How can some people live at higher altitudes while other people get ill visiting these places?

Grade Band: High School • Discipline: LS • Time: Three 50-minute class periods

Lesson Level Performance Expectation

- Develop a model to show how body system relationships can be used to explain why some people get mountain sickness symptoms visiting low oxygen environments while others are able to live there. (SEP: 2.3; DCI: LS1.A; CCC: 4.2)

What Students Will Figure Out

- High altitude locations have oxygen levels that are up to 40% less than those at sea level.
- Humans need oxygen for cellular respiration, so reduced oxygen can lead to dizziness, fatigue, loss of energy, shortness of breath, loss of appetite, or sleep problems.
- Some people are able to live in high altitude areas with low oxygen.
Lesson Snapshot

High school students, as scientists, investigate people’s experiences at high altitudes in order to answer the following driving question: How can some people live at higher altitudes while other people get ill visiting these places? Students figure out that high altitude locations have lower oxygen levels and the lower oxygen levels are what causes mountain sickness for visitors. Students will model their initial ideas about what they think is different physiologically between people who live in low oxygen environments and those that visit there.

Phenomenon

*Students read a case study about someone who has acute mountain sickness at Everest Base Camp because there are low oxygen levels at higher altitudes.* Students find out that *some human populations have been able to live in these low oxygen environments for thousands of years.*

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<td>• Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.</td>
<td>• Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)</td>
<td>• When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.</td>
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<td>• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level (HS-LS1-2)</td>
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This lesson could be one in a series of lessons building toward the following Performance Expectation(s):

**HS-LS1-2:** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific function within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organisms movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper suction of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

Materials

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Lesson Preparation

Material Prep

- Prepare to share the handouts with students through your school classroom management system or make printed copies.
- Prepare the Driving Question Board. This can be done on a sheet of chart paper or poster/foam board. Set up one board for each class and ensure you can easily put up and take down the boards between classes. For the initial development of the boards, it is suggested that classes do not see the question developed from previous classes; however, once all the boards have been developed, it is appropriate to keep them all in a visible space.

Experience the Phenomenon

What Students Are Doing

In this section, students are introduced to a case study about a person who gets acute mountain sickness while visiting Everest Base Camp, although other human populations have been living at high altitudes for thousands of years.

Teacher Guidance

1. Introduce students to the case study.

   Say “I have an interesting case study about a person who got sick when they went mountain climbing that I thought we could explore together.”

   Display SLIDE 2. Direct students to create a Notice and Wonder chart to record their observations and questions about the case study.

   Present the case study to students by viewing and reading SLIDES 3 THROUGH 9.

   Allow students to share their noticings and wonderings with a partner before asking students to share them with the rest of the class.

Some things students might notice

- Jamie does not live anywhere near Mt. Everest.
- Jamie is known to be very healthy and physically fit.
- Mt. Everest is the tallest mountain on Earth.
- Jamie lives in a location that does not have mountains.
- Jamie has a lot of symptoms.
  - Headache
  - Dizziness
  - Tiredness
  - Shortness of breath
- Jamie does not think they have a cold or any typical illness.
- Jamie did not experience these symptoms until they started climbing.

Some things students may wonder

- Why did Jamie get sick?
- Does Jamie often get sick when visiting new places?
- Is it common to get sick from climbing mountains?
- Does everyone get sick like this climbing Mt. Everest?
- Is this a unique experience that only happens on Mt. Everest?
- What is happening to Jamie’s body that is causing these symptoms?
- Will this happen to me if I climb a mountain?
- Is there some medicine or an inhaler that Jamie could take to get better?
- Does Jamie need to go see a doctor?
- Is this sickness serious?
- Would Jamie get better if they climbed down the mountain?
2. Share additional mountain sickness data.

Say, "There are a lot of questions asking if this happens to other people or if these symptoms are unique to our case study. I had similar questions. I found a study from the National Institute of Health’s (NIH) Natural Library of Medicine that seemed like it had some relevant information. The NIH is responsible for biomedical and public health research. Display SLIDE 10.

