



FUTURE U.

Boeing 360 Experience | Plant Study

Objectives

Students will be able to:

- **Research** a career that could contribute to deep space innovation and consider how this career could impact plant growth on Mars.
- **Analyze** how a plant's characteristics and its environment must align in order for the plant to thrive in outer space.
- **Evaluate** how an additional plant of their choosing could adapt to the Martian environment and justify whether introducing this plant to deep space would be worth the effort.

Overview

Our 360 experience brings students to the Boeing Mars Experiment Laboratory as they investigate how to grow plants in Martian soil. Students will be responsible for picking seeds to plant, selecting their genetically engineered properties, and determining the factors that will enable the plants to thrive in the Martian environment. Throughout the experience, students will explore the many important roles and jobs that play a part in introducing plant life to Mars, as well as the information that astronauts would need to know to successfully cultivate an extra-terrestrial plant. They will also consider the steps that must take place in order to introduce additional plants to deep space!

Grade level

6–8

Materials

- Devices with internet access, at least one per every 2-3 students
- Career Cards, two copies (cut out)
- Boot Up handout, one per student
- Experience handout, one per student
- Reorient #1 handout, one per student
- Reorient #2 handout, one per student

Boot Up

Tell students that they will soon be participating in a simulation in which they visit the Boeing Mars Experiment Laboratory and investigate different plant traits and environmental conditions that may help astronauts move forward with planting seeds in Martian soil. Explain that before it is possible to grow anything on Mars, an enormous amount of work must take place on Earth!

Divide students into small groups. Assign each group one of the following careers and give a corresponding Career Card to each group:

Mechanical Engineer

Aerospace Engineer

Plant Biologist

Budget Analyst

Plant Geneticist

Geotechnical Engineer

Meteorological Technician

Plant Pathologist

Next, distribute a Boot Up handout to each student. Review the instructions provided, and instruct each group to use the internet* to research answers to the questions below:

1. Every job has a variety of duties and responsibilities. What are some of the different responsibilities and duties that could be associated with this career?
2. Pretend you now have this job and you are assigned to help with the mission of successfully growing plants on Mars. How could your work contribute toward this goal?

*Note: If time for internet research is not available, students may use the information on the cards to infer answers to the questions above.

Once the students' research is complete, ask each group to share their answer to #2 with the class. Together, discuss the similarities and differences among the positions, as well as how the jobs could work together to help plant life on Mars become a reality.

Experience

Distribute an Experience handout to every student and review the questions provided. Explain that each student will be responsible for taking notes on this sheet as they move through the 360 experience.

Reorient

Two activity options are available for students to summarize, apply and synthesize their learning:

Reorient #1

In pairs, students can create a one-page instructional diagram to help astronauts understand how to plant seeds on Mars. Students should pretend that the first astronauts to visit Mars will be given a single envelope containing these instructions and a packet of seeds. In order for the astronauts to successfully plant this seed, the visual should clearly explain the seed's genetic design, as well as the conditions the seed will need to grow and thrive.

Reorient #2

In pairs or small groups, students will select an additional grain, fruit or vegetable that they would like to plant on Mars. They will perform research to learn more about the plant's characteristics, and they will explain how the plant would need to be modified in order to survive in a Martian environment. They will then consider the benefits of the food it produces and justify whether planting a modified version of this plant on Mars would be worth it!

Note: If students need guidance while performing internet research for this activity, the National Gardening Association (garden.org/learn/library/foodguide) is a good starting point.

National Standards

Next Generation Science Standards

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Common Core English Language Arts Standards

CCSS.ELA-LITERACY.CCRA.W.1 Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

Directions: Perform research to learn more about your assigned career. Then work as a group to answer the questions below.

Career: _____

Question #1: Every job has a variety of duties and responsibilities. What are some of the different responsibilities and duties that could be associated with this career?

Question #2: Pretend you now have this job and you are assigned to help with the mission of successfully growing plants on Mars. How could your work contribute toward this goal?



Directions: Perform research to learn more about your assigned career. Then work as a group to answer the questions below.

Career: _____

Question #1: Every job has a variety of duties and responsibilities. What are some of the different responsibilities and duties that could be associated with this career?

Question #2: Pretend you now have this job and you are assigned to help with the mission of successfully growing plants on Mars. How could your work contribute toward this goal?

