

## Investigating the Effects of Hypoxia

Companion Lesson to X-STEM All Access Episode "[Hypoxia & Aerospace Physiology](#)"

<b>Grade/ Grade Band:</b> 9-12	<b>Topic:</b> Hypoxia	
<b>Brief Lesson Description:</b> Students discuss the challenges pilots face at high altitudes, investigating incidents of hypoxia.		
<b>Performance Expectation(s):</b> <b>HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.</b>		
<b>Specific Learning Outcomes:</b> Students will apply knowledge of hypoxia to create a lung model and explain how reduced oxygen levels affect the body		
<b>Narrative / Background Information</b>		
<b>Prior Student Knowledge:</b> Students must know and understand the human respiratory system and circulatory systems. Students should understand how altitude can impact the human body.		
<b>Science &amp; Engineering Practices:</b> <b>Developing and Using Models</b> Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). <ul style="list-style-type: none"> <li>Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (<a href="#">HS-LS-1-2</a>)</li> </ul>	<b>Disciplinary Core Ideas:</b> <b>LS1-A: Structure and Function</b> 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. ( <a href="#">HS-LS-1-2</a> )	<b>Crosscutting Concepts:</b> <b>Systems and System Models</b> Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions-including energy, matter, and information flows-within and between systems at different scales ( <a href="#">HS-LS-1-2</a> )
<b>Possible Preconceptions/Misconceptions:</b> Students might think that hypoxia is a rare occurrence and not a significant concern in aviation.		
<b>LESSON PLAN – 5-E Model</b>		
<b>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:</b> Begin the lesson with the questions “ <i>What happens to the body at high altitudes? How might this affect pilots?</i> ” Lead a class discussion about aviation and the challenges pilots face at high altitudes.  Share the video <a href="#">Hypoxia &amp; Aerospace Physiology</a> and the New York Times Article <a href="#">Pilots Kept Losing Oxygen and the Military Had No Idea Why. Now There’s a Possible Fix</a> . by John Ismay from December 27, 2018  Have students write the description of what happens during MSgt Beltran’s training session. (Possible answers include: <b>academics</b> -threats in situational awareness, human performance or human factors, and vision to show visual illusions that may occur in flight; <b>hands-on component</b> - time in an altitude chamber where pilots learn to recognize their hypoxia symptoms so they know how to recover from them; <b>unaided night vision</b> -illustrating loss of peripheral vision and deteriorating loss of vision in the dark to learn the importance of dark adaptation and self-imposed stresses they can control; <b>rapid decompression simulation</b> ; <b>reduced oxygen breathing device</b> (ROBD)  For Teachers content knowledge: <a href="#">The Physiology of High-Altitude Exposure</a> , NIH; <a href="#">How does altitude affect the body and why does it affect people differently?</a> , The Conversation		
<b>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:</b> Collect the following materials prior to lessons (per group) <ul style="list-style-type: none"> <li>4 small plastic baggies</li> <li>4 balloons</li> <li>10 rubber bands</li> <li>8 straws</li> <li>tape</li> </ul> In small groups, instruct students to use their knowledge of the respiratory system to create a model representation of a lung using the materials provided. Students should record an illustration of the model and write a description of how it works.		

Next, ask students to record 2-3 hypotheses about how the model's functionality might change as altitude increases.

**EXPLAIN: Concepts Explained and Vocabulary Defined:**

Explain to students that **hypoxia** refers to low levels of oxygen in your body tissues. It causes symptoms like confusion, restlessness, fatigue, difficulty breathing, blurred vision, nausea, increased heart rate and euphoria.

Ask students, *what is the purpose of oxygen in the human body?* (possible ans.: helps us grow, reproduce, and turn food into energy) and *how does oxygen get into your cells?* (you breathe oxygen into your lungs, and it travels through your airway into the alveoli where it crosses over into the blood cells to be carried throughout the body)?

