Lesson Overview

On Day 2, students research their assigned environment and career. This helps students more clearly define the design criteria and constraints. After researching the assigned environment and career, students begin to think about the impact their environment may have on a human body. Students imagine what would happen to a scientist working in their environment without a biosuit. Students create an initial model to show and explain their predictions about what may happen to the heart, lungs, blood vessels, skin, and eyes of a scientist working in their environment without a biosuit. The emphasis of the model is explaining the **HOW** and the **WHY** of the body response to the environment.

Connecting to the Next Generation Science Standards

On Day 2, students make progress toward developing understanding across the following three dimensions:

- **Science and Engineering Practices**: Asking Questions and Defining Problems, Developing and Using Models
- **Crosscutting Concepts**: Influence of Science, Engineering, and Technology on Society and the Natural World, Cause and Effect, Structure and Function

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 contributes toward building understanding of the following **engineering** performance expectations:

- **MS-ETS1-1**: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

This lesson contributes toward building understanding of the following **life science** performance expectations:

- **MS-LS1-3**: Use argument supported by evidence for how the body is a system of interacting sub-systems composed of groups of cells.
- **MS-LS1-8**: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
Specific Connections to Classroom Activity

In this lesson, students investigate the intended environments for their biosuits. By learning more about the intended environment and task, students are better able to articulate the design criteria and constraints for their biosuits.

As students begin to think about the impact of the environment on scientists and engineers, they predict ways the human body systems might respond to the environment. Students consider the ways in which the sensory input of cold water may change physiological functioning of various body systems. Through this process, students begin to understand that sensory receptors respond to stimuli and the human body is a system of interacting subsystems.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>NGSS Element</th>
<th>Connections to Classroom Activity</th>
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<tbody>
<tr>
<td>Asking Questions and Defining Problems</td>
<td>Define a design problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.</td>
<td>By investigating the intended environment for their biosuit, students further refine their definitions of the design problem. At the end of the lesson, students develop a model to show their predictions about what happens to the body when it is exposed to cold water. In this model, students focus on how the body responds and why the body reacts the way it does.</td>
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</table>

Developing and Using Models
- Develop a model to predict and/or describe phenomena.
- Develop a model to describe unobservable mechanisms.

Science and Engineering Practices

In this lesson, students focus on identifying the key characteristics of the environment for which their biosuit is intended. By researching the environment, students can more clearly articulate design criteria and constraints.

When students consider the human body’s response to cold water, they predict how different body systems might respond to the cold water. Students consider how the different systems might work together.

When students consider the body’s response to cold water, they predict how exposure to cold water may impact the body. Through this prediction, students work with the idea that sense receptors respond to stimuli and that the body responds to the stimuli.
### Crosscutting Concepts

<table>
<thead>
<tr>
<th>Influence of Science, Engineering, and Technology on Society and the Natural World</th>
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<tbody>
<tr>
<td>- The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values, by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.</td>
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<table>
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<tr>
<th>Cause and Effect</th>
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<tbody>
<tr>
<td>- Cause and effect relationships may be used to predict phenomena in natural or designed systems.</td>
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<table>
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<tr>
<th>Structure and Function</th>
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<tbody>
<tr>
<td>- Structures can be designed to serve particular functions by taking into account properties of different materials and how materials can be shaped and used.</td>
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</table>

As students investigate the intended environment for their biosuit, they also consider the societal and ecological needs for the biosuit. In doing so, students think about why the engineering job is necessary to society or the natural world.

As students consider the effects of cold water on the body, they develop an understanding that external stimuli can cause internal responses in the human body.

Students work with the idea that certain body systems or structures serve certain functions that are necessary for human survival.

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### Basic Teacher Preparation

In this lesson, students conduct research on their environment and career. Students need access to books, copies, or computers that allow them to conduct independent research. You may want to identify a list of suggested websites or resources for students to use in their research. An initial list is provided in Appendix E.

Refer to the Extreme Biosuits Student Handbook ahead of time so you can address any questions students might have. Day 2 documents can be found on pages 15–18 in the Extreme Biosuits Student Handbook. The documents used in this lesson are:

- **Researching Our Environment and Career** (page 15)
- **Defining the Problem and Identifying Solutions (Round 2)** (page 16)
- **Predicting the Response to Our Environment** (pages 17 and 18)

To prepare for the whole group discussions, review the Talk Science Primer (See Suggested Teacher Resources for Day 1).

### Required Preparation

<table>
<thead>
<tr>
<th>Required Preparation</th>
<th>Links/Additional Information</th>
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<tbody>
<tr>
<td>- Gather or purchase the required materials for the lesson</td>
<td>Refer to the Materials List below</td>
</tr>
<tr>
<td>- Review suggested teacher preparation resources and the recommended websites</td>
<td>Refer to the Suggested Teacher Resources section at the end of this lesson</td>
</tr>
<tr>
<td>- Identify suggested websites for student research</td>
<td>See Appendix E</td>
</tr>
</tbody>
</table>
## 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>Extreme Biosuits Student Handbook</td>
<td>Given to students on Day 1</td>
<td>1 per student</td>
<td>[Resource Link]</td>
</tr>
<tr>
<td>Computer access</td>
<td>Students will use web or print resources to research their assigned environment</td>
<td>1 per student (or group)</td>
<td>Available in most schools</td>
</tr>
<tr>
<td>Print resources</td>
<td>If computers are not available, make several print resources available to students</td>
<td>2 or 3 resources per group</td>
<td>Various web resources</td>
</tr>
</tbody>
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Day 2: Where the Scientist or Engineer Works

Introduction (5 minutes)

Begin the lesson by referencing the DQB. Yesterday, students made progress on the question, *What is a biosuit?* Today, students begin to focus on the question, *Why are biosuits needed in certain environments?* To begin answering this question, students need to learn more about their environments. Ask students to share what they already know about their environments. Tell students that their first task today is to find out more about their assigned environment and career.

