Lesson Overview

On Day 3, students review the basic needs of all living things and determine how these needs apply to crew members in a spacecraft and on the surface of a foreign planet such as Mars. They also determine some of the constraints of space travel and determine their effect on living spaces. They then design a habitat for either a spacecraft to support travel trip to Mars or to reside on the surface of Mars.

Connecting to the Next Generation Science Standards

On Day 3, students make progress toward developing understanding across the following three dimensions:

- **Science and Engineering Practices**: Developing and Using Models
- **Disciplinary Core Ideas**: LS2.A Interdependent Relationships in Ecosystems
- **Crosscutting Concepts**: Cause and Effect

Day 3 is best taught in tandem with other lessons relating to LS2.A.

In the following table, the specific components addressed in this lesson are underlined and italicized. The specific connections to classroom activity are stated.

### Performance Expectations

This lesson can be used to enhance the development of the following **life science performance expectations**:

- **MS-LS2-1**: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

### Specific Connections to Classroom Activity

In this lesson, students develop a model habitat for astronauts during their mission to Mars. Students take into account the availability of resources in the habitat and the effect the living and nonliving resources may have on the astronauts.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>NGSS Element</th>
<th>Connections to Classroom Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science and Engineering</td>
<td>Developing and Using Models</td>
<td>Students develop a model of a proposed habitat for astronauts either on their journey to Mars or during their stay on Mars. The habitat is a simple system that has less predictable factors.</td>
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<tr>
<td>Practices</td>
<td>Use and/or develop a model of simple systems with uncertain and less predictable factors.</td>
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</tbody>
</table>
Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>LS2.A: Interdependent Relationships in Ecosystems</th>
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</thead>
<tbody>
<tr>
<td>• Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.</td>
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</table>

Crosscutting Concepts

<table>
<thead>
<tr>
<th>Cause and Effect</th>
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<tr>
<td>• Cause and effect relationships may be used to predict phenomena in natural or designed systems.</td>
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</table>

In the student model of a proposed habitat, students take into account the interactions between living things and nonliving factors. Students consider the effects of both on astronaut survival.

In developing their model habitat, students consider the cause and effect relationships between the living and nonliving factors and the astronauts’ survival.

Basic Teacher Preparation

Continue with the student teams formed on Day 2. Alternatively, consider having students complete this lesson’s activities individually. Make copies of the needed habitat photos, or locate them online.

Required Preparation

- Gather or purchase the required materials for the lesson
- Ensure technology is available to project or allow students to access the recommended websites
- Review suggested teacher preparation resources in advance

Links/Additional Information

- Refer to the Materials List below
- Refer to the Suggested Teacher Resources at the end of this lesson

Materials List

<table>
<thead>
<tr>
<th>Item</th>
<th>Description/Additional Information</th>
<th>Quantity</th>
<th>Where to Locate/Buy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer (or computers) with Internet access and a projector</td>
<td>1 per class for projecting to entire class, or access to a computer lab</td>
<td>Available in most schools</td>
<td></td>
</tr>
<tr>
<td>Photos of native plants and animals indigenous to various habitats</td>
<td>Can be shown from picture books or identified on the Internet and projected to the class</td>
<td>Images of animals in their habitats [Web Link]</td>
<td>Images of plants from various habitats [Web Link]</td>
</tr>
<tr>
<td>Drawing paper, or access to computers with drawing programs</td>
<td></td>
<td>Paper available in schools</td>
<td>Drawing software, such as Sketchpad [Web Link]</td>
</tr>
</tbody>
</table>
Day 3: Mission #2—Living on Mars

Introduction (5 minutes)

Show students a picture of a familiar native plant, and ask them what this plant needs to survive. Discuss what would happen if the plant was picked up and moved to a different climate. **Would it survive? Why or why not?** Repeat this process with a picture of a plant from a very different environment.

Show a picture of familiar local animal, and then an animal from a completely different habitat. Discuss how the animals have adapted to survive where they live.

