Asian Herb in Space 2021 Mission-1
Australian Education Guide

Supported by:

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1. Introduction

1.1. Overview of Asian Herb in Space (AHiS)

The Asian Herb in Space (AHiS) project is the third Space Seed for Asian Future (SSAF) program of Kibo-ABC. SSAF is a simplified experiment program that is ideal for introducing beginners to the "Kibo" experiments. The design of the experiment minimises expense, resources and saves time. In the AHiS experiment, sweet basil and holy basil are grown in the International Space Station (ISS) for one month. After growing the basil plants on the ISS, the experiment will be returned to Earth and undergo detailed investigations such as morphological, scent and gene expression analysis.

It is HIGHLY RECOMMENDED now go to the AHIS site and explore the sections, especially the materials and research for education section.

1.2. Objectives of the program

- Investigate the effect of microgravity on plant growth in comparison to their counterparts on earth.
- Encourage scientific research between students, schools, universities, and space agencies across the world.
- Promote environmental and microgravity science.
- Develop interest and skills in scientific space experiments and methodology.
- Inspire further research for the students and academics both nationally and internationally.

1.3. Target audience

The target audience is from preschool to university researchers, including school and community groups. Primary school students may wish to carry out simple observation experiments whilst others may complete more complex and detailed experiments.

2. Sweet basil growth experiment procedure in the ISS on AHiS Mission-1

2.1. Plant Chambers used on the ISS.

The plant chamber is a rectangular container made of polycarbonate with the following characteristics:

- length 7.5 cm x width 7.5 cm x height 11.0 cm
- transparent and suitable for observation
- air ventilation holes except the bottom of the plant chamber, each 1 cm diameter
- a gas-permeable membrane on each side (Fig. 2.1)
- a water injection port is attached to the bottom. This port is used for watering by syringe (Fig. 2.2).
- Rock-wool with 16 grains of sweet basil seeds lay in the base of the plant chamber. Rock-wool has good water retention, it functions as a medium for the plants instead of soil (Figs. 2.3 and 2.4).

Fig. 2.1 Photos of the Plant Chamber with air ventilation holes covered in gas-permeable membrane.

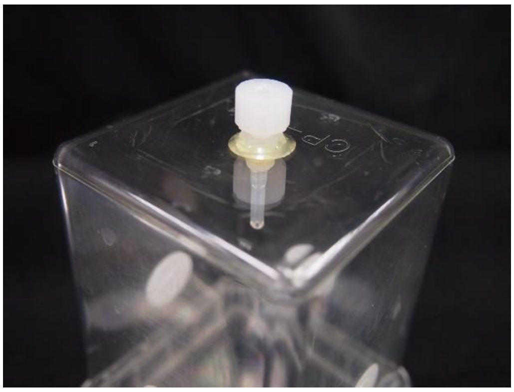


Fig. 2.2 Water injection port of the Plant Chamber

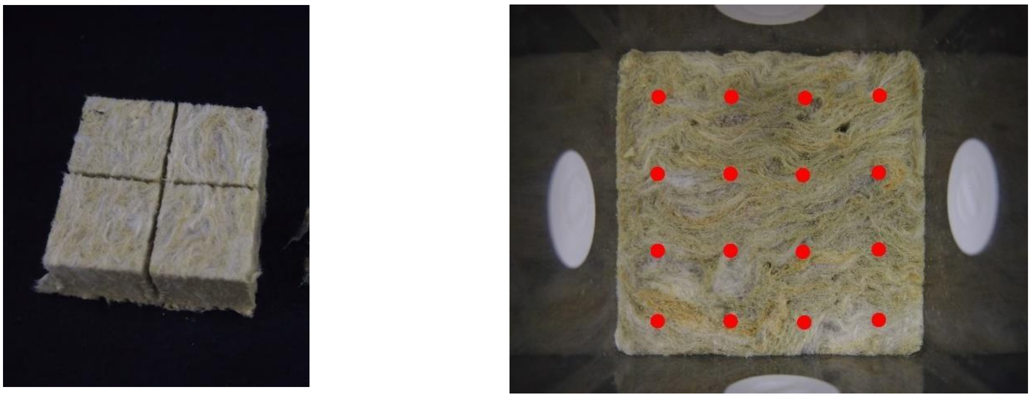


Fig. 2.3 Block of rock-wool for base of plant chamber. Red dots indicate positions to sow sweet basil seeds.

Fig. 2.4 The Plant Chamber with rock-wool

2.2. Watering solution on the ISS

The OAT House series of fertilisers are water soluble and designed for hydroponics or soil free culture. They contain major elements and trace amounts of metal ions necessary for plant growth.

Table. 2.1 is an excerpt from the OAT House website and shows the nutritional content of each fertiliser.

https://www.oat-agrio.co.jp/cgi/psearch/item/2013101716413104/index.html

Table. 2.1 Original concentration of OAT house fertiliser

OAT house #1	OAT house #2
TN (Total nitrogen) * 10.0%	TN (Total nitrogen) 11.0%
P2O5 (phosphorus) 8.0%	Ca (calcium) 16.4%
K2O (potassium) 27.0%	
MgO (magnesium) 4.0%	
MnO (manganese) 0.10%	
B2O3 (boron) 0.10%	
Fe (ferrum) 0.18%	
Cu (copper) 0.002%	
Zn (zinc) 0.006%	
Mo (molybdenum) 0.002%	

*Total nitrogen includes ammoniacal nitrogen and nitrate nitrogen.