Ask students to add to their Notice and Wonder chart as they look at the data from the slide. Then allow students to share additional observations and questions about this illness. If students have personal experience or know someone who has experienced getting sick when traveling at higher altitudes, provide time for students to share these experiences.

Some things students might notice
- People start to have issues once they get above heights of 2,500 m.
- Up to half of people who ascend to heights about 2,500 m develop mountain sickness.
- Mountain sickness can happen within hours or after several days.
- Common symptoms include headache, weakness, fatigue, insomnia, and decreased appetite.

Some things students may wonder
- What type of sickness is mountain sickness? Is it like a cold?
- How do people catch it?
- Is it random who gets this sickness?
- What is causing people to actually get sick?
- What is special about being above 2,500 m?
- Why does it take days for some people to get it, while it can happen to other people in a matter of hours?

Thank students for sharing. Explain that we will be using their noticings throughout the lessons to help them figure out more about mountain sickness.

3. Generate ideas about investigating the medical mystery.

Display SLIDE 11. Say, "Wow we have a lot of great questions. Now we need to do the hard work of figuring out what is going on. What kind of information or data will be needed to figure out what is going on when people get mountain sickness?"

Provide five minutes for students to write their ideas for investigations and necessary data. Meanwhile, create a new poster titled “Ideas for Investigations and Data We Need.” Next, ask students to turn and talk with a partner about their ideas. Finally, facilitate a whole class discussion. As students share their ideas, record them on the poster.

Additional Guidance
- It is important that the public record of students’ thinking is displayed in a shared space where all students can refer to the ideas and questions posted there throughout the storyline.
- Sharing ideas and questions is an important part of the figuring-out process. Making ideas and questions public will allow students to investigate and develop science ideas as a community of learners. Read more about this approach in the Recording Student Ideas Publicly section of the High Altitude Living Storyline Front Matter.
Investigate the Phenomenon

What Students Are Doing
In this section, students investigate their question “How can some people live at higher altitudes while other people get ill visiting these places?” Students will examine the symptoms of acute mountain sickness and connect these symptoms to the lower oxygen levels at higher altitudes.

Teacher Guidance

4. Examine medical forms and body system diagrams in order to make sense of acute mountain sickness.
   Display SLIDE 12. Distribute a copy of the patient medical chart (NIH EV Handout 1.1) along with the body systems handout (NIH EV Handout 1.2). Let students know that when Jamie went to the doctor, the doctor documented all of their symptoms. Tell students that they are going to use the doctor’s notes to figure out what is going on. To help make sense of the symptoms, students should consider how they connect to different systems inside the body. Direct students work with a partner to discuss and map the symptoms from the doctor’s note onto the body systems diagrams.

5. Facilitate a discussion to allow students to share what systems are connected to the symptoms the doctor observed.
   Facilitate a consensus discussion and have students share what systems they think are affected by mountain sickness. The goal of this discussion is to highlight what systems we agree are affected by mountain sickness. Students will use this information to connect to the environment in the next step. Use the following clarifying questions to highlight student findings.

   Suggested prompts
   - What body systems do we agree are being affected by the symptoms of mountain sickness?
   - What evidence from the patient’s symptoms support our ideas?
   - How are these body systems connected to each other?
   - Now that we have identified the affected body systems, what additional information do we need to figure out what is causing these symptoms?

   Listen for:
   - Students might agree on the following affected systems:
     - The respiratory system: Is affected by mountain sickness because the person says they are short of breath.
     - The circulatory system: Is affected by mountain sickness because the person’s symptoms show an increase in heart rate
     - The nervous system: Is affected by mountain sickness because the person’s symptoms indicate they have a headache
   - All of these systems are connected because they all play a role in moving oxygen around the body.
   - We need to see if there is something about the mountain environment that could be causing these symptoms.
How can some people live at higher altitudes while other people get ill visiting these places?

