTES: Brainstorm the criteria for selecting a plant to test on the ISS. This will be used later in the lesson.

**Pose the question:** *How much of a plant is edible? How much of a plant needs to be recycled?*

## Investigate • Waste not want not

(Slide 15) Show students an edible plant (with roots) obtained from the local area.

Discuss the different parts of the plant, what parts are edible, and what parts cannot be eaten (are waste matter).

✎ STUDENT NOTES: Note the edible parts of the plant on the diagram drawn in the previous lesson.

As a demonstration, or in individual teams, wash the soil from the roots of the plant and separate the edible portion from the non-edible waste matter.

(Slide 16) Discuss how these two portions could be measured and compared.

**Potential discussion prompts**

* *How could we measure how much is in each portion?*
	+ By weighing each portion.
* *What would normally happen to the non-edible/waste matter portion here on Earth?*
	+ It is usually composted into soil that can be reused to grow more plants.
* *Is that possible on the ISS? Why or why not?*
	+ Not currently. Some portions are wasted.
* *What happens to waste on the ISS?*
	+ All waste matter is packed into a small container and is released to burn up on re-entry to the Earth’s atmosphere. This means we cannot reuse/recycle the waste matter.
* *How would this be different on the Moon or Mars? Could we recycle the waste there?*

(Slide 17) Use scales to measure the mass of the whole plant, the edible portion, and the inedible portion.

Discuss the lack of decomposers (fungi and bacteria) and worms that might help with the breakdown of the inedible portions into compost.

✎ STUDENT NOTES: Draw a table to record the results of the measurement.



Discuss if this plant would be worth growing on the ISS. Refer back to the brainstorm of criteria of plants to test on the ISS.

(Slide 18) Compare the plant to the proportions of spinach—60g edible and 40g inedible. Discuss how difficult it is to compare the mass.

**Potential discussion prompts**

* *Does more of the plant’s energy go into growing the edible portion, or the inedible portion? Which has the greatest mass?*
* *How could we compare the edible proportions of big plants to small plants?*
* *What does percentage mean?*
* *Which is larger, 5 grams or 10 grams?*
* *Which is a bigger proportion, 10% or 15%?*
* *Which is a bigger proportion, half (50%) of a big plant or half (50%) of a small plant?*
	+ They are both the same proportion (50%).
* *If one plant is 40% edible, and another plant is 50% edible, which plant has the greatest proportion that is edible?*

Divide groups of students according to their abilities and select the appropriate data tabs from the **Edible plant Data resource**. Discuss how tables are a good way to organise data, and that graphs are a way to visually use data to tell a ‘story’.

### Adapt the data

There are four sets of data provided as part of this activity.

**Data 1:** The original dataset containing the mass of edible and inedible proportions. Students need to convert this data into percentages before generating a column graph of the data.

**Data 2:** The original dataset with the percentages already calculated. Students use this data to generate a column graph for comparison of edible proportions.

**Data 3:** A simplified dataset containing just the plants and their proportions. Students use this data to generate a column graph for comparison of edible proportions.

**Data 4:** The simplified dataset with the column graph already inserted for students who have a limited ability to use a computer or spreadsheet.

(Slide 19) Guide students through the process of:

1. Calculating the percentage values for edible and inedible proportions.
2. Reducing the number of decimal places—on the Home tab, in the Number group, select ‘Decrease decimal’.
3. Select the data to be graphed (plant, percentage edible, percentage inedible) by holding down the CTRL key and selecting the data in those three columns.
4. In the Insert tab, select ‘Column graph’ in the Charts group.
5. Select the chart, then select the Chart Design tab.
6. Select ‘Add Chart Element’ from the LHS of the top ribbon to add a title for the graph and axis labels.
7. The completed graph can be printed or copied and pasted into STUDENT NOTES.

## Integrate • Using secondary data

(Slide 20) Discuss the advantages and disadvantages of using secondary data.

