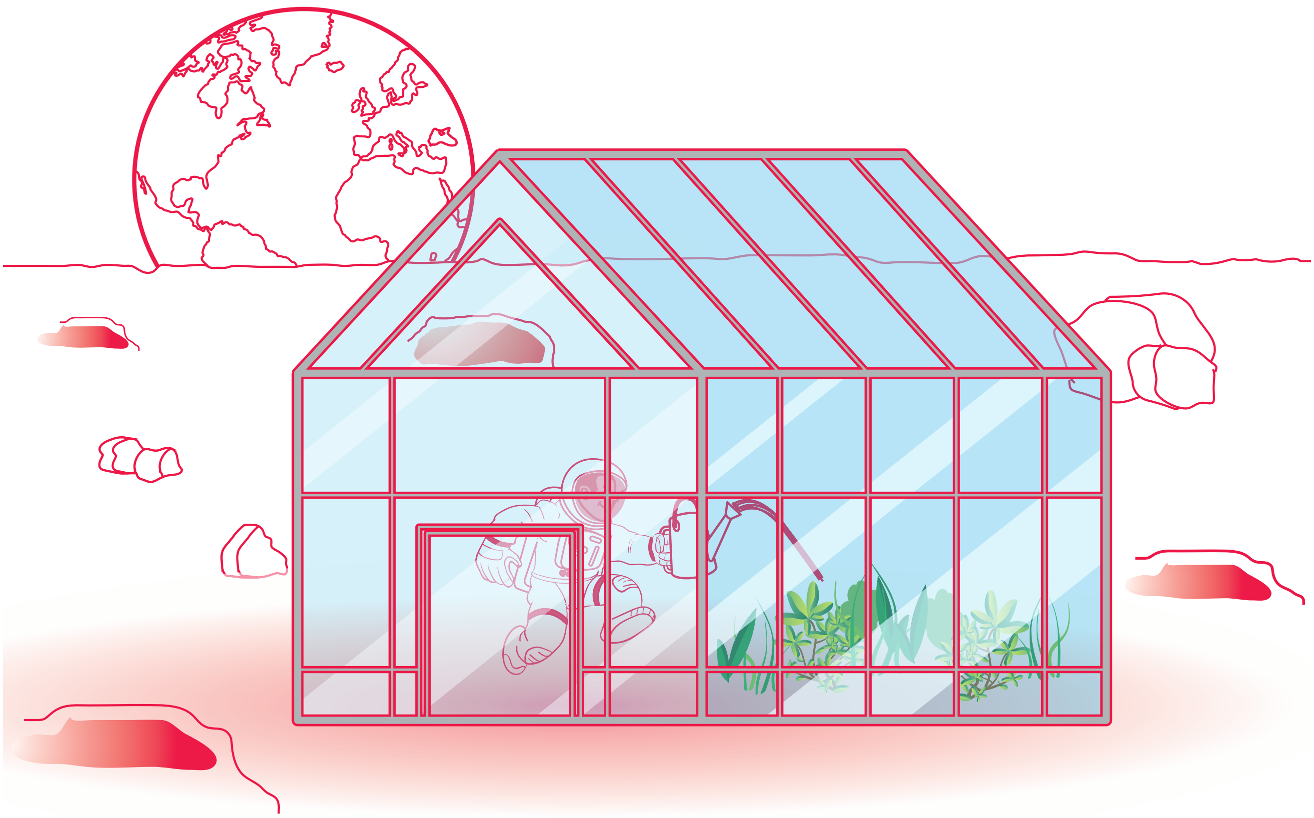
teach with space

→ ASTROCROPS

Growing plants for future space missions



European Space Agency

teach with space – astrocrops | PR43
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→ ASTROCROPS

Growing plants for future space missions

Fast facts

Subject: Science, Biology

Age range: 8-12 years old
Type: pupil activity, school project

Complexity: medium
Lesson time required: 30 minutes per week for 12 weeks
Cost: medium
Location: classroom

Includes the use of: gardening equipment

Keywords: science, biology, plants, seeds, germination, basil, tomato, radish, stem, leaf, fruit, flower, root

Brief description

In this set of activities students will build an understanding of germination and plant growth by following the development of three unknown plants for 12 weeks. They will conduct measurements and make observations to evaluate their plants' growth and health. Students will use their observations to make a hypothesis about which species of plants they are growing and discuss whether these plants are suitable for growing on long duration space missions.

