

TEACHER GUIDE

EXPLORE 1 LESSON 26



Module Question: *How does milk help in muscle recovery from soreness induced by intense exercise?*

What We Figure Out:

We figure out that the muscles are composed of cell structures called myofibers. The molecular structure of the myofibers and the filaments within the myofiber help the muscle fiber function. For example, when a muscle contracts, its myofibers slide past each other in a coordinated manner; conversely, when the muscle relaxes, these myofibers slide past each other in the opposite direction. When muscles contract and relax during exercise, they undergo tiny microtears in their structure. These microtears are responsible for the feeling of muscle soreness.

3D Learning Objective:

Students **compare findings in two data sets** to determine how **changes to the structure** of **specialized muscle cells** impact their **function**.

Time estimate:

50 minutes

Materials:

Lesson 26 Student Guide
Lesson 26 Student Handout Weight Lifting Sequence Cards
Lesson 26 Student Handout Data Set
Lesson 26 [Muscle Contraction Video](#)
Lesson 26 [Wrist Contraction Video](#)

Targeted Elements

SEP:

DATA-H4:

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

DCI:

LS1.A-H1:

Systems of specialized cells within organisms help them perform the essential functions of life.

CCC:

SF-H2:

The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and



		used, and the molecular substructures of its various materials.
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Directions



Part 1: Our Motivation

USE OF PHENOMENA

Between Lessons 26-30, students will focus on the Module Phenomenon. In Lesson 31, they will return to the Anchor Phenomenon and create presentations to help their peers understand how milk can help them recover from exercise.

Display the Class Consensus Explanation from Lesson 25. Ask students to identify any gaps in the explanation that they need to figure out how milk helps in muscle recovery from soreness induced by intense exercise. Ask students to share what some of those gaps were. In student responses, listen for the following ideas:

- We think protein in milk has to do with recovery, but we don't know what happens to the amino acids in the bloodstream after the protein in milk is digested.
- We don't know what happens to muscles and/or muscle cells to make them feel sore.

Build off student responses to share that, to help us figure out how proteins help in recovery, it will first help to figure out what happens to muscles when they are sore, so we will now gather evidence on what happens in muscles during exercise to make them feel sore. Finally, point out questions related to proteins and muscles from the Driving Question Board. Share a few selected questions that align with what students will investigate in the upcoming lesson. Example student questions or ideas could include:

- What happens in muscles during or after exercise that makes them need to recover?
- What happens to make muscles feel sore after exercise?
- Why do muscles get sore after exercise?

Students should record these questions on their Lesson 26 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: Obtaining Information About Muscle Contraction

Place students in groups of four and pass out the Lesson 26 Student Handout Weight Lifting Sequence Cards to each group. There are 12 total cards. Each card describes an event in the sequence of lifting a weight and what happens in a person's muscles.

In groups, ask students to sequence the cards to represent the order of events that happens in muscles when a weight is lifted. Students can record the sequence they determine on their Lesson 26 Student Guide Part 2: Obtaining Information About Muscle Contraction.

Allow students time to work to sequence the cards. As students work, circulate the group to support students in their thinking. Ask pressing questions such as:

- What event do you think happens first? Why do you think that?
- What is happening on the cellular level when the weight is lifted?
- What role do specialized cells have in lifting the weight?

After groups have completed sorting their cards, they should summarize what role specialized muscle cells and specialized nerve cells play in lifting the weight. They can record this summary on their Lesson 26 Student Guide Part 2: Obtaining Information About Muscle Contraction.

Hold a whole-class discussion to build a class consensus card sequence. Ask a group to share out which card they thought was first in the sequence and why, and ask the class if they agree or disagree with this choice. If the class disagrees, spend some time discussing the reasoning that each different group must support their idea. Facilitate the conversation to reach an agreement on the first step, then ask a different group to share what card they placed second. Repeat this discussion strategy to reach a class consensus sequence for all the cards. Throughout the discussion, be sure to focus on the role of specialized cells and how they contribute to lifting the weight.

After you build a class consensus card sequence, show the [Muscle Contraction video](#) to the class. As students watch, ask them to record what they find in the video that helps them better understand what they figured out in the card sort. Ask a few students to share what they found. If students share new ideas, add them to the class consensus card sequence.

To help transition to the next part of the investigation, ask students to reflect on what they have figured out so far versus what they still need to figure out to understand what happens during exercise to make muscles sore. They should record their answer for the remaining question on their Lesson 26 Student Guide Part 2: Obtaining Information About Muscle Contraction. In student responses, listen for:

- We have seen the structure of a muscle cell and how it contributes to movement during exercise, but we haven't yet figured out what happens to the muscle to make it sore and weak.



Part 3: Analyzing and Interpreting Data

Next, students will view figures from two scientific journal articles showing how the structure of muscle cells change after two different types of stimulation: intense exercise and electrical stimulation that simulates exercise.

Distribute the Lesson 26 Student Handout Data Set and share that they will now compare and contrast two data sets that scientists have collected when trying to determine what happens to muscles to make them sore and weak. Explain that the two data sets were taken after individuals experienced weightlifting exercise or after electrical stimulation, which is often used to stimulate exercise. Students will compare the findings of these two studies to determine if their findings are consistent and what changes occur to the structure of muscle fiber cells. They should record their answers on their Lesson 26 Student Guide Part 3: Analyzing and Interpreting Data.