**Potential discussion prompts**

* *What is secondary data?*
	+ Data collected by someone else at an earlier time.
* *How do we know if we can trust the secondary data? What things do we look for?*
	+ We need to know how the data was collected, if there were any controls, has the data been checked by other scientists.
* *Where did this data come from?*
	+ From a peer-reviewed journal. The journal details are listed next to the data.
* *What does ‘peer-reviewed’ mean?*
	+ The information in the article has been checked by expert scientists in their field.
* *Why is peer-reviewed data more reliable?*
	+ Because it has been checked by another scientist who is an expert in that area.
* *What claims can we make about this data? What plant has the most/least waste matter?*
* *What do we normally do with waste matter on Earth? How can we recycle the waste matter?*
	+ Most food waste goes into compost where bacteria and fungi decompose it and turn it into soil and fertiliser. Matter is recycled.
* *Why can’t astronauts do the same thing with their waste?*
	+ For health reasons, astronauts cannot have anything decomposing on the ISS. It would contaminate the air with fungi or bacteria, as well as produce carbon dioxide.

✎ STUDENT NOTES: Complete **Selecting plants Resource sheet**.

Encourage students to make a claim that identifies the best or worst plants to grow on the ISS. Guide students to use evidence from their graphs (or prior experience with the plants, such as plant height) to support their claim. Reasoning links the evidence with the claim.



Compare students’ claims against the criteria decided early in the lesson.

Discuss the foods that form diets from different parts of the world (including First Nations Australians). Encourage students to consider how all diets could be catered for.

**Potential discussion prompts**

* *Does everyone eat the same foods?*
* *What did you have for dinner last night?*
* *Does everyone in this class eat/like the same food?*
* *Have you ever eaten something new or different at someone else's house?*
* *Think of the astronauts on the International Space Station. What countries do they come from?*
	+ Russia, America, Canada, Japan, Belgium, Denmark, France, Germany, Italy, Holland, Norway, Spain, Sweden, Switzerland, UK, Australia.
* *Do they all eat the same food?*
* *How does this affect the food that is prepared for the astronauts?*
* *How could we plan for this when growing food on the Moon or Mars?*

Extension: Watch the video [Space Plants – how they are adapting?](https://www.youtube.com/watch?v=CN5PA3Mq-SE) (4:27).

### Reflect on the lesson

You might:

* compare how energy is lost from the ISS through heat, but the water matter could be recycled if it could be done safely.
* research one of the selected plants to identify how long it takes to grow, to provide more evidence and reasoning for students’ claims.

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**Y7**

Ecosystems beyond Earth • Lesson 4 • Space invaders (biosecurity)

**Lesson 4**

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# Lesson overview

Students will examine the complex nature of food webs and how they can be affected when a new species is introduced. This is then compared to the need for biodiversity and biosecurity on the ISS or space settlements.

## Key learning goals

Students will:

* model an Australian food web.
* model how an introduced species can affect other plants and animals in a food web.
* compare the biosecurity measures taken in Australia to those needed on the ISS.
* discuss the importance of biodiversity in an ecosystem.

Students will represent their understanding as they:

* construct an Australian food web.
* describe how plants and animals will be affected by an introduced species in the food web.
* describe the importance of biodiversity in an ecosystem.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* representing flows of energy in a food web.
* predicting the impact of introducing new species in an ecosystem.
* the importance of biodiversity to an environment’s health.

**Potential summative assessment**

Students working at the achievement standard should:

* analyse food webs to show feeding relationships between organisms in an ecosystem and the role of microorganisms in disease.
* examine how events such as the introduction of a species cause changes in populations.
* examine First Nations Australians’ response to the invasive species Myrtle rust and their effect on food webs that many communities are part of and depend on for produce.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth?tabIndex=2) for further information.

## List of materials

**Whole class**

* **Ecosystems beyond Earth Resource PowerPoint**

**Each group**

* **Australian food web Resource cards**
* Butcher/A3 paper

**Each student**

* Individual science notebook

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-orient** | 5 minutes | Whole class |
| **Question** | 10 minutes | Whole class |
| **Investigate** | 30 minutes | Small group/Whole class |
| **Integrate** | 30 minutes | Small group/Whole class |

## Inquire

## Re-orient

Discuss the types of plants and the growing conditions that will be needed to grow food on the ISS or in space settlements.