In the AHiS experiment, the dissolved concentrations of OAT House #1 powder and OAT House #2 powder will be 0.3% and 0.2%, respectively. To achieve these concentrations, dissolve 3.0 g of OAT House #1 and 2.0 g of OAT House #2 fertiliser powder each in 1000 mL of bottled water. These solutions will be used to water the seeds during the investigation.

Table 2.2 shows the nutritional content of the watering solution.

Table. 2.2 OAT house fertiliser concentration after mixing with water.

OAT house #1	OAT house #2
TN (Total nitrogen) 0.030%	TN (Total nitrogen) 0.022%
P2O5 (phosphorus) 0.024%	Ca (calcium) 0.0328%
K2O (potassium) 0.081%	
MgO (magnesium) 0.012%	
MnO (manganese) 0.0003%	
B2O3 (boron) 0.0003%	
Fe (ferrum) 0.00054%	
Cu (copper) 0.000006%	
Zn (zinc) 0.000018%	
Mo (molybdenum) 0.000006%	

2.3. Growth conditions on the ISS

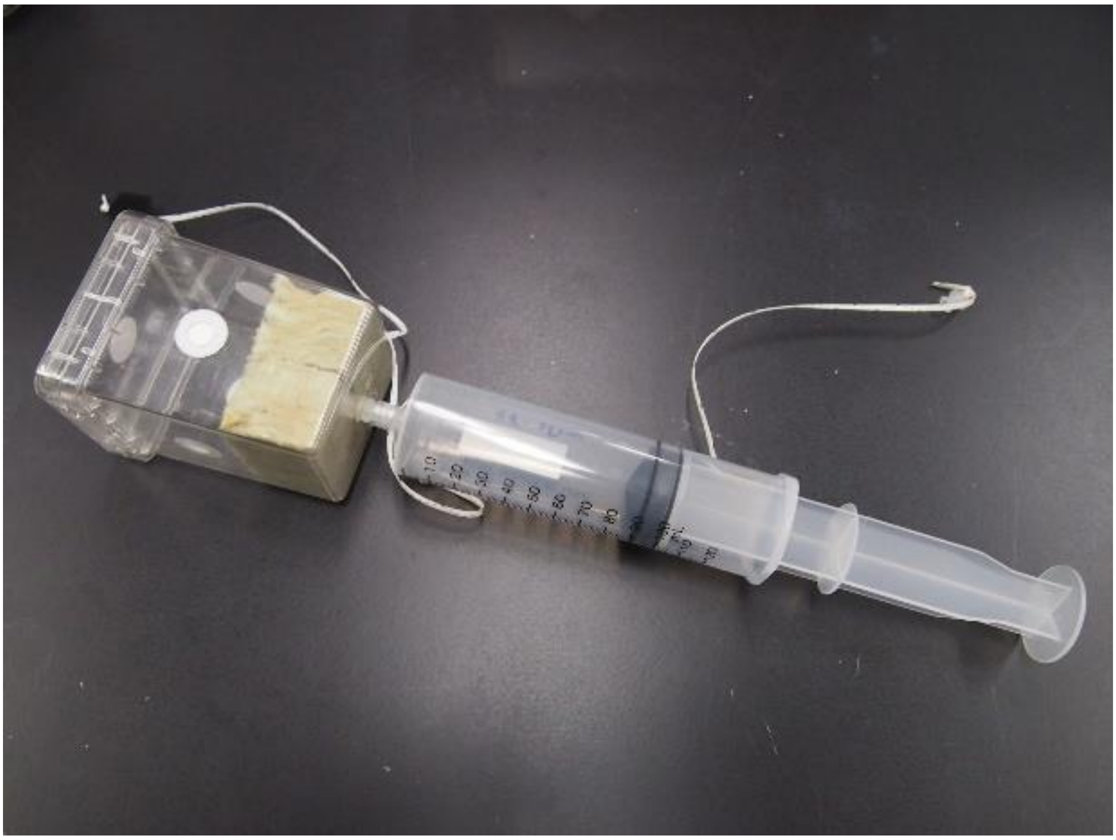
The cultivation environment on the ISS/Kibo cabin is as follows:

Parameter	Value	Remarks
Temperature:	21 - 25 degrees Celsius	ISS environment
Humidity:	40 - 60 %	ISS environment
Light intensity:	40 µmol/m^2/sec	6 cm away from the 40-Watt fluorescent light
Lighting period:	Continuous light	24-hour continuous white fluorescent light
CO_2 concentration:	3500 to 4000 ppm	Approximately 10 times higher compared to the ground.
Gravity:	10^{-6} G	Microgravity