This activity is part of a series that includes "AstroFood", where students investigate other possible future space foods, and "AstroFarmer", where students explore growing plants in space and factors that affect plant growth.

Learning objectives

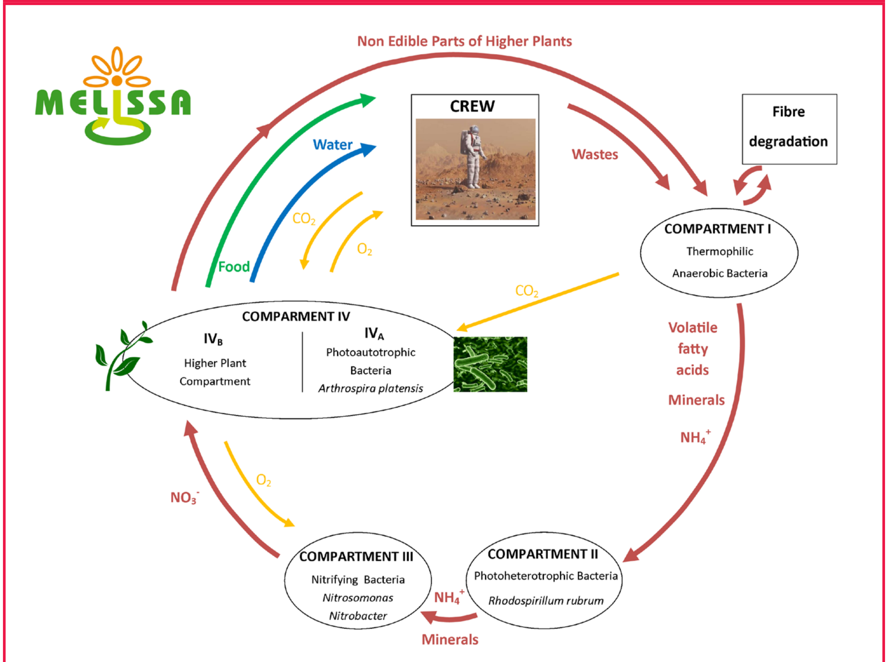
- Observe and describe how seeds grow into mature plants.
- Create scientific diagrams and use labels.
- Execute systematic observations and measurements.
- Interpret results and draw conclusions from the results.
- Be able to perform comparative and fair tests.

→ Introduction

If astronauts are going to settle on the Moon, or explore further reaches of our Solar System, they will need air, food and water. Currently, the only human outpost is the International Space Station (ISS). The ISS is supplied with water and food from Earth. Each astronaut needs approximately 1 kg of oxygen, 1 kg of dehydrated food and 3 kg of water per day. Supplying 5 kg of supplies per astronaut per day from Earth is costly and impractical for long duration space missions, so scientists are researching how to create a closed life support system could be used in space. Such a life support system is essential for further space exploration and will also help us improve the way we use resources on Earth.

The ESA-led Micro-Ecological Life Support System Alternative programme (MELiSSA) seeks to perfect a self-sustaining life support system that could be flown in space in the future, supplying astronauts with all the oxygen, water and food they require. This would work by recycling everything without any resupply from Earth. Waste products and CO2 from humans would supply the plants with the essential ingredients for growing and the plants would, in turn, provide oxygen and food for humans as well as filtering waste water.

Figure 1



↑ Overview of MELiSSA's closed loop system

MELiSSA is researching and collecting data about these space plants and how they could be grown in a closed system.

In this set of activities students will grow their own space plants and track their progress as they grow from a seed into a mature plant!

→ Activity 1: Let it grow

In this activity, students will track the development of three unknown seeds. As the seeds develop into adult plants, students will learn to make scientific observations and record data to track the growth over time. Students should complete the activity by presenting their results in a letter to Paxi.

Equipment

- Printed student data logbook for each group
- Ruler
- 3 pots
- Soil or other growth medium
- Plant nutrients
- Basil, radish and tomato seeds

Exercise

Divide the class into groups of 3 or 4 and give each group 3 pots, soil, plant nutrients and seeds. The students should label each pot A, B and C and not know what plant they are planting in each pot at the beginning. For this activity, it is recommended that you use radish, basil and tomato seeds. A guide on how to plant each seed is provided below.