## Question • Protecting ISS food

**Pose the question:** *Why is it important for the ISS or settlements on the Moon or Mars to have their own food supplies?*

Discuss the challenges of providing food to ‘space settlements’ including:

* the preparation of long-life foods.
* minimising the weight and volume of the foods (to reduce the fuel costs, and the room needed to pack them in the rocket).
* the stress placed on the food during lift-off (up to 3 times Earth’s gravity) and microgravity (almost undetectable gravity).
* the time taken to reach the settlement (ISS = 4 hours, Moon = 3 days, Mars = >9 months).

**Pose the question:** *What would happen if the food becomes rotten?*

## Investigate • Australian Case Study

(Slide 22) Discuss how Australia is an island and takes biosecurity measures to protect the food we grow. Studying how pests have been introduced into Australia can provide us with hints on what might need to be done on settlements in space.

**Potential discussion prompts**

* *How does Australia prevent diseases from coming in?*
* *Has anyone seen the small form filled in when you arrive in Australia on a plane or a boat? It asks if you have visited any overseas farms during your trip. Why do you think Australia asks these questions?*
* *What could be the impacts of introducing a new pest (plant, animal, pathogens, or disease-spreading vectors)?*

(Slide 23) Explain that students are going to model the impacts of introducing Myrtle rust into an Australian environment.

Student groups use the **Australian food web Student resource** cards to set up an Australian food web.

✎ STUDENT NOTES: Record the food web.

Watch the video [Myrtle rust, the silent killer](https://www.youtube.com/watch?v=377xA_FeJoA) (11:13).

(Slide 24) Discuss the fungal disease Myrtle rust (*Puccinia psidii*):

* It is native to Central America, the Caribbean, South Africa, and New Caledonia.
* It infects and kills eucalyptus trees, bottle brush, paperback, and tea trees.
* Currently, only one species of Myrtle rust is present in Australia (*Austropuccinia psidii*).

In small groups, students discuss the impact of this disease on the Australian food web.

✎ STUDENT NOTES: Write how each plant and animal in the food web would be affected (increase or decrease populations) and why. For example, the Eucalyptus population would decrease because of infection. Populations of kangaroos, ants, snails, and grasshoppers will decrease because of less food supply. The population of spinifex will decrease because more of it will be eaten.

Discuss how this food web is not representative of an Australian ecosystem which is much more complex in its interactions.

**Potential discussion prompts**

* *Do you think this food web represents all the plants and animals that are an Australian ecosystem? What other plants and animals might be present?*
* *How might one of these animals (select one) change the food web?*
* *What is the challenge of trying to model everything that happens in an ecosystem?*

**Pose the question:** *How can Australia protect its plants and animals from new species?*

Discuss how First Nations communities and rangers are at the forefront of identifying species and places that are threatened by introduced species such as Myrtle rust.

**Optional:** Watch the video [Roots of Resilience (13:04)](https://www.youtube.com/watch?v=d2M18ApA-uA) that tells the story of environmental biosecurity from a First Nations' perspective.

(Slide 25) Brainstorm how Australian biosecurity is working to keep new species out of Australia, through thorough checking or restricting the movement of plant materials and wood into Australia and checking any shoes or clothing from visitors that might carry spores or seeds on them.

## Integrate • Fungi in space

**Pose the question:** *How could an introduced fungus affect plants on the ISS or space settlements?*

(Slide 26) Discuss how there are not many types of different plants on the ISS or future settlements. This means one introduced pest could wipe out most of/all of the food.

✎STUDENT NOTES: Record and define the term ‘biodiversity’—the number of different types of plants and animals in a particular habitat or area.

**Pose the question:** *Why will it be important to have a big biodiversity of plants in future space settlements?*

Discuss the [2016 fungal infection of zinnia plants on the ISS](https://www.space.com/31556-space-fungus-attacks-space-station-plants.html). Four out of seven plants died within a very short time. Ask students to consider the consequences if a Moon settlement suddenly lost over half of their food plants. Would it help if there were many different types of plants being grown?