Tell students hypoxia can happen anywhere along the journey. Lung disease and heart disease increase your risk of hypoxia. Ask students to explain *why lung or heart disease might lead to increased risk of hypoxia* (possible ans., these systems are instrumental to moving oxygen through the body, if they are damaged then less oxygen is transported)?

Next explain that as altitude increases, oxygen level decreases due to the low air pressure. As air rises, the air pressure drops and the air expands making less room for gas molecules, hence there are fewer nitrogen, oxygen, and carbon dioxide molecules. The decreased air pressure means there is less oxygen available for breathing, making the lungs work harder to deliver oxygen to the bloodstream. But with time the body can adjust to the high altitude and low air pressure.

Secure the following materials:

- small poster board, 11x14
- colored paper
- glue/adhesive
- markers

In their small groups, students create a diagram illustrating hypoxia using the lung models created during the explore section of the lesson.

**Vocabulary:**

**Hypoxia-lack of sufficient oxygen in the blood, tissues and cells to maintain normal physiological function**

**ELABORATE: Applications and Extensions:**

Assign each group a scenario involving pilot decision-making under the influence of hypoxia. Have students research and present how hypoxia might impact the pilot's ability to make critical decisions in the given scenario. Each student should submit a brief written report describing the impact hypoxia has on the situation.

Scenarios with possible answers:

- 1. Altitude Misjudgment:** A pilot is flying at a high altitude and starts to experience hypoxia. How does hypoxia affect their ability to gauge altitude accurately, and what decisions might they make in these situations?
  - a. They misjudge their altitude and descend too rapidly, believing they are at a safe altitude because they can experience blurred vision during hypoxia.
  - b. In a euphoric state pilots might not recognize the danger until it is too late to recover.
- 2. Navigation Error:** A pilot is on a long cross-country flight when she becomes hypoxic due to an inadequate oxygen supply. How might hypoxia impact her ability to make decisions regarding navigation and course corrections?
  - a. The pilot may start to lose focus and misinterpret their navigation instruments, leading the plane off-course.
  - b. The pilot could become disoriented because they are feeling fatigued as a result of their hypoxia, making an incorrect navigation decision.
- 3. Emergency Response:** During a routine flight a pilot experiences hypoxia due to a malfunctioning oxygen system. How does hypoxia affect his ability to respond to the engine failure and make critical decisions regarding emergency procedures and landing options?
  - a. Restlessness is a symptom of hypoxia; the pilot may not accurately read the instruments and understand that there is engine failure.
  - b. They might not respond quickly or effectively to execute the emergency procedures because they are experiencing euphoria, or they are fatigued.
- 4. Weather Changes:** A pilot flying at a high altitude encounters unexpected severe weather conditions, including turbulence and icing. Hypoxia sets in, what are some decisions they might not make accurately in these situations?
  - a. The pilot may be feeling an increased heart rate as a result of hypoxia, and they may not be able to recognize the turbulence and therefore they are unable to identify the best course of action.
  - b. The pilot may not accept the severity of the weather conditions and continues the flight as planned.
  - c. Because hypoxia may cause confusion the pilot might not consider diverting to an alternate or closer airport during an ice storm or inclement weather.

- 5. Communication Breakdown:** While flying in a mountainous region over Peru, a pilot experiences hypoxia due to insufficient cabin pressurization. At the same time, they need to communicate with air traffic control (ATC) for weather updates and air traffic. How does having hypoxia impact the pilot's ability to effectively communicate?
- Because hypoxia may cause confusion the pilot may have difficulty articulating their needs or understanding the instructions from the air traffic controller.
  - If shortness of breath is a symptom of their hypoxia, air traffic control might misunderstand what the pilot is saying and end up giving the incorrect advice.

During the discussion, highlight the work that MSgt Beltran does to prepare pilots- like simulations to be able to identify the signs of hypoxia early and develop workarounds based on their symptoms.

