TEACHER GUIDE
EXPLORE 1A LESSON 16

Food and Agriculture Center for Science Education

Module Questions: *Why are there so many changes to my body during exercise? How does milk help with recovery from these changes?*

What We Figure Out:

We analyze and interpret data from two different studies to figure out that oxygen consumption increases during exercise.

3D Learning Objective:	**Time estimate:**	**Materials:**
Students compare findings in two data sets to determine how exercise changes the amount of oxygen inhaled and used by muscles.	50 minutes	Lesson 16 Student Guide Lesson 16 Student Handout Data Set Wheelchair Athlete Fitness Test Video

Targeted Elements

SEP:	DCI:	CCC:
DATA-H4: **Compare and contrast various types of data sets (e.g., self-generated, archival)** to examine **consistency of measurements and observations.**	**LS2.B-H1:** Photosynthesis and **cellular respiration (including anaerobic processes) provide most of the energy for life processes.**	**SC-H1:** **Much of science deals with constructing explanations of how things change and how they remain stable.**

Directions

Part 1: Our Motivation

USE OF PHENOMENA

Between Lessons 16-20, students will focus on the topic of exercise from the Module Phenomenon. In Lessons 21-22, they will focus on the topic of recovery from the Module Phenomenon. In Lesson 23, they will investigate a related phenomenon. They will return to the Anchor Phenomenon in Lesson 24 and revise their presentations to help their peers understand how milk can help them recover from exercise.

Remind students that they concluded the last lesson by identifying gaps in their explanations describing why heart rate, breathing rate, muscle burn, and fatigue occur during exercise and how milk helps recover from these changes. Ask students to share what some of those gaps were. In student responses, listen for the following ideas:

- We aren't sure why the increased breathing rate and heart rate increased during exercise. Does the body need more oxygen and nutrients during exercise?
- We aren't sure what is happening inside the muscles to make them fatigue and burn.
- We aren't sure how the body makes energy to make the muscles keep moving.
- We aren't sure if there is a connection between energy and the muscles getting tired.

Build off student responses to share that we will now gather evidence on whether the increase in breathing during exercise results in more oxygen getting into the body. Share a few selected questions from the Driving Question Board that align with what students will investigate in the upcoming lesson.

Example student questions or ideas could include:

- Why does body temperature elevate during a workout?
- Why does your body temperature return to normal after it elevates?
- How long does it take body temperature to return to normal after working out?

Students can record these questions on their Lesson 16 Student Guide Part 1: Our Motivation. This will help students understand how this lesson connects to what they were trying to figure out about the Module Phenomenon.

Part 2: Analyzing and Interpreting Data

Share with students that to investigate if the body needs more oxygen during intense exercise, they will analyze the methods and data from two scientific studies that asked similar questions. Distribute the Lesson 16 Student Handout Data Set and share that students will compare

the two studies to determine if their setup and findings are similar. Students can record their answers on their Lesson 16 Student Guide Part 2: Analyzing and Interpreting Data.

STUDENT SUPPORT

Students may be unfamiliar and/or curious about how a fitness test can be performed on a wheelchair treadmill. You may want to show a few seconds of the Wheelchair Athlete Fitness Test Video to demonstrate the exercise and technique used in Study 2.

TEACHER SUPPORT

The experimental methods for Study 1 involve the use of a catheter. To help students understand the function of this device, you could ask if any students have donated blood and ask students to explain how the collection process works. You can also explain its function to students. Share that a catheter is any kind of thin, flexible tube inserted into a blood vessel with a needle and syringe. They are used to draw out fluid, such as blood, from the body. A catheter can collect blood samples without the need to reinsert a needle into a vein each time blood is drawn. Scientists can use catheters for the same things when performing investigations and collecting data on how different kinds of nutrients and molecules change in the blood before, during, and after exercise.

CCC SUPPORT

SC-H1: Much of science deals with constructing explanations of how things change and how they remain stable.

In this lesson, students use data that shows oxygen levels begin at a steady state at rest and undergo change in response to exercise. Students should notice that both data sets start with a data point while participants are at rest (stable state), followed by changing levels of oxygen during exercise.

SEP SUPPORT

DATA-H4: Compare and contrast various types of data sets (e.g., self-generated, archival) to examine **consistency of measurements and observations.**

In middle school, students analyze and interpret data to identify similarities and differences in findings. In this unit, students build on this middle school understanding to compare the findings from multiple different studies to determine the consistency of findings, including both measurements (methods) and outcomes (data). In this lesson, students analyze and interpret the data from two studies. They are provided with the methods and data and are asked to compare the two studies to determine if their methods and findings are consistent.

This builds on the INFO-H1 practice they used in Module 2 (Lessons 9 and 11) and again in Module 3 (Lesson 15), in which they analyzed the design and outcomes from single scientific research articles.

Allow students time to analyze the methods of the two experiments and the data presented to determine if the study findings were consistent with each other and to reflect on how the study used the lens of stability and change. As students work, circulate the room to press students' thinking. Ask questions such as:

- How were the two experiments designed? What methods were used? How are the designs similar/different?
- What were the objectives of the two experiments? How are they similar/different?
- How can you use the lens of stability and change to analyze this data? Why does that lens seem helpful for studying how the body responds to exercise?
- How do you think you can determine if the outcomes of the two studies are the same? What should you look for?