✎STUDENT NOTES: Discuss the answer to this question and record it.

(Slide 27) Discuss how NASA prevents infectious diseases from arriving on the International Space Station by inspecting and quarantining most food before it is loaded onto a rocket.

### Reflect on the lesson

You might:

* research and share the [biosecurity measures used to prevent infections from reaching Australia](https://www.agriculture.gov.au/biosecurity-trade/policy/australia).
* re-examine the intended learning goals for the lesson and consider how they were achieved.
* discuss how students were thinking and working like scientists during the lesson.

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**Y7**

 Ecosystems beyond Earth • Lesson 4A • Biosecurity testing

**Lesson 4A**

**INQUIRE**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth/lesson-4a-biosecurity-testing](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth/lesson-4a-biosecurity-testing?utm_source=docx&utm_medium=lesson_4a&utm_campaign=EBE) |

# Lesson overview

Students model a biosecurity measure used to detect an infectious agent on an imported product.

## Key learning goals

Students will:

* consider the importance of biosecurity measures required in a space settlement.
* model a biosecurity measure that can be used to detect an exotic pest.

Students will represent their understanding as they:

* describe the process of testing in biosecurity.
* describe the consequences of false-negative biosecurity results in a space settlement.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* predicting the impact of introducing new species in an ecosystem.
* the importance of biodiversity to an environment’s health.

**Potential summative assessment**

Students working at the achievement standard should have:

* identified the evidence being cited to support a claim and evaluating conflicting evidence.
* demonstrated an understanding of how energy flows into and out of an ecosystem via the pathways of food webs.
* selected and constructed appropriate representations to organise data and information.
* processed data and information and analysed it to describe patterns, trends and relationships.
* identified possible sources of error in methods and identified unanswered questions in conclusions and claims.
* identified evidence to support their conclusions and constructed arguments to support or dispute claims.
* selected and used language and text features appropriately for their purpose and audience when communicating their ideas and findings.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth?tabIndex=2) for further information.

## List of materials

**Whole class**

* **Ecosystems beyond Earth Resource PowerPoint**

**Each group**

* Bicarbonate soda powder (to sprinkle over two of the objects)
* 5 random objects to be tested (possibilities include shell, stone, old shoe, plastic toy, piece of sandwich or fruit etc.). The objects will need to be prepared prior to the class—refer to the [Lab Tech notes in the *Preparing for this sequence* tab](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth?tabIndex=3#toc-lab-tech-notes) for directions.
* 5 plastic bags
* 5 x swabs or tissues
* 6 x 50mL beakers
* Access to tap water
* **Universal indicat**or in dropper bottles
* Permanent marker

**Each student**

* Individual science notebook
* Safety glasses
* Laboratory coat
* Gloves
* **Biosecurity testing Resource sheet**

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-orient** | 5 minutes | Whole class |
| **Question** | 5 minutes | Whole class |
| **Investigate** | 30 minutes | Small group |
| **Integrate** | 20 minutes | Whole class/Small group/Individual |

## Inquire

## Re-orient

Allow students time to make observations and take measurements of their plants.

Discuss how all the people in a moon settlement could be affected if the plants become infected with an introduced organism.

## Question • Border Control

(Slide 29) Discuss some of the border control mechanisms that are used on farms or at the border, including shoe baths and brushes, special clothing covers and tests that detect potential contaminants or infectious agents.

**Pose the question:** *How could border agents test if an exotic pest was on an object?*

## Investigate • Biosecurity Agent

Explain that students will act as border control agents, to test if a contaminant is present on objects people want to bring into the space settlement. You may want to set up a full border control scenario in your classroom.

Show students the objects they will be testing and demonstrate the procedure outlined in the **Biosecurity testing Resource sheet**. The objects should have been prepared before the lesson according to the [*Preparing for this sequence* instructions](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth?tabIndex=3#toc-lab-tech-notes).