Mini-Lesson: Researching our Environment and Career (20 minutes)

Students begin to research their environment and career on their own. Refer to Researching Our Environment and Career on page 15 of the *Extreme Biosuits Student Handbook*. Instruct students to record their findings in the chart. Point out the three questions at the bottom of page 15 that ask about temperature.

Give students 15 minutes to research their environment and career.

After 15 minutes, have students share their findings with their group. Students should jot additional notes on page 15 as they learn more about their environment or career from their group.

Instruct students to revisit the Defining the Problem and Identifying Solutions chart they developed on Day 1 (page 13). Now that students have more information, they add to the chart. Instruct students to add additional ideas to Defining the Problem and Identifying Solutions (Round 2) on page 16 in the *Extreme Biosuits Student Handbook*. Again, students may not be able to fill in the last column. After Day 3, students revisit the chart again to fill in the final column.

Investigation: Predicting the Response to Our Environment (15 minutes)

Now that students know more about their environment and career, instruct students to imagine a scientist or engineer working in their environment *WITHOUT* wearing a biosuit. Ask students how they think the body would respond to the environmental conditions. Have students share ideas.

After a brief discussion, refer students to Predicting the Response to Our Environment on page 17 of the *Extreme Biosuits Student Handbook*. Read the instructions out loud. Review the body systems identified in the diagram on page 17. The diagram shows the relationship between various body systems and the integumentary system (the skin). Using the diagram, students can gain an initial sense of the ways that the body systems work together. Students build on this understanding throughout the following activity.
In this activity, students create a model of their predictions about how the body would respond to their environment. Instruct students to create their model on page 18 in the *Extreme Biosuits Student Handbook*. Students should focus specifically on the following five organs and body systems—heart, lungs, blood vessels, skin, and eyes. Student models should show **WHAT** they predict might happen to the organ or organ system. The emphasis, though, should be on the **HOW** and **WHY** the body responds in the way that they predict.

Students may struggle to connect the body response to the **HOW** and **WHY**. At this point in the process, encourage students to make their ideas public. Avoid looking for a “right” answer or an accurate explanation. Rather, encourage students to share their thinking and model their predictions.

**Whole Group Discussion: Sharing our Predictions (10 minutes)**

After students create their models, ask students to share their models with their group members. Students should try to explain the **WHAT**, **HOW**, and **WHY** of their models. Bring the class together for a whole group discussion. Begin the discussion by having a few students or groups share their predictions. Press for students to share the reasoning behind their predictions. Encourage students to ask each other questions.

After sharing predictions, ask students to think about how they might test their predictions in the classroom. Have students share their ideas for testing their predictions. Remind students that all of the environments include scientists working underwater, in water that is colder than the air. Students will likely bring up the idea that they should simulate diving into cold water. They could measure the heart rate, breathing rate, blood pressure, skin response, and eye response to cold water. Tell students that in the next lesson, they work with their group to engage in that investigation to figure out how the body responds to the environment.

**NGSS Key Moment**

The authors of NGSS emphasize the development and use of conceptual models. Conceptual models are explicit representations of a scientist’s understanding of a phenomenon. They are working models that communicate the scientist’s current and developing understanding. When developing conceptual models, students should focus on making their thinking public through words, pictures, and representations.

**NGSS Key Moment**

This discussion represents the first step in the process of designing an investigation—a key science and engineering practice. Although students do not actually design the investigation, they brainstorm possibilities. Later, students may compare their ideas to the actual investigation.
Assessment

Several opportunities for formative assessment exist in this lesson:

- **Biosuit Student Handbook** entries can be used to monitor student progress during the module. For this lesson, focus specifically on student research on Researching Our Environment and Career on page 15.
- The developing **Defining the Problem and Identifying Solutions (Round 2)** chart can be used to track student progress across several lessons.
- Consider gathering evidence of student progress through small group and whole group discussions.

Use the identified assessment opportunities to monitor student progress on disciplinary core ideas, science and engineering practices, and crosscutting concepts. Provide appropriate supports or extensions when necessary.

Reference **Appendix B** for suggestions for meeting the needs of all learners.

Community Connections

Some students may have parents or other relatives who work in extreme environments. Consider inviting these individuals to come to class and speak about their work environments and the challenging characteristics or features of the environment.

Suggested Teacher Resources

<table>
<thead>
<tr>
<th>Meeting the Needs of All Learners</th>
<th>Extreme Biosuits Teacher Handbook, Appendix B.</th>
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<tr>
<td>Task Assignment Resources</td>
<td>Extreme Biosuits Teacher Handbook, Appendix E</td>
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<tr>
<td>Extreme Biosuits Student Handbook</td>
<td>[Resource Link]</td>
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<tr>
<td>CK12.org: Chapter 11, Human Biology</td>
<td>[Web Link]</td>
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<tr>
<td>MITK12Videos on how body counteracts changes in temperature</td>
<td>[YouTube Link]</td>
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