2.4. Growth procedure on the ISS

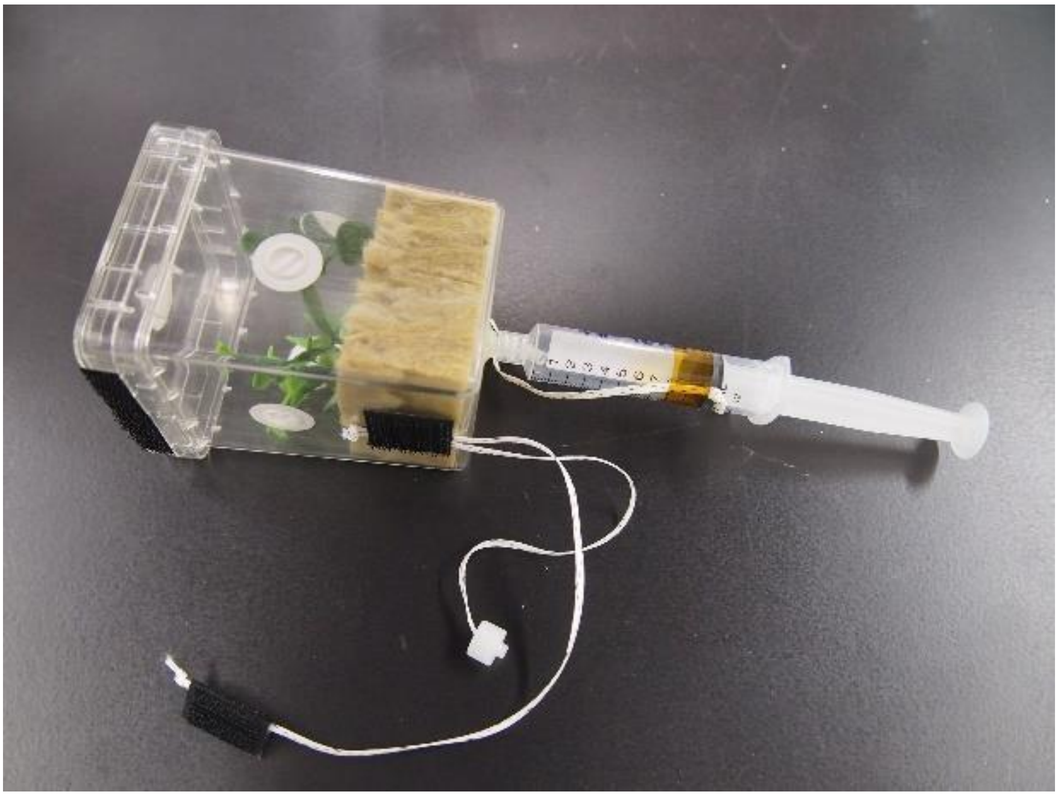
At the beginning of the experiment, the crew will inject 100 mL of watering solution using a 100 ml syringe for each plant chamber from the injection port at the bottom of the plant chamber (Fig. 2.5). The crew will then attach the plant chamber to the ISS/Kibo cabin wall near the fluorescent light.

Fig. 2.5 Plant Chamber with 100 ml syringe



After 10 days, the crew will take photographs of the growing plant without opening the plant chamber's lid. They will add 10 ml of watering solution to each plant chamber.

Fig. 2.6 Plant Chamber with a 10 mL syringe



After 20 days, the crew will again photograph the plants and add 10 ml of water solution. (Fig 2.6)

After 30 days from the beginning of the experiment, the crew will photograph the growing plant without opening the plant chamber's lid. Then, the crew will put the plant chamber in the freezer.

The plants will be returned to Earth in a frozen state. They will be analysed in detail by professional researchers.