Finally, show a picture of a person, and discuss basic needs to survive in different climates. **How do humans accommodate and adapt to live in various extremes?** Show a picture of an astronaut in a zero-gravity setting. Discuss how people are impacted as they try to survive in the unique setting of a spacecraft for several months as they travel to and from Mars. **Once they land on a planet that does not have an atmosphere, what problems will they face? How can those problems be addressed?**

Allow students 5 minutes to work in their teams to make lists of the problems that need to be addressed. Have students revisit their letter to NASA to add ideas to the criteria and constraints of living on Mars.

Design Work: Create a Habitat (30 minutes)

Bring students back together for a group discussion of the issues that have to be addressed. (Some examples include the need for oxygen, food, water, waste systems, mental stimulation, exercise, space, sleeping quarters, and so forth). If some of the categories shown here do not emerge, ask questions to elicit these responses from students. Be sure to emphasize the idea that humans depend on living and nonliving factors to survive. If critical needs are not met, the astronauts may be at risk.

**NGSS Key Moment**

Beginning the lesson by engaging students in a discussion about what plants and animals need to survive draws out current student conceptions about interdependent relationships in ecosystems. Use student ideas to guide the amount support provided throughout the lesson.

**NGSS Key Moment**

As you introduce the design work, emphasize the idea that humans rely on living and nonliving factors. Reinforce the idea of cause and effect in natural and design systems. Help students understand that when certain living or nonliving factors are unavailable, it may have a negative effect on the astronauts.
After the class has created a group list of the most critical needs, discuss the constraints of cargo space on a spaceship. Tell students that their team (or each individual) has been contracted to come up with designs for living quarters for four Mars mission crew members. Students should design the crew’s housing quarters on Mars keeping in mind that they will be on Mars for almost a year.

Allow students to work in their teams (or individually) on their designs. They may sketch on sheets of paper or use a computer drawing program. Encourage the use of labels and accurate dimensions as much as possible.

Students should label living and nonliving factors necessary for the astronaut’s survival.

After designing the habitat, students should write a justification for their design decisions. Students should relate the design decisions to the living and nonliving factors needed for survival. Students should also comment on what might happen if elements of their proposed habitats may be missing. This, and a sketch of the habitat, should be incorporated into the letter to NASA.

**Lesson Close (15 minutes)**

Discuss the following questions as a group:

- *What challenges did they think about?*
- *What solutions did they identify?*
- *What accommodations will need to be made to ensure survival in space?*
- *What other needs still have to be addressed in their designs?*

After the discussion, ask students to think about which engineering teams would be involved in the design planning or construction (for example, launch team for weight considerations, environmental control team for the volume of area contained in their design, and so forth). Finally, show students interior shots of the first manned space capsules, the space shuttle, and the International Space Station.

Ask students to identify elements in their own designs that they see in the real-life images:

*How do the spacecraft differ from each other and from the students’ designs?*

Use the Web Resources to show students photos of other crew quarter designs (including inflatable quarters) currently being designed and refined by the aerospace industry. Discuss which problems the new crew quarter designs solve. Ask students to identify the constraints of using inflatable quarters. Encourage students to continue their design process at home. Let students know they should plan to talk about Mars’ surface conditions and engineering problems in the next lesson.

[Web Resources]

- Manned Space Capsules [Web Link]
- Space Shuttle [Web Link]
- International Space Station [Web Link]
- Inflatable Space Station [Web Link]
- Inflatable Mars Quarters [Web Link]
- Other Astronaut Living Quarters [Web Link]
Assessment Opportunities

Use the habitat models and justification paragraphs to inform your understanding of developing student conceptions related to LS2.A, Cause and Effect, and Developing and Using Models. Provide additional supports or extensions when necessary. Reference Appendix B for suggestions for meeting the needs of all learners.

Community Connections

If parents, guardians, or family members of any students work as architects, consider inviting them to visit the classroom to assist as a volunteer or to share their work experiences as designers of physical spaces intended to enhance human quality of life.

Suggested Teacher Resources

<table>
<thead>
<tr>
<th>Meeting the Needs of All Learners</th>
<th>Mission to Mars Teacher Handbook, Appendix B</th>
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<tbody>
<tr>
<td>Manned Space Capsules (Gemini)</td>
<td>[Web Link]</td>
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