1. Half-fill the 50 mL beaker with tap water.
2. Dip a clean swab or cotton wool in the water so that it becomes damp. This will allow it to collect any dust particles, fungal spores, or bacterial spores on the items.
3. Wipe the wet swab or cotton wool over every surface of one of the objects.
4. Place the wet swab or cottonwool in the beaker of water. Gently mix the beaker to detach any particles that may have wiped off the object.
5. Use the permanent marker to label the beaker with the object's name.
6. Add 6 drops of universal indicator into each beaker containing the swabs or cotton wool.

Objects that have been dusted with bicarb soda will cause the universal indicator to become blue/purple. A negative result (with no contamination) will be green.

✎STUDENT NOTES: Complete the tests and record results on the **Biosecurity testing Resource sheet**.

## Integrate • Consequences of false negative results

(Slide 30) Discuss and compare the results of the testing.

**Potential discussion prompts**

* *Which objects tested positive for the fungus? How do you know?*
* *How sure were you that your testing was accurate?*
* *What are the consequences to the space settlement if you are wrong and some of the objects allowed into the settlement had a fungus on them?*
* *How could this be explained to people who wanted to settle on the Moon? How much science would they need to know?*

Discuss the consequences of an introduced species that could affect all the plants growing as food on the Moon (3 days travel from Earth) or Mars (>9 months from Earth). Consider the added time taken to prepare rockets and food supplies.

✎STUDENT NOTES: Complete the **Biosecurity testing Resource sheet**.

### Reflect on the lesson

You might:

* write a formal scientific report on the growth of lettuce plants from Lesson 2.
* research ways that farms can disinfect shoes and equipment to prevent infections from spreading between farms.
* re-examine the intended learning goals for the lesson and consider how they were achieved.
* discuss how students were thinking and working like scientists during the lesson.

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**Y7**

 Ecosystems beyond Earth • Lesson 5 • Space farming

**Lesson 5**

**ACT**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth/lesson-5-space-farming](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth/lesson-5-space-farming?utm_source=docx&utm_medium=lesson_5&utm_campaign=EBE) |

# Lesson overview

Students consolidate their learning by designing a pod that could be used to grow the food that is needed for the International Space Station or a space habitat.

## Key learning goals

Students will:

* identify some of the challenges of producing food in space.
* evaluate the designs of other students and provide feedback.

Students will represent their understanding as they:

* design a pod that could be used to produce food on the Moon or Mars.
* communicate their design to their peers.
* provide feedback on other students’ designs.

## Assessment advice

In this lesson, assessment is summative.

Students working at the achievement standard should have:

* identified the evidence being cited to support a claim and evaluated conflicting evidence.
* demonstrated an understanding of how energy flows into and out of an ecosystem via the pathways of food webs.
* predicted the effects on the local ecosystem when living things such as pollinators are removed.
* examining how the introduction of infectious fungi can cause changes to the population.
* consideration of abiotic factors such as waste or nutrients in the soil can impact the growth of a plant population.
* described how individuals and communities use scientific knowledge.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-7/ecosystems-beyond-earth?tabIndex=2) for further information.

## List of materials

**Whole class**

* **Ecosystems beyond Earth Resource PowerPoint**

**Each group**

* Sticky notes for ideation or feedback
* Drawing paper for designing food pods
* **Optional:** materials to design models of a food pod

**Each student**

* Individual science notebook

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Connect** | 15 minutes | Whole class |
| **Anchor** | 15 minutes | Whole class/Small group/Individual |
| **Design** | 30-60 minutes | Whole class/Small group |
| **Communicate** | 30-60 minutes | Whole class/Small group/Individual |

# Act

## Connect • Our space future

Discuss how scientific knowledge of space has led to expectations of new settlements in space. Consider the ethical, environmental, social, and economic considerations of this settlement.