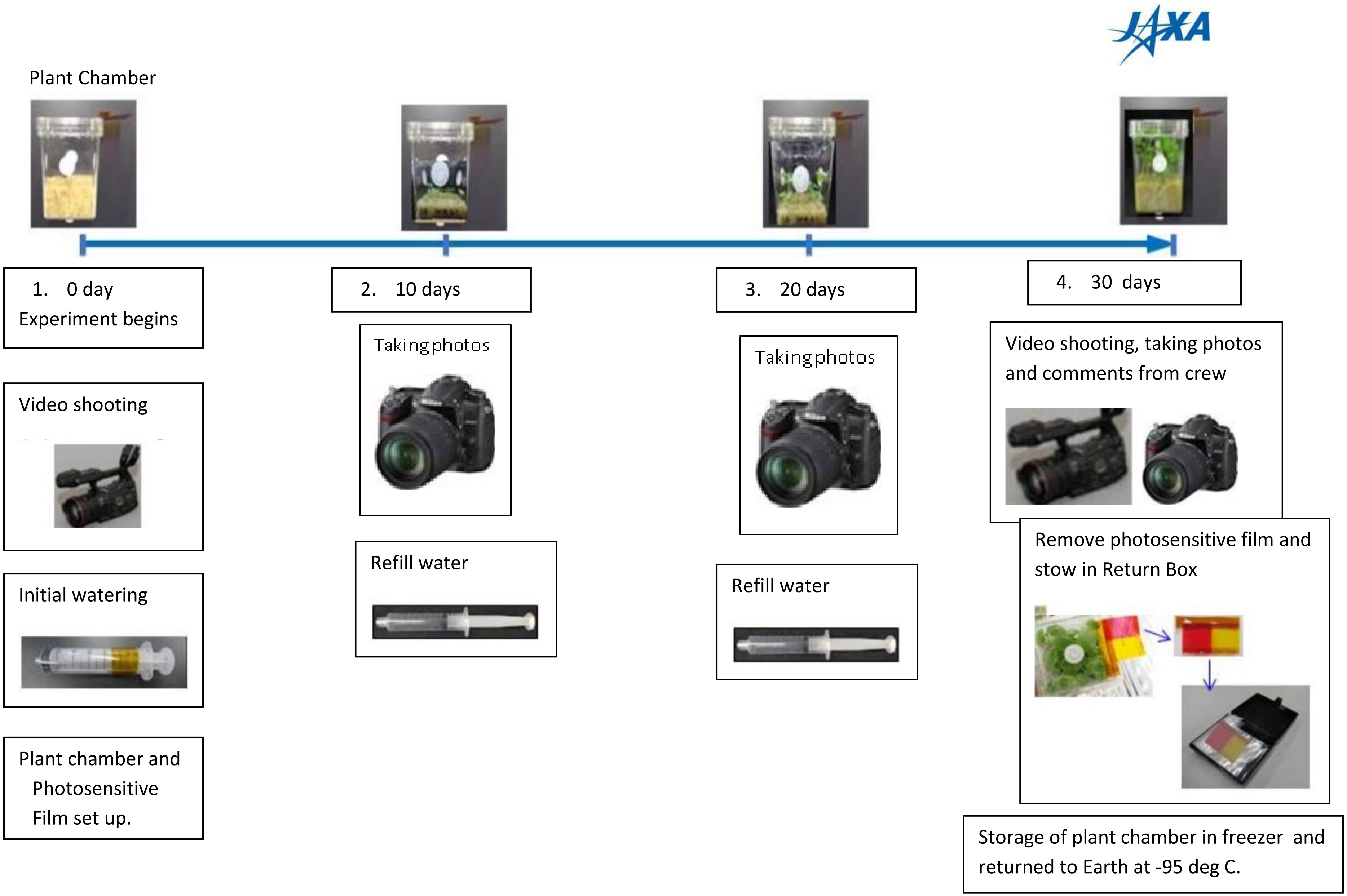


Fig 2.7 ISS experiment operation flow

3. Introduction to Ground-based experiments on AHiS Mission-1

3.1. Your kit

Your kit includes the following:

- Seedling starter tray kit
- A clip lock bag that has Sweet basil seeds that stayed on Earth and are from the same seed lot as the ones that went to space (labelled with a star sticker)
- A clip lock bag that has Sweet basil seeds that are from a different seed lot to the ones that went to space (no label)
- Osmocote seedling potting mix
- Laminated plan for seed distribution
- 20/25 ml syringe
- Spoon

3.2. Seedling starter tray kit

In the AHiS space experiments, plant chambers are used to grow herbs (Fig. 3.1).

Fig. 3.1 Plant Chamber

The plant chambers are unavailable to all participants in the AHiS Mission 1 ground control experiment. Therefore, it is necessary for everyone to use the same seedling starter tray kit provided (Fig. 3.2).

Fig. 3.2 Seedling starter tray kit

The seedling starter tray kit has three components. It is a rectangular container made of light plastic which has the following characteristics:

– watertight base tray that measures 178 mm by 135 mm by 50 mm. The base tray provides warmth to the plant bed and balances moisture levels.
– seed tray that has 12 cells measuring 38 mm x 38 mm x 50 mm each. This is a perfect cell size to maintain ideal temperature and optimal root growth, plant development, plant starter and seed germination.
– humidity control dome designed to keep the seedlings moist and reduce water evaporation.
– a transparent lid to allow observations without removal.

3.3. Seed Raising Potting Mix

In the AHiS space experiment, the plant chamber has rock-wool, which has good water retention and functions as a medium for plants instead of soil.

The JAXA recommendation is to use seed raising potting mix. We have selected Osmocote Seedling Potting mix and it has been supplied in your kit. Please read instructions carefully before you open the bag. Use safety glasses and gloves when handling the mix.

3.4. Fertiliser

In AHiS space experiments, OAT House series fertiliser is used as a nutrient for growing sweet basil. As we are experimenting with seed raising potting mix as a medium, you **do not need to add fertiliser.** The seed raising potting mix contains the elements necessary for plant growth. This method has been suggested by JAXA to replicate the method used on the ISS. All Australian locations will be using the same mix from Osmocote.

Osmocote Seed and Cutting Premium potting mix has been developed by horticultural experts to provide the ideal moisture and nutrients environment for healthy plants. The formulation provides the ideal growing environment for raising stronger seedlings.

Fig. 3.3 Seed raising potting mix.

It contains:

- controlled release fertiliser – distributes nutrients as plants need it, up to 6 months.
- wetting agent – ensures nutrients get to the root zone.
- water crystals – absorbs water and releases it back to plants.
- growth stimulants – encourage strong root development for healthier, more vigorous plants.
- trace elements – micronutrients vital to plant growth
- coir peat – improves water holding for circulation and better root development.

3.5. Growth conditions

(a) Temperature
A warm environment is desired for the growth of sweet basil. The optimum temperature is about 22 to 30 degrees Celsius. Exposure to temperatures that are too cold or too hot will decrease the germination rate.

Place a thermometer near the seed tray and record the temperate every day at approximately the same time. (NOTE: A thermometer is not supplied in the kit.)

(b) Light
Light is needed for seed germination and healthy plant growth. Place seed tray in a well-lit position such as near a window or close to a desk light.

(c) Water
Seeds require moisture to germinate, and seedlings also require moisture for photosynthesis and ongoing growth.

(d) Carbon Dioxide
The CO_2 concentration on the ISS is about 10 times higher than on the ground. You will not be requested to replicate this.

4. Instructions for Ground based experiments on AHiS – Mission 1

4.1. Risk management and safety

Health warning. The Osmocote Seedling and Cutting Potting Mix contains micro-organisms. Avoid breathing dust or mists. Wear particulate mask If dusty. Wear gloves and keep product moist when handling. Wash hands immediately after use.

