

# SCIENTIFIC METHOD

## RESEARCH ON THE ISS

GRADE

NAME

OBJECTIVE	TEACHER PREP
Students will learn about the importance of the scientific method by identifying the steps in the experiment below.	Discuss the scientific method with your students. <ul style="list-style-type: none"> <li>• What are the steps of the scientific method?</li> <li>• Why is the scientific method important?</li> </ul>

These lessons address NGSS standards: Science and Engineering Practices: Asking Questions; Defining Problems; Planning and Carrying out Investigations; Analyzing and Interpreting Data; Using Mathematics and Computational Thinking; Constructing Explanations; Obtaining, Evaluating and Communicating Information.

### BACKGROUND



Dr. Anna-Lisa Paul and Dr. Rob Ferl study how plants respond to extreme conditions like the microgravity environment on the International Space Station (ISS). Their goal is to discover changes in how plant cells develop in space, which may improve growing food on Earth and help future astronauts live on Mars.

### YOUR TASK

A new group of scientists are trying to repeat Dr. Paul's and Dr. Ferl's experiment, but they forgot to include section titles in the report on their findings, and now it is all mixed up! Use Dr. Paul's and Ferl's notes from their plant experiment below to help these new researchers label their report. Write the letter from the Experiment Sections below in the circle next to the Research entry it best matches. Each letter will only be used once.

### EXPERIMENT SECTIONS

- Q QUESTION:** The question is the first part of the scientific process. What question do I want to answer?
- H HYPOTHESIS:** A hypothesis is a statement that can be proven true or false. It is often written in the form "if"...."then"....
- E EXPERIMENT:** The experiment is an activity that is used to test if your hypothesis is true or false.
- D DATA:** Data are the results of the experiment.
- C CONCLUSION:** The conclusion is a final statement that describes what you learned from the experiment and results.

RESEARCH	
1 Do plants need gravity to grow? <input type="radio"/>	4 Experiment and data show that plants do not need gravity to grow. <input type="radio"/>
2 I will test how plants grow without gravity by observing how their roots grow in the microgravity environment of the ISS. <input type="radio"/>	5 <b>DAY 1:</b> Seed germinates <input type="radio"/> <b>DAY 4:</b> Root emerges from the seed coat <b>DAY 6:</b> Small roots emerge from the seed and leaves emerge from seed coat <b>DAY 10:</b> Roots are 2 centimeters long <b>DAY 14:</b> Roots are beginning to skew, or grow slanted toward the right <b>DAY 21:</b> Roots are 4-5 cm long and are branching out
3 If the plant roots grow slanted and branch out, or skew, then plants do not need gravity to grow. <input type="radio"/>	

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Special acknowledgment and thanks to the Center for Advancement of Science in Space (CASIS) and NASA for their contributions.



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## DID YOU KNOW?

**CO<sub>2</sub> AS PLANT FUEL** Plants grown on the ISS can consume carbon dioxide (CO<sub>2</sub>) that people produce and generate small amounts of oxygen – all through the fundamental plant growth process called photosynthesis.

**NO SOIL!** Astronauts grow plants in space without soil using hydroponics. The minerals (food) that plants need are dissolved in water that circulates through the root system.

**TASTE TEST** In August 2015, for the first time ever, astronauts harvested and ate the lettuce they grew in space.

**SPACE VEGGIES** Plants like rice, tulips, onions, peas, radishes, lettuce, wheat, and cucumbers have been grown on the ISS.

**JUST LIKE ON EARTH** Seeds germinated on the ISS sprouted roots that behave like they would on Earth, growing toward water and nutrients.

**A LIVING LABORATORY!** Astronauts on the ISS have to perform many different experiments each day. Some experiments include living plants and animals.

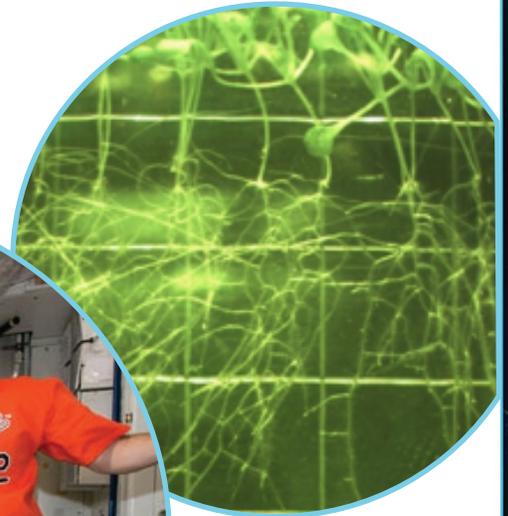
**BIG DISCOVERIES** Scientists can learn a lot about how plants live and better ways to grow plants by studying their growth on the ISS.

**THE PERFECT CROP** Leafy greens grow quickly and are ideal for growing on the ISS.

**WHAT TO PLANT NEXT?** Dwarf tomatoes and peppers may be the next crops grown in space.

Left: Russian Federal Space Agency (RSA) cosmonaut Anton Shkaplerov and NASA Commanders Barry (Butch) Wilmore and Terry Virts strike a Zero-G pose inside the ISS.

Right: "Space plants" do not need gravity to grow.



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