Plant A – Basil

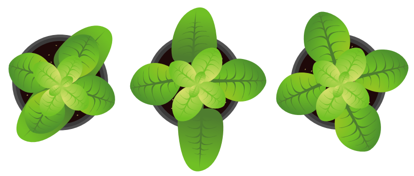
The students should fill pot A ¾ full with potting soil and add some water. They can then add some seeds to the wet soil before adding a thin layer of soil over the seeds. It will take 8-12 days for the seeds to germinate and for the stems to start coming through the soil. Throughout this period the students should ensure the seeds stay sufficiently wet. The students can begin to add nutrients to the soil after germination. The seeds do not need nutrients at the beginning because they have them stored within the seed. Place the pot where they will be exposed to plenty of sunlight. It should take approximately 6 weeks for the basil to grow into full plants. Take care not to over water the plant.

2 weeks

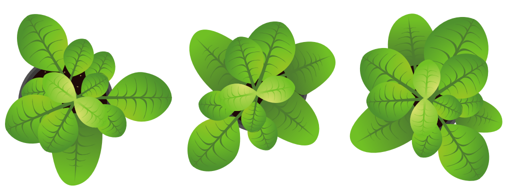
3 weeks

4 weeks

5 weeks

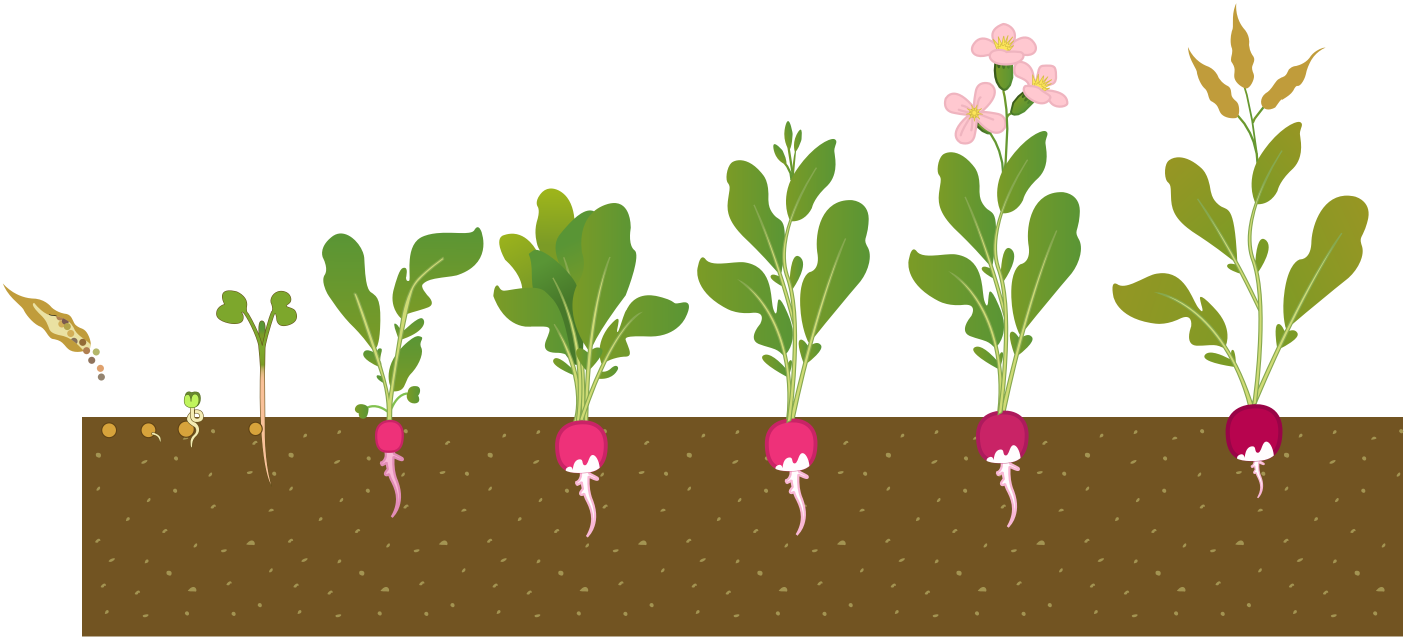


6 weeks



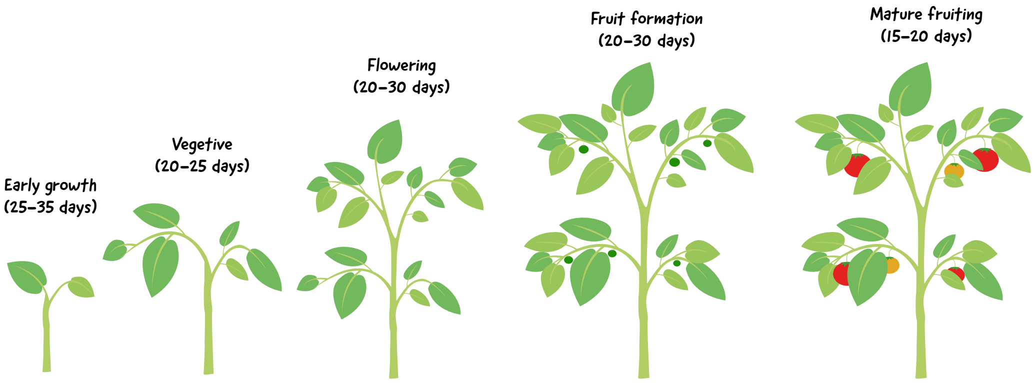
Plant B – Radish

Radishes are cool-weather root vegetables. Fill the pot with soil but do not compact it and add a few radish seeds. You may wish to plant multiple radishes at the beginning and then thin them after germination to leave only the healthiest in the pot. Radishes like cool weather, lots of sunlight and the soil should stay thoroughly moist but not be over watered. Once the stems of the radish plants begin to break the surface of the soil, you can add some fertiliser/plant nutrients to help the radishes grow. The radishes should take approximately 4 weeks to grow fully.



Plant C – Tomato

Tomatoes are long-season, heat-loving plants which will take the longest of the three plants to grow (typically 12 weeks). Moisten the soil and fill the pot with soil to within 2cm of the top. Place two or three seeds into each pot and cover over with about 1cm of soil, firm it over the seeds and moisten the soil. At the beginning, you can cover the pots with clear kitchen wrap to hold the moisture in. Place the pots in a warm, sunny spot. Once the sprouts break the top of the soil, remove the plastic wrap. After the plants have grown a bit, remove some so that the strongest, healthiest plant is left in the pot on its own. Continue to keep the soil moist but do not saturate and once the plant has grown a bit you can add plant nutrients/fertiliser to help the growth.



Recording the data