CCSS SUPPORT

RST 9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Students compare the findings from one study to another and determine if the findings support or contradict each other.

FORMATIVE ASSESSMENT OPPORTUNITY

Students compare findings in two data sets to determine how exercise changes the amount of oxygen inhaled and used by muscles.

Assessment Artifacts:

- Students' comparison of findings between the two data sets for consistency (Lesson 16 Student Guide, Part 2: Analyzing and Interpreting Data).
- Students' reflection on how stability and change informed the design of these two studies (Lesson 16 Student Guide Part 2: Analyzing and Interpreting Data).

Look Fors:

- Students compare the findings between the two studies and determine if they think the findings are consistent or not (DATA-H4).

- Students describe how oxygen levels in the breath and blood change in response to exercise (LS2.B-H1).
- Students describe how the lens of stability and change can be used to study changes in the body in response to exercise (SC-H1).

Assessment Rubric:

	Emerging	Developing	Proficient
Sample Student Response	Comparison of study findings: The findings were consistent. Stability and change reflection: The scientists measured changes in oxygen during exercise in both studies.	Comparison of study findings: I would say that the findings are consistent with one another. However, only one study measured the changes in blood flow during exercise, so it is not possible to say if that finding is consistent. Stability and change reflection: The scientists in these studies measured how the amount of oxygen in breath and the blood changed as the participants underwent exercise and compared it to the stable state at rest. This is similar to how in previous studies we looked at, the scientists measured body temperature and blood volume during exercise vs. at rest. It seems that scientists study the human body by measuring various factors in the body that change in response to exercise.	Comparison of study findings: Both studies seem to indicate that the amount of oxygen being used and consumed by the participants is greater during exercise than it is at rest, and it is also greater for high-intensity exercise than for low-intensity exercise. I would say that the findings are consistent with one another. However, only one study measured the changes in blood flow during exercise, so it is not possible to say if that finding is consistent. Stability and change reflection: The scientists in these studies measured how the amount of oxygen in breath and the blood changed as the participants underwent exercise and compared it to the stable state at rest. This is similar to how in previous studies we looked at, the scientists measured body temperature and blood volume during exercise vs. at rest. It seems that scientists study the human body by measuring various factors in the body that change in response to exercise.
How to Achieve This Level	Student completes 0-1 out of 3 Look Fors	Student completes 2 out of 3 Look Fors	Student completes 3 out of 3 Look Fors

To Provide Additional Support for Students
Consider the following supports for students as they analyze the data sets:

- Ask students to revisit previous questions on their Student Guide related to the design, methods, and objectives of the two experiments and use these to inform their ideas about whether the findings of the studies are consistent.
- Encourage students to use a more focused approach, such as, "What is similar/different" between the design, methods, objectives, and outcomes of the two studies.
- Hold a class discussion about what it means for two data sets to have similar methods and/or similar outcomes. Build a class definition of what to look for to determine if the two are similar.
- Ask students to return to the scientific studies from Modules 1 and 2 and consider how scientists used the lens of stability and change to design the study and/or design the data collection. Then, directly compare how the studies from Modules 1 and 2 used stability and change to the studies in this lesson.
- Use a more familiar example, such as if students were trying to determine if the same dish from two different restaurants tasted similar or different. Ask students what they would want to know about the restaurant and the people eating the dish. Make an analogy to share that students would want to know if the preparation of the meal (the experimental methods) was similar and if the taste and overall enjoyment of the meal (the outcome of the experiment and what is measured) was either the same or was similar in nature (e.g., scrambled eggs prepared at two different restaurants can have different cooking temperatures, but the diners say the eggs from both places taste the same).
- Engage students in a peer feedback session. Provide students with the Look Fors, and use a protocol such as Tell-Ask-Give or norms such as SPARK. Students can use the Look Fors to provide feedback to each other on how they can improve selected Look Fors in their work.

After students have analyzed the methods and data, hold a whole-class discussion for students to share what they have found. Facilitate the conversation so that students agree that:

- The two studies both measured changes in oxygen levels during exercises of different intensities. One study measured changes in oxygen inhaled, and the other measured changes in oxygen and blood flow entering a leg muscle.
- The patterns in the data of each study were similar. Oxygen inhalation and oxygen consumption by leg muscles increase during exercise. Exercise at higher intensities consumes significantly more oxygen than exercise at lower intensities.
- We looked at how the levels of oxygen changed during exercise and during recovery. We can conclude that many of the factors in the human body that can be measured during exercise change during exercise as compared to a stable state at rest.

After the class discussion, navigate to the next lesson by first reminding students that they are trying to figure out why their breathing rate changed so much during exercise. Ask students to make a prediction based on what they found out in this lesson by asking "If oxygen

consumption in inhalations increases during exercise, leading to more oxygen in the bloodstream, then what would you predict happens to carbon dioxide in exhalations during exercise?"

Use a Think-Pair-Share to have students share a few ideas. Student responses may vary.

1. Students are given time to think independently about their responses.
2. Students find an elbow partner.
3. Students take turns sharing their thoughts with their partner. Each student should be given time to respond.

Acknowledge student responses and share that students will investigate this in the next lesson.