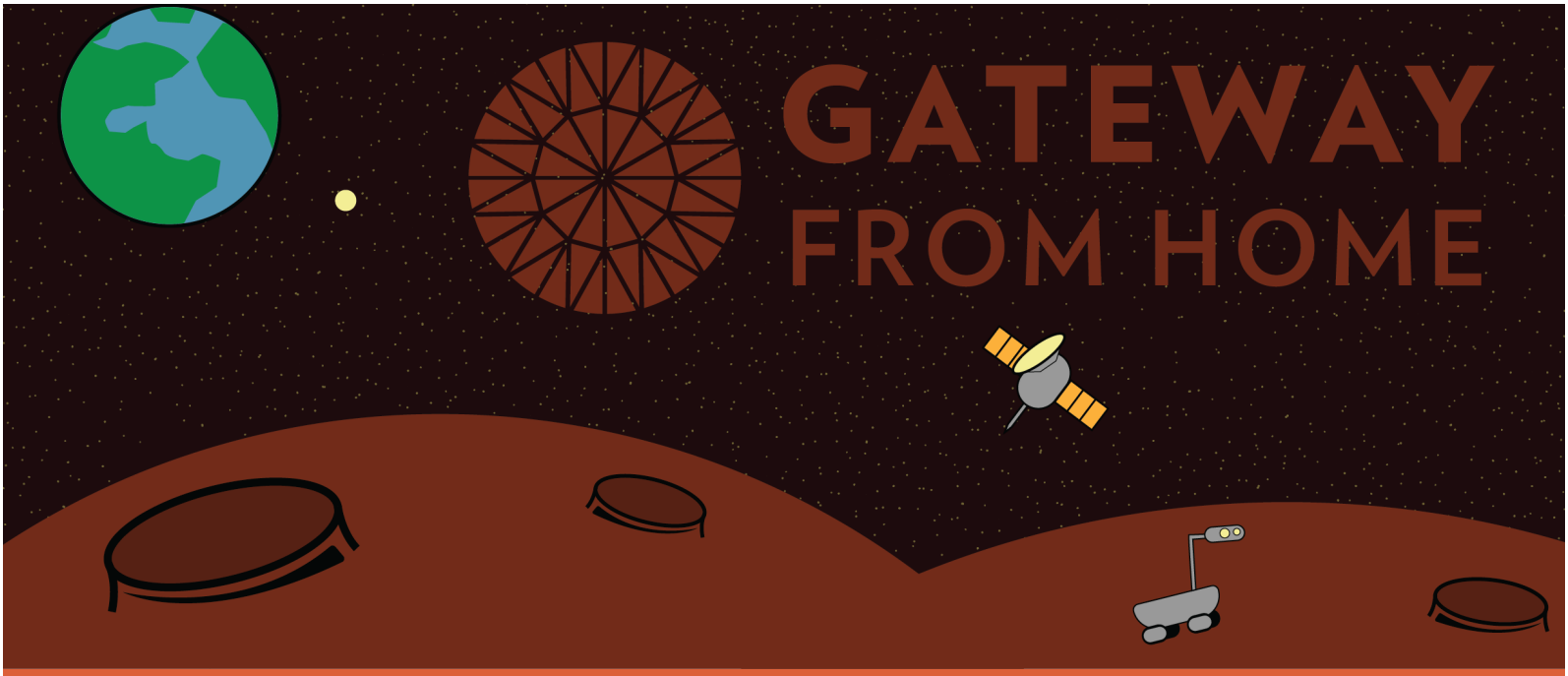
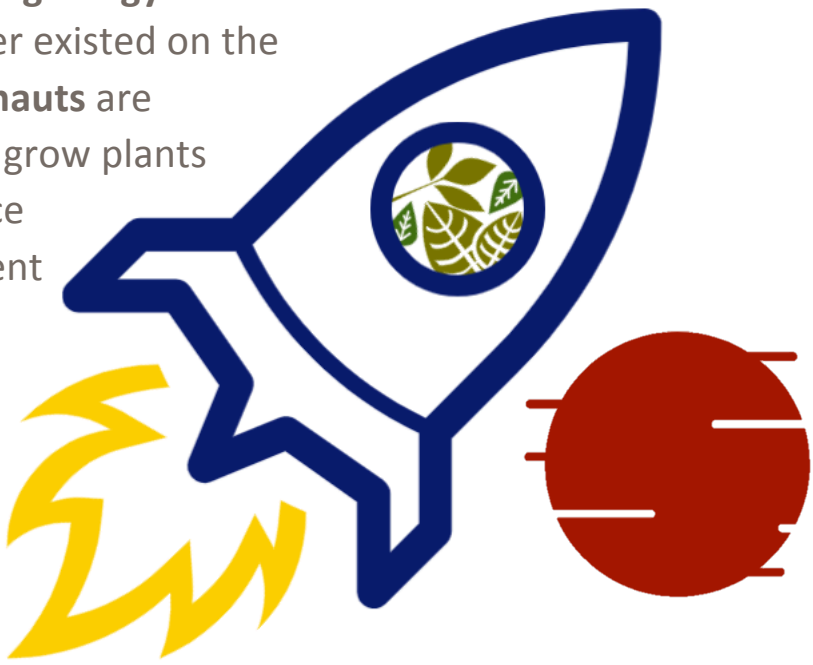