6. **Compare and contrast high altitude environments and environments at sea level.**

   Say, *It seems like we need to understand more about how mountain environments are different from sea level environments. I have a slide that highlights some of the key differences between these environments. Let’s look for conditions in the mountain environment that could be causing the mountain sickness symptoms.* Display **SLIDE 13.** Provide time for students to compare the information on the slide to the map of symptoms on the body systems handout.

7. **Facilitate a discussion to connect acute mountain sickness symptoms with the high altitude environment.**

   Start by discussing environmental differences between high altitude environments and environments at sea level. As students share, have them focus on which of these differences could be causing the mountain sickness symptoms students mapped on the different body systems. Consider using the following prompts to facilitate this discussion.

   **Suggested prompts**

   - What differences did you notice between high altitude environments and low altitude environments?
   - Do you see any connections between any of these differences and mountain sickness symptoms? Can any of the differences explain any of the mountain sickness symptoms? Explain your thinking.
   - What body systems might be affected by low oxygen levels?
   - How else might we refer to high altitude environments if we are trying to explain why people are getting mountain sickness?

   **Listen for:**

   - There are differences in the landscape, the air, and water.
   - Yes, in high altitude environments there is less oxygen in the air. Oxygen is needed or transported by the body systems that were most affected by mountain sickness.
   - The respiratory system and circulatory system are most affected by oxygen, but the nervous system might also be affected based on Jamie’s symptoms.
   - High altitude environments are low oxygen environments.

8. **Introduce students to a population of people that have lived in a high altitude environment for thousands of years**

   Say, *We have figured out a lot about how mountain sickness symptoms are connected to the low oxygen environments in mountains, but as we have been talking about this, I am reminded that there are people who live on mountains. Let’s take a closer look at a population that has lived in these mountains for thousands of years.* Display **SLIDE 14.** Provide time for students to examine the Sherpa population data. Use the following prompts to facilitate a whole class discussion.

   **Suggested prompts**

   - Who lives on these mountains?
   - Do you think most of these people experience mountain sickness? Explain why or why not.
   - What questions do you have about the people who live in these low oxygen environments?
How can some people live at higher altitudes while other people get ill visiting these places?

Listen for:

- Sherpa is a Tibetan ethnic group.
- No, it says that they have been living in these mountains for over 6,000 years. If it was causing them to get sick, they probably would not be still living there.
- How are they able to live in a low oxygen environment while other people are getting sick visiting these places? Or some version of the lesson’s driving question. Let students know that they will continue to investigate this question as well as others on their Driving Question Board throughout the unit.

Additional Guidance

Be careful when introducing the Sherpa population to not essentialize them or their culture. Remind students that while they live on the other side of the world, there are more similarities than differences between all human populations. For additional information to support culturally responsive instruction, consider reading STEM Teaching Tool # 53.

Model the Phenomenon

What Students are Doing

In this section, using knowledge of the body systems affected by a low oxygen environment, students will create initial models about the differences between people who live in these environments and those that get ill visiting them. Students will share their models and create a Driving Question Board to capture questions they have about the populations that are able to live in these environments.

Teacher Guidance

9. Create an initial model to explain how some people can live in low oxygen environments while other people get ill visiting these areas.

Say, Let’s try to develop a model to explain the driving question, “How can some people live at higher altitudes (low oxygen environments) while other people get ill visiting these places?” Display SLIDE 15. Distribute a copy of the Mountain Sickness Model (NIH EV Handout 1.3) to each student. Tell students to put their name on their handout as you may want to collect it at the end of class to get a sense of what they are thinking. Inform students that models allow us to view a system from a different perspective or scale; see the scale prompt below.

Suggested prompts

- How could making a model that allows us to see what is happening inside the body help us explain why some people can survive in low oxygen environments?
- How could including areas where we zoom in to a body part help us figure this out?
- Why is it important to develop two models? One, of a person who gets mountain sickness in a low oxygen environment and another of a person who lives there?
How can some people live at higher altitudes while other people get ill visiting these places?