In the student guide you will find a logbook for recording the data. Print out a copy of the logbook for each group. It is suggested that data is recorded once per week for each plant. The students can design the front cover and create a team name. In each table there is space to write the height of the plant, the number of leaves, the number of fruit and the number of flowers. There is also space to write comments that could be about the weather that week, the amount of water given to the plants or any other relevant information. A section is included for the students to write what they think each plant could be. There is space for the students to draw a diagram of each plant every week to help them track the overall growth of the plant. The students should label their diagrams including: leaves, flowers, fruit and stem.

Once each plant is fully grown, the students can eat what they have grown. Ask the students which part of each plant they think is edible. Ensure you thoroughly wash anything the students will be eating and check for any allergies.

Discussion

The three plants all have different growth rates and the edible parts of each plant are all different. Radishes are the fastest growing and can be ready to harvest in as little as 4 weeks. Basil takes approximately 6-8 weeks and tomatoes take approximately 12 weeks. We eat the leaves of the basil plant, the root of the radish plant and the fruit of the tomato plant.

Ask the students which plant they think might be the most suitable for growing on a long duration spaceflight. Ideally, you want a fast growing, resilient, edible plant that provides a lot of nutrition without taking up a lot of space or requiring too much attention. Ask the students to present their conclusions in a letter to Paxi. You can send the students letters to Paxi at paxi@esa.int.

As an extension, ask the students if they think there are other plants (that they have not grown in this activity) which they think would be more suited for growing on long duration space missions. Scientists are currently investigating wheat and potatoes as possible space crops.

Conclusion

When we travel out into space we need a controlled system because the external environment is very harsh; the temperature can be well below freezing and there may be prolonged periods of darkness in which the plants cannot photosynthesise. Therefore, growing plants in space will have to be done in a controlled system. These systems are less influenced by external events such as amount of water, darkness and varying temperatures. For a more in depth look at how different factors affect plant growth you can do the AstroFood and AstroFarmer activities.