Life in Space!

Why do you think humans explore space?

Organizations like NASA and scientists of all kinds across the globe are studying space because we want to learn more about where Earth came from, where we are headed, and what else is out there in the vast universe.

What about life in the universe outside Earth? Scientists are using **exploratory rovers** to explore the **geology and characteristics** of Mars to learn whether life ever existed on the Red Planet. **Botanists and astronauts** are teaming up to study how we can grow plants as food on the International Space Station and eventually on sediment from **other planets**.



What can you learn and imagine about **life in space** from your own home here on Earth?

1. The Colors & Science of Martian Soil

Why is the surface of Mars red? Rovers have shown us images of our neighbor planet's dusty, rocky, red-brown surface. If this color reminds you of the rust we find here on earth, it's because rust and Martian soil both contain a compound called iron oxide!

We can also see shades of gray, white, and red in the silica, ice, and mineral deposits across the surface of Mars. Just like the Earth, the soil and rocks of Mars contain a wide diversity of minerals that take on different shades and colors.

The red, rocky, and dry Martian surface. Image: NASA / JPL

Rust on iron here on Earth. Rust, or *iron oxide*, forms when iron is exposed to moisture and oxygen.

Earth soils contain organic materials that make growing plants possible. Image: Colombo et al. 2018

Can you recreate the colors of the Martian rocks and sediments? How does Martian soil compare with the soil of our own planet? Learn about Earth and Martian mineralogy in this activity inspired by the NASA Jet Propulsion Laboratory's programming.

You will need:

- NASA Jet Propulsion Laboratory Mars mineralogy coloring sheet
- Crayons
- Glue
- Ground spices (like cayenne, cumin, turmeric, ginger, and others)
- Collecting container

1. Use crayons in the colors of Mars to color in the planet. Use colors like reds, browns, tans, and grays to recreate the natural diversity in the coloration of the planet's mineralogy – a set of Multicultural Crayons works well for this!
2. Trace the lines on the coloring sheet with a bead of glue. This will recreate the natural relief (peaks, valleys, and texture) of the planet's surface.
3. While the glue is still wet, sprinkle it with the spices, which closely resemble the colors of Mars. Tap the excess off of the coloring sheet into a sink or other container, and let your creation dry.
4. Head outside and use your collection container to collect samples of soil from your yard or local environment. Try to find as many colors as you can!
5. Compare your Earth soil samples to your Mars recreation. How do they compare? What is similar, and what is different?

2. Life on Mars

What does life on another planet look like? Scientists suspect that if there has been ever been liquid water on Mars (as opposed to ice), the planet may have supported life in the form of microbes, or bacteria! Researchers have debated for decades over the finding of what may be ancient fossilized Martian bacteria found in meteorites.