TEACHER SUPPORT

If you think your students are unfamiliar with electrical stimulation, you may want to show a short video, such as [this wrist flexion video](#), that demonstrates the technique.

Allow students time to compare and contrast the methods of the two experiments and the data presented. As students work, circulate the room to listen for students' thoughts. Ask pressing questions such as:

- How is the data similar/different? Why are they the same/different?
- 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 has the structure of the muscle fibers changed after exercise/electrical stimulation?
- How do you think you can determine if the outcomes of the two studies are the same? What should you look for?

FORMATIVE ASSESSMENT OPPORTUNITY

Students **compare findings in two data sets** to determine how **changes to the structure** of **specialized muscle cells** impact their **function**.

Assessment Artifacts:

- Students' comparison of the findings of two studies that investigate what makes muscles weak and sore (Lesson 26 Student Guide Part 3: Analyzing and Interpreting Data).
- Students' conclusions that they draw from the two studies (Lesson 26 Student Guide Part 3: Analyzing and Interpreting Data).

Look Fors:

- Students compare the methods by which the two data sets were collected (DATA-H4).
- Students compare the data shown in the two different studies and record what changes they notice to the structure of the muscle cells and if these changes are consistent across studies (DATA-H4, LS1.A-H1).
- Students examine the changes to the structure of the muscle cells and how this impacts their function to lift weight and produce force (LS1.A-H1, SF-H2).

Assessment Rubric:

	Emerging	Developing	Proficient
Sample Student Response	<p>Comparison of Findings:</p> <p>The studies were similar because they both investigated muscle soreness.</p> <p>Conclusion:</p> <p>Muscle soreness is caused by intense exercise.</p>	<p>Comparison of Findings:</p> <p>The methods were similar, but one experiment used human samples, while the other used cells grown in a petri dish. The data that they obtained was similar as well in that both experiments were trying to use microscopy to visualize the changes that might have occurred to the muscle fiber cells after exercise.</p> <p>Conclusion:</p> <p>Muscle soreness and weakness seem to be caused by exercise and changes that occur to the cells of muscles.</p>	<p>Comparison of Findings:</p> <p>The methods were similar, but one experiment used human samples, while the other used cells grown in a petri dish. The data that they obtained was similar as well in that both experiments were trying to use microscopy to visualize the changes that might have occurred to the muscle fiber cells after exercise. The structure of the muscle cells seems to be significantly changed after exercise in both studies. The studies were performed differently because one examined the structure of the muscle fibers after exercise, and one examined changes after electrical stimulation. However, the findings of the two studies are showing the same effect on the muscle fiber cells in that the fibers are disorganized in both cases.</p> <p>Conclusion:</p> <p>Muscle soreness and weakness seem to be caused by exercise that disrupts the structure of the muscle fiber</p>

			cells. Muscle cells undergo microtears that disrupt the structure of the cells, so this likely impacts the function of the cells because the fibers cannot slide properly past each other.
How to Achieve This Level	Student completes 0 out of 3 Look Fors	Student completes 1-2 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 review what they figured out in Part 2 about the structure of muscle cells and how their structure supports their function of lifting weights. Then, ask how what they've observed in these data might impact the function of the muscles.
- Ask students to explain the methods and data presented to identify similarities and differences.
- Hold a class discussion on 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 recall data analysis and comparison strategies that they and the class used in previous lessons.
- 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 compared and contrasted 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 structure of the muscle cells seems to be significantly changed after exercise and after the simulated exercise. The studies were performed differently because one examined the structure of the muscle fibers after exercise, and one examined change after electrical stimulation. However, the findings of the two studies show the same effect on the muscle fiber cells in that the fibers are disorganized in both studies.
- Muscle soreness and weakness seem to be caused by exercise that disrupts the structure of the muscle fiber cells. The structure of the cells has changed significantly, so this likely impacts the function of the cells because the fibers cannot slide properly past each other.

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 findings across multiple data sets to determine if the findings from one data set are consistent with findings from another.

**Part 4: Asking New Questions**

As a final step in this lesson, students will create a new list of questions to help them determine what additional information they need to know to help them figure out how protein helps in muscle recovery. They can write these questions on their Lesson 26 Student Guide Part 4: Asking New Questions. Add these questions to the “Recovery From Exercise” category of the Driving Question Board so they can continue to be referenced in the coming lessons.

To facilitate students asking questions, use the Question Formulation Technique.

1. With their group, students take 5 minutes to brainstorm questions about what they need to know about how dairy foods are created and distributed.
2. Students then look at all their questions and choose the 3-5 questions they think are most important to be answered to help them figure out the Module Question.
3. A representative from each group will then share their prioritized questions with the whole class. As students share their prioritized questions, they will add them to the Driving Question Board.

LOOK FOR

In student responses, listen for the following ideas:

- How do our muscles get back to normal after exercise?
- What are the signals that help muscles recover, and how do they work?
- How does milk help our muscles go back to normal?
- When muscles recover from soreness, do the microtears go away?