4.2 Storage of sweet basil seeds prior to planting

The basil seeds have a poor germination rate when exposed to high temperatures and humidity. To prevent a decrease in the seed germination rate, put the seeds in the refrigerator below 10 degrees Celsius until you are ready to sow the seeds.

4.3 Day 0 - Preparing your greenhouse and planting the seeds.

i. Using gloves and safety goggles/glasses, add potting mix to a level 1 cm from the top of each of the 12 sections in the greenhouse growing tray. If the potting mix has dried out or you are filling the tray on a windy day, you should also wear a mask.
ii. Using the syringe, carefully add 10 mL of water to each section. Add water if required during the experiment. Document the amount of extra water.
iii. Place the humidity control disc into the hole in the lid of the greenhouse and twist the disc so that all holes are covered.
iv. Using the supplied laminated plan, drop one seed onto the top of the potting mix in each section of the tray. Gently press the seed down so it is in full contact with the potting mix BUT do not bury the seed. Basil seeds need light to germinate.
v. Place the lid on the greenhouse. Make sure all the holes in the humidity disc are covered.
vi. Place the greenhouse in a well-lit, warm position. Select a location which can remain the same throughout the duration of the experiment. Once seeds germinate, take the plastic dome off. Leave in a warm place (min 22 degrees).

4.4. Observation of plant growth

The information or data that you record about plant growing conditions and the more measured characteristics, the better your information will be for analysing your investigation results and drawing conclusions for your research. All collected data should be recorded regularly in a personally designed data logbook or using a data sheet. See examples in section 5.

The following are basic characteristics that you may choose to observe, measure, and record.

Carefully describe the growing conditions under which the experiment is conducted. The use of identical conditions helps minimise differences that may occur due to the physical environment.

- ➢ Germination rate: Record the number of seeds that sprout and the date that each sprout appeared. Monitor how many of the seeds sprout within the first two weeks.
- ➢ Plant height: Measure and record this measurement daily.
- ➢ The number of leaves: Count and record daily.
- ➢ Observation of glandular hair cells on the leaves: Behind the leaves of basil plants are glandular hair cells that secrete essential oils. Let's observe the shape of the cell. You have to use a microscope or magnifying glass to observe glandular hairs. And what kind of smell do you detect?

5. Comparison of ISS and ground data

5.1. Point of comparison.

Sweet basil plants may or may not grow well. Think about why some plants grow well and why some don't. It is a learning opportunity to acknowledge the differences between the ISS (microgravity conditions) and the Earth (1G conditions) through plant growth experiments. One Giant Leap Australia Foundation is expected to evaluate each participant's report from a scientific perspective.

You will compare growth such as stem length, leaf size, leaf color, number of leaves, and glandular hair cells on the back of leaves. We will attempt to find out how these are different from the sweet basil grown on the ISS.

What is the difference between the ISS environment and your experiment conditions? These differences may significantly affect the results of growth experiment.

- ➢ Temperature
- ➢ Humidity
- ➢ Light
- ➢ Fertilizer
- ➢ Growth medium
- ➢ CO_2 concentration
- ➢ Plant chamber (ventilation efficiency, water supply volume, plant density)
- ➢ Presence or absence of gravity

↓

What will change when you change these?

5.2. How to write a report

The structure of a general experiment report is as follows.

(1). Experimenter's name (Your name)

(2). Date and duration of the experiment
(3). Objective: What is the experiment to observe?
(4). Prediction/Hypothesis
(5). Experimental method: How to make the plant box, the growing environment, what kind of work and how did you do it?
(6). Results: What kind of results did you get? (Please use “Plant growth records, photographs, Graph, Table, etc.” to make it easy to understand.)
(7). Discussion: What did you think of the obtained experimental results? (For example, what is the cause of the difference in growth between the basil grown on the ISS and the basil grown on Earth?)

5.3 A science journal

A science journal is a record of observations, experiences, and reflections. It contains a series of dated chronological entries. It can include text, drawings, sketches, measurements, labelled diagrams, photographs, spreadsheets, and graphs.

By using a science journal students are engaged in a real science situation as they keep a record of their observations, ideas, and thoughts. Students can use the journal to reflect on their learning. They will see evidence of how their ideas have changed and developed over the time of the science experience.

Students keeping a science journal enables students to experience and understand how scientists work. It also aligns to the Australian Curriculum in Science, English and Mathematics.

Examples on the following pages.

Asian Herb in Space

School/Group:			
Seed type: Sweet basil			
Date Seeds Planted:			
Dates of Germination			
Earth Seeds		Space Seeds (star)	
E1		S1	
E2		S2	
E3		S3	
E4		S4	
E5		S5	
E6		S6	

When did you first notice the distinctive basil smell/aroma?

(You may need to rub a leaf between your fingers to test this.)

Can you explain this smell?

Asian Herb in Space

Seed type: Sweet basil

Date:

(use one page for each data collection date)

Seed	Height	Number of Leaves	Other information
S1			
S2			
S3			
S4			
S5			
S6			
E1			
E2			
E3			
E4			
E5			
E6			

Asian Herb in Space			
Seed type: Sweet basil			
Seed Name: S1 S2 S3 S4 S5 S6 E1 E2 E3 E4 E5 E6			
Date	Height	Number of Leaves	Other information

Suggested Scientific report template

Aim:

Background Information:

Hypothesis:

Equipment:

•	•	•
•	•	•
•	•	•
•	•	•

Risk Assessment:

Risk	Mitigation

Method/Procedure:

1.
2.
3.
4.
5.
6.
7.
8.