**EVALUATE:**

**Formative Monitoring (Questioning / Discussion):** Assess students' understanding of the role oxygen plays in the body during the discussion of the proper training mentioned in the video, their lung model and hypoxia poster diagram

**Summative Assessment (Quiz / Project / Report):** Assess students' understanding of hypoxia and its impact on the human body through their responses to the the scenarios

**Elaborate Further / Reflect: Enrichment:** Students research colleges and universities with aeronautical and aviation programs and create a summary profile of the school and the program

Or students can research technological devices used to prevent and detect hypoxia in pilots and create a presentation on the technology

**SOCIAL EMOTIONAL LEARNING ACTIVITY**

**CASEL Competency: RESPONSIBLE DECISION-MAKING**

MSgt Beltran is all about responsible decision-making, from her 4-year career plan to training pilots to being prepared in case of an hypoxia event. She knows the importance of making caring and constructive choices about personal behavior and social interaction and that it requires open-mindedness, reasoned judgements, and anticipating and evaluating the consequences of one's own actions.

**The Decision-Making Adventure** is an opportunity to practice decision-making skills. In this activity students listen to a problem and weigh the pros and cons before making and announcing their decision. Remind students the keys to making good decisions are:

1. Define the problem- What is the problem? In your own words describe the problem in your scenario.
2. Explore options- What are 3 possible options for solving the problem?
3. Consider consequences- What are the potential consequences of each option?
4. Identify values- Which values or principles are most important in this decision?
5. Decide and act- What should you do? Make your decision based on the values and consequences discussed.
6. Evaluate the results- Reflect on the decision, was it responsible? Why or why not?

**Prepare for game:**

Materials (per group)

- 11"x14" sheets of paper
- marker
- die
- index cards (1 per student)
- coin/chip (1 per student)

Set-up

- have students write a problem they are facing on the index card or create scenario cards\* in advance
- have students create the game board on the 11x14 sheet of paper with a path consisting of spaces, each space represents a step in the **DECIDE** model (**D**efine, **E**xplore, **C**onsider, **I**dentify, **D**ecide, **E**valuate)

Directions

In small groups, students will take turns rolling a die and moving their game piece (coin/chip) along the path. When they land on a space, they must answer the question related to the step of the decision-making process (see above for questions). Conduct a class discussion on the Decision-Making Adventure, asking students to share insights and lessons learned.

\*Scenario Examples

**Academic Challenge-** You've been struggling in your advanced math class. Your teacher has offered you an opportunity to drop the class and switch to a standard math course, however, you fear that this decision might affect your college prospects. What should you do?

**Social Dilemma-** You've been invited to a party by your close friends. When you arrive you notice people are drinking alcohol and eating laced brownies. You value the friendship, but also are aware of the impact of addiction and want to make responsible choices. How do you

handle this situation?

**College Acceptance-** You have received acceptance offers from a couple of colleges, each with different financial aid packages. One college offers a full scholarship, while the other, your dream school is providing a limited financial aid package. How do you decide which college to attend?

**Extracurricular Challenge-** You’ve been offered a part-time job that pays well, but it conflicts with your involvement in the school club/sport that you’re extremely passionate about. The job could provide financial independence, but your commitment to the club/sport could help you earn a scholarship or internship in the near future. What’s your choice, part-time job or extracurricular activity?

**Ethical Dilemma-** You discover that a friend is cheating on a crucial exam. You value honesty and academic integrity which are a part of the school’s motto “*Probitas, Integritas, Perseverantia*”. The teacher asks the class to share what they know about the cheating situation. What actions should you take, and how do you approach your friend about this situation?

**INTERDISCIPLINARY CONNECTIONS/IDEAS**

**SL.11-12.5** Make strategic use of digital media (e.g., textual, graphic, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence to add interest.

Materials Required for This Lesson/Activity	
Quantity	Description
per student	Laptops
per group	Small plastic sandwich baggies, 4
per group	balloons, 4
per group	rubber bands, 10
per group	straws, 8
per group	poster board, 11x14
per group	colored paper
per group	markers
per group	glue/adhesive
per group	paper, 11x14
per group	die
per student	coin/chip
per student	index cards



Lesson Created by Stacy Douglas  
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