Listen for:

- Making a model would allow us to show what happens inside the body when there is less oxygen outside of the body.
- Oxygen molecules are really small compared to organs in the body. Having zoom-in bubbles could allow us to show what is happening to the body at different scales (molecular scale, different body organ scale, the whole-body system scale).
- We are trying to make sense of what happens differently in the bodies of people who get sick in low oxygen environments and people who have lived in these environments their whole life.

10. **Students share models in small groups and create a list of similarities and differences.**

Use the Talking Sticks Protocol to give each student 30 seconds to share and explain what their model is showing. Give students another minute to record a list of similarities and differences among all models that were shared. Bring the class together and create a public model of common similarities and differences in student models.

11. **Develop a Driving Question Board.**

Remind students that after we heard about the case study, many of them asked what was going on that caused that individual to get mountain sickness. Can our models or the information we read about body systems and mountain environments help us answer that question?

Listen for:

- Mountain environments have significantly less oxygen than those at sea level.
- Many people who climb mountains get ill because their body has to work harder to get oxygen.
- All of the symptoms of mountain sickness are connected to body systems that require or transport oxygen around the body.

Acknowledge that students have answered part of the lesson’s driving question, but they still can’t explain why some people are able to live in low oxygen environments without symptoms. Ask students if they have any new questions after developing their models.

Give students time to generate their questions individually. Encourage them to generate multiple questions, but tell students that they will be sharing their questions one at a time.

Say, *It is important that we hear everybody’s questions, and we might find that some of our questions are similar to our classmates’ questions. We are going to create a Driving Question Board (DQB) to help us organize our questions so they can guide our investigations.*

- Direct individual students to read their questions to the class and post them to the DQB.
- Ask students if they have related questions. If so, allow them to share how the question is related and post it near the others to create groups of questions.
- Choose another student to share their question.
Sample Student Questions

- Can people just get used to living in low oxygen environments?
- What is different about their body systems that allows people to live in low oxygen environments?
- Would people that live at high altitudes get sick if they came down the mountain?
- How do other organisms that live in the mountains deal with these low oxygen levels?
- Why are certain populations of people able to live in low oxygen environments?
- Does the lifestyle of the people who live in these places help them in low oxygen environments? Are they healthier?
- Are there other people that are able to live in low oxygen environments?
- Is there a genetic reason why some people are able to live in low oxygen environments?

12. Facilitate a classroom discussion to categorize the questions.

Say, We really have identified a lot of great questions! Our next step is to categorize our questions, then think about how we can figure out the answers to our questions.

- Place students in groups and ask them to think about how to organize the questions into categories.
- Next, ask groups to think about how they can figure out the answers to their questions.
- Ask groups to share their thoughts and suggestions for investigations with the class.
- Capture the investigation ideas on a separate piece of chart paper, the board, or a digital document.

Say, We have a lot of great ideas about how to continue our investigation! Based on our discussion, we have figured out the following:

- High altitude locations have oxygen levels that are up to 40% less than those at sea level.
- Humans need oxygen for cellular respiration, so reduced oxygen can lead to dizziness, fatigue, loss of energy, shortness of breath, loss of appetite, or sleep problems.
- Some people are able to live in high altitude areas with low oxygen.

However, it seems like we have some confusion about what is different between people who live in low oxygen environments and people who get ill visiting these areas, and it looks like we need more information about the following questions:

- What is different about their body systems that allows people to live in low oxygen environments?
- Why are certain populations of people able to live in low oxygen environments?
- Can people just get used to living in low oxygen environments?

Additional Guidance

- For more information about developing an initial model, consult the Developing an Initial Model section of the High Altitude Living Storyline Front Matter.
- For more information about developing a Driving Question Board, consult the Driving Question Board section of the High Altitude Living Storyline Front matter.