Results

Discussion

Conclusion

Suggested Journal Entry Page

Investigation:	
Name:	Date:
Time:	Location:
Environmental Conditions:	

Qualitative Observations:

Quantitative Measurements

Notes:

5. Useful information

5.1. Websites

- AHiS portal site

  https://iss.jaxa.jp/en/kuoa/ssaf/2020.html

- The significance of growing herbs in space

  https://iss.jaxa.jp/en/kuoa/ssaf/ahis_supplement_1.html

- Scent of herbs

  https://iss.jaxa.jp/en/kuoa/ssaf/ahis_supplement_2.html

- How to grow Sweet Basil

  https://iss.jaxa.jp/en/kuoa/ssaf/ahis_supplement_3.html

- Let's experiment with Herb ‼
  https://iss.jaxa.jp/en/kuoa/ssaf/ahis_supplement_4.html

5.2. Research papers

- Growth and Morphogenesis of Azuki Bean Seedlings in Space during SSAF2013 Program https://www.jstage.jst.go.jp/article/bss/28/0/28_6/_article/-char/ja/
- Comprehensive report on the Auxin Transport space experiment: the analysis of gravity response and attitude control mechanisms of plants under microgravity conditions in space on the International Space Station. https://doi.org/10.2187/bss.34.12

6. Australian Curriculum Outcomes

Some suggested Australian Science Curriculum Links (https://www.australiancurriculum.edu.au/f-10-curriculum/science/)

Year	Science Understanding	Science as a Human Endeavour	Science Inquiry Skills	Achievement Standards
Foundation	ACSSU002 Biological sciences	ACSHE013 Nature and development of science	ACSIS014 Questioning and predicting ACSIS011 Planning and conducting ACSIS233 Processing and analysing data and information ACSIS012 Communicating	Students describe the behaviour of familiar objects. They suggest how the environment affects them and other living things. Students share and reflect on observations and ask and respond to questions about familiar objects and events.
Year 1	ACSSU017 Biological sciences ACSSU211 Biological sciences	ACSHE021 Nature and development of science ACSHE022 Use and influence of science	ACSIS024 Questioning and predicting ACSIS025 Planning and conducting ACSIS026 Planning and conducting ACSIS027 Processing and analysing data and information ACSIS213 Evaluating ACSIS029 Communicating	Students describe changes in their local environment and how different places meet the needs of living things. Students respond to questions, make predictions, and participate in guided investigations of everyday phenomena. They follow instructions to record and sort their observations and share them with others.
Year 2	ACSSU030 Biological sciences	ACSHE034 Nature and development of science ACSHE035 Use and influence of science	ACSIS037 Questioning and predicting ACSIS038 Planning and conducting ACSIS039 Planning and conducting ACSIS040 Processing and analysing data and information ACSIS041 Evaluating ACSIS042 Communicating	Students describe changes to objects, materials and living things. Students pose and respond to questions about their experiences and predict outcomes of investigations. They use informal measurements to make and compare observations. They record and represent observations and communicate ideas in a variety of ways.
Year 3	ACSSU044 Biological sciences	ACSHE050 Nature and development of science ACSHE051 Use and influence of science	ACSIS053 Questioning and predicting ACSIS054 Planning and conducting ACSIS055 Planning and conducting ACSIS057 Processing and analysing data and information ACSIS215 Processing and analysing data and information ACSIS058 Evaluating	Students group living things based on observable features and distinguish them from non-living things. They describe how they can use science investigations to respond to questions. Students use their experiences to identify questions and make predictions about scientific investigations. They follow procedures to collect and record observations and suggest possible reasons for their findings, based on patterns in their data. They describe how safety and fairness were considered

			ACSIS060 Communicating	and they use diagrams and other representations to communicate their ideas.
Year 4	ACSSU072 Biological sciences ACSSU073 Biological sciences	ACSHE061 Nature and development of science ACSHE062 Use and influence of science	ACSIS064 Questioning and predicting ACSIS065 Planning and conducting ACSIS066 Planning and conducting ACSIS068 Processing and analysing data and information ACSIS216 Processing and analysing data and information ACSIS069 Evaluating ACSIS071 Communicating	Students describe relationships that assist the survival of living things and sequence key stages in the life cycle of a plant or animal. They identify when science is used to understand the effect of their actions. Students follow instructions to identify investigable questions about familiar contexts and make predictions based on prior knowledge. They describe ways to conduct investigations and safely use equipment to make and record observations with accuracy. They use provided tables and column graphs to organise data and identify patterns. Students suggest explanations for observations and compare their findings with their predictions. They suggest reasons why a test was fair or not. They use formal and informal ways to communicate their observations and findings.
Year 5	ACSSU043 Biological Sciences	ACSHE081 Nature and development of science ACSHE083 Use and influence of science	ACSIS231 Questioning and predicting ACSIS086 Planning and conducting ACSIS087 Planning and conducting ACSIS090 Processing and analysing data and information ACSIS218 Processing and analysing data and information ACSIS091 Evaluating ACSIS093 Communicating	Students analyse how the form of living things enables them to function in their environments. Students discuss how scientific developments have affected people's lives, help us solve problems and how science knowledge develops from many people's contributions. Students follow instructions to pose questions for investigation and predict the effect of changing variables when planning an investigation. They use equipment in ways that are safe and improve the accuracy of their observations. Students construct tables and graphs to organise data and identify patterns in the data. They compare patterns in their data with predictions when suggesting explanations. They describe ways to improve the fairness of their investigations, and communicate their ideas and findings using multimodal texts.
Year 6	ACSSU094 Biological Sciences	ACSHE098 Nature and	ACSIS232 Questioning and predicting	Students describe and predict the effect of environmental