→ LINKS

ESA resources

AstroFood
esa.int/Education/Teachers_Corner/Astrofood_-_Learning_about_edible_plants_in_Space_Teach_with_space_PR41

AstroFarmer
esa.int/Education/Teachers_Corner/Astrofarmer_-_Learning_about_conditions_for_plant_growth_Teach_with_space_PR42

Moon Camp Challenge esa.int/Education/Moon_Camp

Mission X - train like an astronaut www.stem.org.uk/missionx

Moon animations about the basics of living on the Moon
esa.int/Education/Moon_Camp/The_basics_of_living

ESA classroom resources esa.int/Education/Classroom_resources

Paxi animations esa.int/kids/en/Multimedia/Paxi_animations

ESA missions

MELiSSA project esa.int/Our_Activities/Space_Engineering_Technology/Melissa

Eden ISS https://eden-iss.net

Extra information

MELiSSA Foundation www.melissafoundation.org

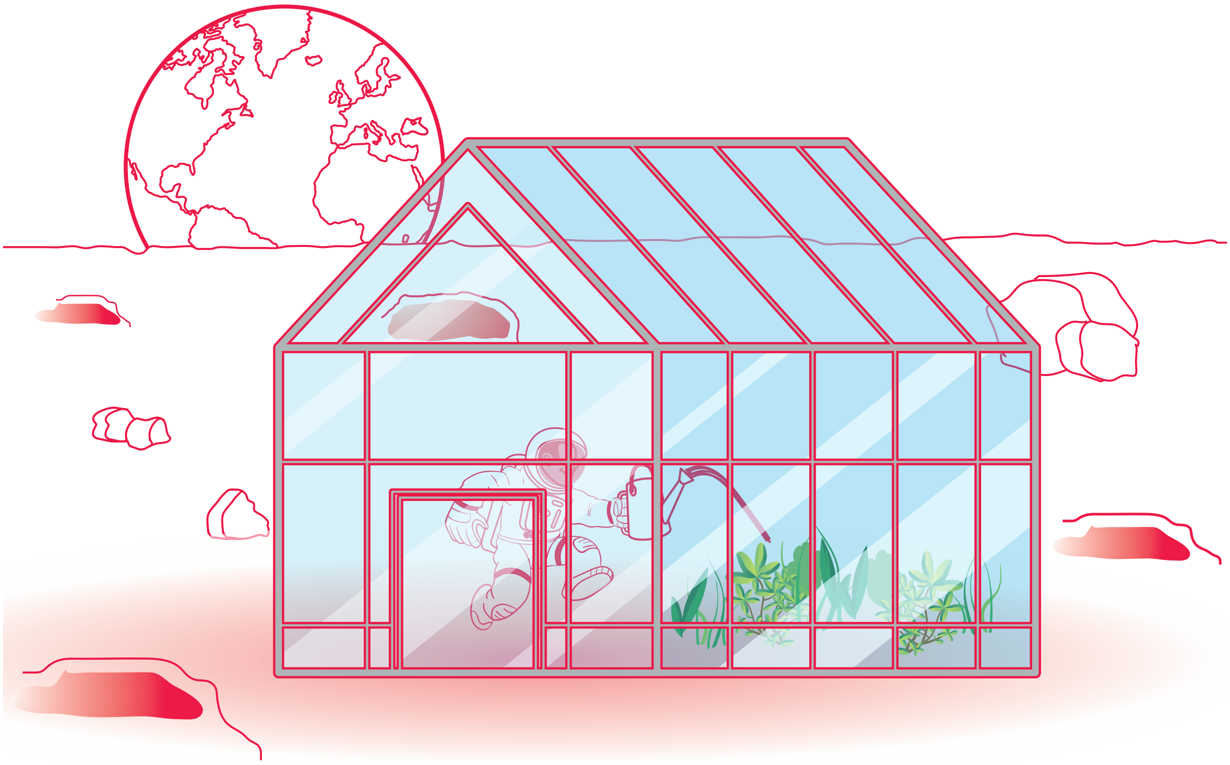
MELiSSA using spirulina as a test subject
directory.eoportal.org/web/eoportal/satellite-missions/m/melissa

ESA Euronews – Growing food in space
esa.int/spaceinvideos/Videos/2016/05/ESA_Euronews_Growing_food_in_space

Astroplant, citizen science project supported by ESA www.astroplant.io

My AstroCrops

Data Logbook



Team: __________

Paxi needs your help

Paxi needs your help gathering data about plants that he could grow on his long distance space journeys. You will need to become scientists and carry out a scientific investigation. This will involve making observations, taking measurements and recording data. Paxi has sent a mission statement for you.