**Potential discussion prompts**

* *Why do you think people want to travel into space or settle on the Moon or Mars?*
* *Some people say we need to ‘fix’ the environment on Earth first. Why do you think they say that?*
* *Some people are paying hundreds of thousands of dollars to travel into space on Space-X and other privately built rockets. Do you think that you could afford that? Is it fair to only go if you have the money to go? Why or why not?*
* *Some of the things that have been invented because of space travel include disposable nappies, water filters, scratch-resistant eyeglasses, cochlear implants, anti-corrosion coating, and memory foam. Do you think space travel is worth it? Why or why not?*
* *What are we learning about plants as a result of space travel?*

Watch one of the following videos:

* [How do you grow plants in space? | BBC News (4:19)](https://www.youtube.com/watch?v=vv6ATRPUjrI)
* [Plants in Space (4:21)](https://www.youtube.com/watch?v=46GuymwcFFE) by the Australian Space Agency

Discuss the challenges of growing plants in space, including the need to make use of resources that are already available.

## Anchor • What have we learned about space food?

(Slide 32) Brainstorm as a class or in student groups all the things space scientists need to consider when planning for food supplies in future space settlements.

Students should consider:

* Atmosphere—the limited atmosphere on the Moon and Mars means that plants need to be in a protected environment.
* Energy—how light should be provided.
* Matter—what food should be in the first crops. Consider how much of the plant is edible and the lack of microorganisms to break down the inedible parts in a compost.
* Biosecurity—how they could protect the plants from introduced infections and pests.
* Temperature fluctuations—Moon: -133 degrees Celsius in the dark and 121 degrees Celsius in daylight; Mars: -153 degrees Celsius at the poles and 20 degrees Celsius at the equator at noon
* Length of day—Moon: 2 weeks of daylight and 2 weeks of darkness; Mars day = 24 hours and 37 minutes
* Pollination—how their plants will be pollinated if they want to produce seeds.
* Weight of rockets when planning what is needed to set up a settlement.

✎ STUDENT NOTES: Generate a mind map of all the factors that need to be considered when considering farming in space.

## Design • Intentional farming

**Define the problem**

Discuss the need to define the problem that is facing the scientists who are part of the International Space research teams. Students may need guidance if this is the first time they have done this process. The goal is to summarise the problems faced without predetermining a solution.

One possible example:

*How can scientists make sure that there is enough energy and matter available for plants on the Moon so that they can grow their own food supply without infections or pests?*

**Ideate**

Students brainstorm a variety of ideas that might mimic the conditions on Earth. Students can do this as a class, in small teams, or as individuals. Encourage students to copy ideas from Earth, but also to consider any weird and wonderful ideas. The sorting of ideas is the next stage.

**Deciding the prototype**

Encourage students to group their ideas in general categories including solutions for energy, matter, biosecurity, temperature, and water control. Students should use the argumentation process (claim, evidence, reasoning linking) to help with their decision-making.

**Building a prototype**

Prototypes can take many forms depending on the time and resources available. It may be as simple as a detailed drawing with labels and explanations, or as complex as a scaled model of the arrangements.

Allow students time to complete their prototype designs.

## Communicate • Scientists work in teams

Receiving feedback is an important part of the design process.

Discuss with students how to give effective feedback to each other by planning the approach to be used in the classroom. Each group can use a structured feedback form, checklists, or rubrics to guide their review. The ability of students to provide feedback will vary depending on the time of year (Year 7 students may need more guidance early in the year than late in the year). This can include specific areas to review.

**The science**

* Have the science ideas been explained in the model?
* Does the design consider real scientific principles, like energy flow, recycling matter, biosecurity, or water conservation?
* What plants have been chosen and why?
* Have the nutritional needs (variety of food) of the astronauts been considered?

**The model or design**

* How realistic is the model given the constraints of the lunar environment?
* Does the model offer creative solutions to the problem?
* How practical is the model for actual implementation, considering available resources and technology?
* What could be improved in the design?
* Are there any flaws or missing elements in the model?
* What are the strengths of the model?
* Why did you choose this material for your system?
* Is the design unique and well thought out?

**The communication**

* How well is the model communicated, both visually and verbally?
* What are the assumptions that have been made about the model?

### Reflect on this lesson

* Consider how students might change the way they view the plants they eat.
* Visit a local food producer to compare their approach to nutrients in the soil or biosecurity on their farms.