Stromatolites are special fossils that show how ancient cyanobacteria once lived in reefs built of these microbes. Image: Houston Museum of Natural Science.

Bacteria are microscopic, single-celled organisms that have Earth (and perhaps beyond!) for billions of years. They live everywhere from the bottom of the ocean to our guts to the soil in our environment. **What do you think the microbes on Mars would look like?**

Bonneville Crater of Mars – NASA / JPL / Cornell University

3. Growing Plants in Space

It's important for **astronauts** in space to have access to plenty of healthy foods full of vitamins while on their missions, but packaged foods and supplements need to be resupplied, which won't be possible as we explore further into the universe. This is why NASA is studying **how plants grow on the International Space Station (ISS)**.

Astronauts use a "**space garden**" called the Vegetable Production System (or Veggie) on space to grow plants while in orbit and to study how plant growth processes are affected by the **special conditions** in space. Just like on Earth, plants in space need light, warmth, water, and nutrients to grow.

Peggy Whitson, a NASA astronaut, harvests cabbage from Veggie in the International Space Station. Some of the plants harvested are eaten by the astronauts, and others are sent back to Earth so scientists can study the biology of plants grown in space. Image: NASA

Light/Warmth: Since the ISS is in orbit around the earth, the exposure of the station to sunlight is different than at home. Veggie has special lights that allow plants to grow without the sun. The lights also help guide the direction of the plants' growth without gravity.

Water: Here on Earth, we pour water into soil or rely on rain to give our plants the moisture they need. How does this work without gravity? Plants in the Veggie have a "pillow" of clay, air, and water surrounding the roots. This pillow allows the astronauts to supply water to their plants without it floating away, in a method called *hydroponics.*

Nutrients: The "pillow" that supplies plants with water also contains fertilizer, which gives them all the nutrients they would normally receive from rich and healthy soils back on Earth. They also absorb carbon dioxide from the carefully purified air that circulates the ISS (there's no air outside the space station!)

You can engineer a system for growing plants without soil, or *hydroponically!*

You can also use this system to test how plants respond to **changes in gravity.**

You will need:

- Tap water
- Cotton balls
- Ziplock bag or other resealable container
- Seeds (dried beans soaked the night before, popcorn kernels, flower seeds, or seeds from your yard (like dandelion seeds!)
- Tape
- Picture frame, cereal box, or other self-supporting object

To engineer a mini hydroponic greenhouse system:

1. Drop the cotton balls into the tap water to saturate them and form your plant "pillow" like the ones in the ISS Veggie system. Don't squeeze out the extra water!
2. Place the soaked cotton balls in the resealable bag.
3. Carefully set one seed on the top of each cotton ball inside the bag or container, and seal the bag up with plenty of air trapped inside to create a mini-greenhouse for growing your seeds.
4. Tape the bag to a sunny window and watch your seeds grow over the coming weeks!
5. If, like in the ISS, you don't have a window that receives sunlight all day long, you may need to engineer a support system for moving your greenhouse around. Tape the sealed bag containing the plant "pillows" and seeds to a picture frame or other self-supporting object that you can easily move between windows in your home to follow the sunshine!

To test the effects of gravity on your seedlings:

1. After your seedlings have grown in your mini hydroponic greenhouse, open the bag and carefully turn the "pillow" so that the seedlings face sideways instead of up. Reseal the bag, remembering to leave lots of air inside.

2. Relocate your greenhouse from the sunny window to a dark place, like the inside wall of a closet or kitchen cabinet. Remember to tape the greenhouse so it stays upright!

3. Check on your seedlings in a few days. Have they adjusted the direction of their growth after you turned them?

   Plants adjust can detect gravity and the direction of the earth through a mechanism called *gravitropism* that helps keep them growing up toward the sky!

Now that you've learned about the special conditions needed for plants to grow, what do you think a Martian greenhouse would look like? What about idea Martian plants? Draw them here!