		development of science ACSHE100 Use and influence of science	ACSIS103 Planning and conducting ACSIS104 Planning and conducting ACSIS107 Processing and analysing data and information ACSIS221 Processing and analysing data and information ACSIS108 Evaluating ACSIS110 Communicating	changes on individual living things. Students explain how scientific knowledge helps us to solve problems and inform decisions and identify historical and cultural contributions. Students follow procedures to develop investigable questions and design investigations into simple cause-and-effect relationships. They identify variables to be changed and measured and describe potential safety risks when planning methods. They collect, organise and interpret their data, identifying where improvements to their methods or research could improve the data. They describe and analyse relationships in data using appropriate representations and construct multimodal texts to communicate ideas, methods and findings.
Year 7	ACSSU111 Biological sciences	ACSHE119 Nature and development of science ACSHE223 Nature and development of science ACSHE120 Use and influence of science ACSHE121 Use and influence of science	ACSIS124 Questioning and predicting ACSIS125 Planning and conducting ACSIS126 Planning and conducting ACSIS129 Processing and analysing data and information ACSIS130 Processing and analysing data and information ACSIS131 Evaluating ACSIS132 Evaluating ACSIS133 Communicating	Students predict the effect of human and environmental changes on interactions between organisms and classify and organise diverse organisms based on observable differences. Students describe situations where scientific knowledge from different science disciplines and diverse cultures has been used to solve a real-world problem. They explain possible implications of the solution for different groups in society. Students identify questions that can be investigated scientifically. They plan fair experimental methods, identifying variables to be changed and measured. They select equipment that improves fairness and accuracy and describe how they considered safety. Students draw on evidence to support their conclusions. They summarise data from different sources, describe trends and refer to the quality of their data when suggesting improvements to their methods. They communicate their ideas, methods and findings using scientific language and appropriate representations.
Year 8	ACSSU150 Biological sciences	ACSHE134 Nature and development of science ACSHE226 Nature and development of science	ACSIS139 Questioning and predicting ACSIS140 Planning and conducting ACSIS141 Planning and conducting ACSIS144 Processing and analysing	Students examine the different science knowledge used in occupations. They explain how evidence has led to an improved understanding of a scientific idea and describe situations in which scientists collaborated to generate solutions to

		ACSHE135 Use and influence of science ACSHE136 Use and influence of science	data and information ACSIS145 Processing and analysing data and information ACSIS146 Evaluating ACSIS234 Evaluating ACSIS148 Communicating	contemporary problems. They reflect on the implications of these solutions for different groups in society. Students identify and construct questions and problems that they can investigate scientifically. They consider safety and ethics when planning investigations, including designing field or experimental methods. They identify variables to be changed, measured and controlled. Students construct representations of their data to reveal and analyse patterns and trends and use these when justifying their conclusions. They explain how modifications to methods could improve the quality of their data and apply their own scientific knowledge and investigation findings to evaluate claims made by others. They use appropriate language and representations to communicate science ideas, methods and findings in a range of text types.
Year 9	ACSSU175 Biological sciences ACSSU176 Biological sciences	ACSHE157 Nature and development of science ACSHE158 Nature and development of science ACSHE160 Use and influence of science ACSHE228 Use and influence of science	ACSIS164 Questioning and predicting ACSIS165 Planning and conducting ACSIS166 Planning and conducting ACSIS169 Processing and analysing data and information ACSIS170 Processing and analysing data and information ACSIS171 Evaluating ACSIS172 Evaluating ACSIS174 Communicating	Students analyse how biological systems function and respond to external changes with reference to interdependencies, energy transfers and flows of matter. They describe social and technological factors that have influenced scientific developments and predict how future applications of science and technology may affect people's lives. Students design questions that can be investigated using a range of inquiry skills. They design methods that include the control and accurate measurement of variables and systematic collection of data and describe how they considered ethics and safety. They analyse trends in data, identify relationships between variables and reveal inconsistencies in results. They analyse their methods and the quality of their data and explain specific actions to improve the quality of their evidence. They evaluate others' methods and explanations from a scientific perspective and use appropriate language and representations when communicating their findings and ideas to specific audiences.