<p>MECHANICAL ENGINEERS design and create machines, including space vehicles and robots. They take the machine’s environment and the effects of the environment into account during their design process.</p>	<p>BUDGET ANALYSISTS help create, analyze and implement budgets for projects of all sizes to make sure money is used wisely.</p>
<p>METEOROLOGICAL TECHNICIANS measure and track climate and weather conditions.</p>	<p>AEROSPACE ENGINEERS work in teams to design a range of products, from spacecraft and rockets to commercial aircraft and autonomous vehicles.</p>
<p>PLANT GENETICISTS study a plant’s DNA in order to better understand crops. They also create new varieties of plants with unique traits.</p>	<p>GEOTECHNICAL ENGINEERS research and investigate a site’s soil, rock and underground water conditions in order to assess risks before a construction project begins.</p>
<p>PLANT PATHOLOGISTS are scientists who study plant diseases that are caused by pathogens (living organism such as bacteria, fungi or viruses) or factors in the environment.</p>	<p>PLANT BIOLOGISTS conduct research and experiments in a variety of plant-related areas: from new plant species and plant breeding to how to best treat plant diseases.</p>

Directions: Use this sheet to jot notes throughout the experience. Complete sentences are not needed, but notes must be taken!

Step 1: Use X's to record the optimal plant characteristics needed to help your seed grow and thrive on Mars.

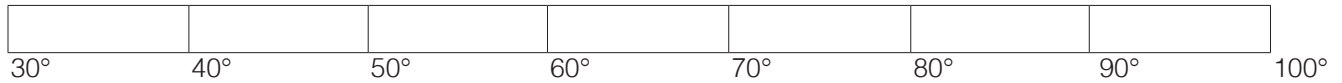
Plant Name: _____

	Low	Medium	High
Photoprotection			
Drought Tolerance			
Cold Tolerance			

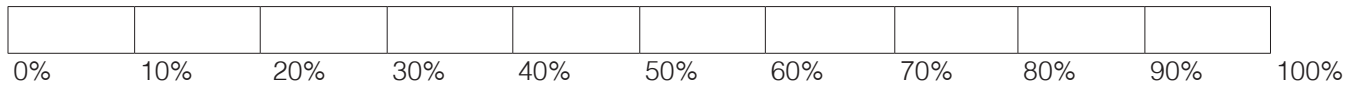
Why do you think this combination of genetic traits would best help a seed survive in the Martian environment?

Step 2: Shade in the charts below to show the range of optimal environmental conditions to help your seed thrive on Mars.

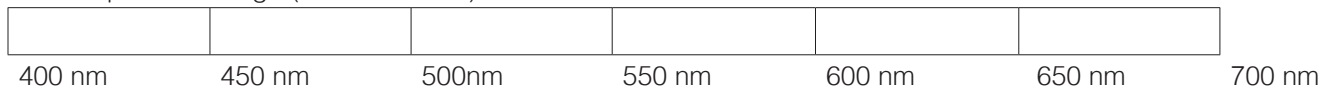
Temperature (in °F)



Moisture:



Visible spectrum range (in nanometers)



Why do you think this combination of environmental conditions would best help your seed grow on Mars? In your response, be sure to consider the genetic traits that you selected above.

If future Mars-bound astronauts could only be given one envelope containing a packet of seeds and a single page of instructions as they left for deep space, what would they need to know in order to make sure the seed successfully develops into a plant?

In the space below, create a one-page visual that will help astronauts successfully plant the seed that you studied. Your visual must include: 1) The name of the plant, 2) Background information to help the astronaut understand how the plant has been genetically engineered, and 3) The steps the astronaut must take to ensure the seed grows and thrives.



While the plants being researched in the Boeing Mars Experiment Laboratory are a great place to start, imagine if you had only four different kinds of food to eat day after day. Let's help the astronauts expand their meal options!

Step 1: If you were going to visit Mars in the future, what fruit, vegetable, or grain would you like to eat there? (Be sure that it wasn't already included in the 360 exploration!) Once you record the crop's name below, perform research to find out more about the crop's light, moisture and temperature requirements.

Crop Name:	
Light Requirements:	
Moisture Requirements:	
Temperature Requirements:	

Step 2: Look back at your Experience notes. Would this crop need to be modified in order to survive on Mars? Explain *if* and *how* your crop would need to be genetically engineered in terms of the following three characteristics:

Photoprotection:	
Drought Tolerance:	
Cold Tolerance:	

Step 3: Before scientists begin the hard work of modifying this seed so it may survive on Mars, decide: Is it worth it? Explain your position carefully below. In your response, consider: Does it seem like this plant has a high chance of Martian survival? Does this plant produce important and nutritious food? Could this food be used in a variety of ways?