Mission statement: Follow the development of three unknown seeds as they grow over 12 weeks. Identify the three plants and decide which one you would take to space.

WEEK 0

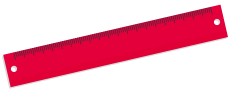
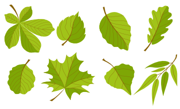
Date:______

Draw your seeds		
Plant A	Plant B	Plant C

WEEK 1

Date:______

Register your measurements

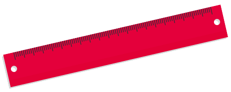
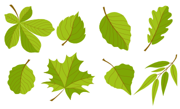
Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

Draw your plants

Plant A	Plant B	Plant C

WEEK 2

Date:______

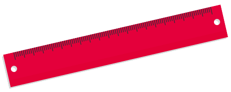
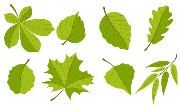
Register your measurements			
Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

Draw your plants		
Plant A	Plant B	Plant C

WEEK 3

Date:______

Register your measurements

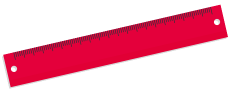
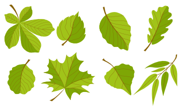
Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

Draw your plants

Plant A	Plant B	Plant C

WEEK 4

Date:______

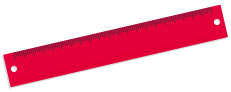
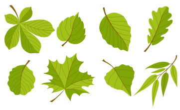
Register your measurements			
Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

Draw your plants		
Plant A	Plant B	Plant C

WEEK 5

Date:______

Register your measurements

Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

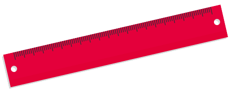
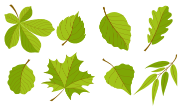
Draw your plants

Plant A	Plant B	Plant C

WEEK 6

Date:______

Register your measurements

Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

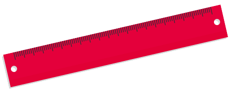
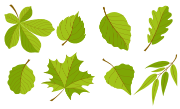
Draw your plants

Plant A	Plant B	Plant C

WEEK 7

Date:______

Register your measurements

Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

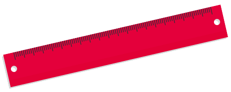
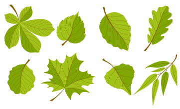
Draw your plants

Plant A	Plant B	Plant C

WEEK 8

Date:______

Register your measurements

Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

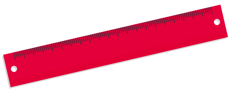
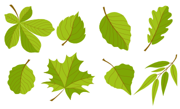
Draw your plants

Plant A	Plant B	Plant C

WEEK 9

Date:______

Register your measurements

Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

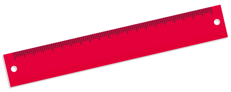
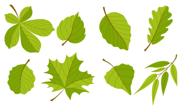
Draw your plants

Plant A	Plant B	Plant C

WEEK 10

Date:______

Register your measurements

Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

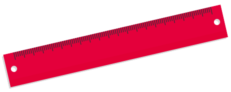
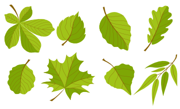
Draw your plants

Plant A	Plant B	Plant C

WEEK 11

Date:______

Register your measurements

Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

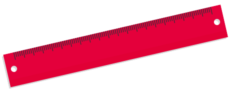
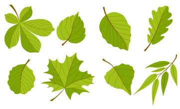
Draw your plants

Plant A	Plant B	Plant C

WEEK 12

Date:______

Register your measurements

Plant	A	B	C
Height (cm) 			
# of leaves 			
# of fruit 			
# of flowers 			
I think we are growing:			
Comments:			

Draw your plants

Plant A	Plant B	Plant C

Letter to paxi

Dear Paxi,

We have completed our mission! After studying the three different seeds we have identified:

Plant A ________

Plant B ________

Plant C ________

We would take _______________ to space because__________________

____

____

____

Your friends,

____