Year 10	ACSSU184 Biological sciences ACSSU185 Biological sciences ACSSU189 Earth and space sciences	ACSHE192 Nature and development of science ACSHE194 Use and influence of science ACSHE230 Use and influence of science	ACSIS198 Questioning and predicting ACSIS199 Planning and conducting ACSIS200 Planning and conducting ACSIS203 Processing and analysing data and information ACSIS204 Processing and analysing data and information ACSIS205 Evaluating ACSIS206 Evaluating ACSIS208 Communicating	Students evaluate the evidence for scientific theories that explain the origin of the universe and the diversity of life on Earth. They explain the processes that underpin heredity and evolution. Students analyse how the models and theories they use have developed over time and discuss the factors that prompted their review. Students develop questions and hypotheses and independently design and improve appropriate methods of investigation, including field work and laboratory experimentation. They explain how they have considered reliability, safety, fairness and ethical actions in their methods and identify where digital technologies can be used to enhance the quality of data. When analysing data, selecting evidence and developing and justifying conclusions, they identify alternative explanations for findings and explain any sources of uncertainty. Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, the quality of the methodology and the evidence cited. They construct evidence-based arguments and select appropriate representations and text types to communicate science ideas for specific purposes.
Stage 6 Biology	ACSBL015 Unit 1: Biodiversity and the interconnectedness of life ACSBL019 Unit 1: Biodiversity and the interconnectedness of life ACSBL021 Unit 1: Biodiversity and the interconnectedness of life ACSBL022 Unit 1: Biodiversity and the interconnectedness of life ACSBL044 Unit 2: Cells and multicellular organisms ACSBL047 Unit 2: Cells and multicellular organisms ACSBL049 Unit 2: Cells and multicellular organisms ACSBL050 Unit 2: Cells and multicellular organisms ACSBL052 Unit 2: Cells and multicellular organisms ACSBL053 Unit 2: Cells and multicellular organisms ACSBL026 Unit 3: Heredity and continuity of life ACSBL029 Unit 3: Heredity and continuity of life	ACSBL008 Science as a Human Endeavour (Units 1 & 2) ACSBL009 Science as a Human Endeavour (Units 1 & 2) ACSBL010 Science as a Human Endeavour (Units 1 & 2) ACSBL011 Science as a Human Endeavour (Units 1 & 2) ACSBL012 Science as a Human Endeavour (Units 1 & 2) ACSBL013 Science as a Human Endeavour (Units 1 & 2) ACSBL014 Science as a Human Endeavour (Units 1 & 2) ACSBL037 Science as a Human Endeavour (Units 1 & 2) ACSBL038 Science as a Human Endeavour (Units 1 & 2) ACSBL039 Science as a Human Endeavour (Units 1 & 2) ACSBL040 Science as a Human Endeavour (Units 1 & 2) ACSBL041 Science as a Human Endeavour (Units 1 & 2) ACSBL042 Science as a Human Endeavour (Units 1 & 2) ACSBL043 Science as a Human Endeavour (Units 1 & 2) ACSBL068 Science as a Human Endeavour (Units 3 & 4) ACSBL069 Science as a Human Endeavour (Units 3 & 4)	ACSBL001 Science Inquiry Skills (Biology Unit 1) ACSBL002 Science Inquiry Skills (Biology Unit 1) ACSBL003 Science Inquiry Skills (Biology Unit 1) ACSBL004 Science Inquiry Skills (Biology Unit 1) ACSBL005 Science Inquiry Skills (Biology Unit 1) ACSBL006 Science Inquiry Skills (Biology Unit 1) ACSBL007 Science Inquiry Skills (Biology Unit 1) ACSBL030 Science Inquiry Skills (Biology Unit 2) ACSBL031 Science Inquiry Skills (Biology Unit 2) ACSBL032 Science Inquiry Skills (Biology Unit 2) ACSBL033 Science Inquiry Skills (Biology Unit 2) ACSBL034 Science Inquiry Skills (Biology Unit 2) ACSBL035 Science Inquiry Skills (Biology Unit 2) ACSBL036 Science Inquiry Skills (Biology Unit 2) ACSBL061 Science Inquiry Skills (Biology Unit 3) ACSBL062 Science Inquiry Skills (Biology Unit 3)	

	ACSBL075 Unit 3: Heredity and continuity of life ACSBL081 Unit 3: Heredity and continuity of life ACSBL082 Unit 3: Heredity and continuity of life ACSBL083 Unit 3: Heredity and continuity of life ACSBL084 Unit 3: Heredity and continuity of life ACSBL091 Unit 3: Heredity and continuity of life ACSBL094 Unit 3: Heredity and continuity of life	ACSBL070 Science as a Human Endeavour (Units 3 & 4) ACSBL071 Science as a Human Endeavour (Units 3 & 4) ACSBL072 Science as a Human Endeavour (Units 3 & 4) ACSBL073 Science as a Human Endeavour (Units 3 & 4) ACSBL074 Science as a Human Endeavour (Units 3 & 4) ACSBL103 Science as a Human Endeavour (Units 3 & 4) ACSBL104 Science as a Human Endeavour (Units 3 & 4) ACSBL105 Science as a Human Endeavour (Units 3 & 4) ACSBL106 Science as a Human Endeavour (Units 3 & 4) ACSBL107 Science as a Human Endeavour (Units 3 & 4) ACSBL108 Science as a Human Endeavour (Units 3 & 4) ACSBL109 Science as a Human Endeavour (Units 3 & 4)	ACSBL063 Science Inquiry Skills (Biology Unit 3) ACSBL064 Science Inquiry Skills (Biology Unit 3) ACSBL065 Science Inquiry Skills (Biology Unit 3) ACSBL066 Science Inquiry Skills (Biology Unit 3) ACSBL067 Science Inquiry Skills (Biology Unit 3) ACSBL097 Science Inquiry Skills (Biology Unit 4) ACSBL098 Science Inquiry Skills (Biology Unit 4) ACSBL099 Science Inquiry Skills (Biology Unit 4) ACSBL100 Science Inquiry Skills (Biology Unit 4) ACSBL101 Science Inquiry Skills (Biology Unit 4) ACSBL102 Science Inquiry Skills (Biology Unit 4)

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