

# TEACHER GUIDE

## EXPLAIN LESSON 29



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

### What We Figure Out:

We figure out that muscles move and contract during exercise and that causes microtears. These microtears create skeletal muscle soreness. Satellite cells, immune cells, and protein synthesis are responses that the body must use to help repair the muscle fibers. This brings skeletal muscles back to a stable state.

### 3D Learning Objective:

Students **revise an explanation using multiple pieces of evidence** to show how the body uses **feedback mechanisms to maintain stable internal conditions when those conditions begin to change**.

### Time estimate:

50 minutes

### Materials:

Lesson 29 Student Guide

### Targeted Elements

#### SEP:

#### CEHS-H2:

**Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today**

#### DCI:

#### LS1.A-H1:

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

#### LS1.A-H4:

**Feedback mechanisms maintain a living system's internal conditions within certain**

#### CCC:

#### SC-H3:

**Feedback (negative or positive) can stabilize or destabilize a system.**



as they did in the past and will continue to do so in the future.

limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.

## 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.

Have students individually review the Explanation from their Lesson 25 Student Guide Part 4: Creating and Sharing Initial Explanations. This explanation describes how students answered the Module Question, *How does milk help in muscle recovery from soreness induced by intense exercise?* This individual review is to see what gaps exist in the explanation from what they have learned so far in the module.

#### TEACHER SUPPORT

Additionally, students could use the Class Consensus Explanation from Lesson 25 Part 5: Creating a Class Consensus Explanation if it is still being displayed on the board.

Ask students if these explanations accurately reflect the new evidence they have about muscle repair and recovery mechanisms. Listen for responses such as:

- We didn't identify that muscle soreness is caused by microtears in the muscles.
- We didn't explain how the body has different responses to help the muscles recover and become stable again.

Next, point to the questions on the Driving Question Board related to muscle soreness and recovery. Share a few selected questions that align with what students will investigate in the upcoming lesson. Example student questions or ideas could include:

- How exactly do muscles recover from physical exercise?
- What happens in the muscle during and after a workout?
- What does our body need for muscle recovery?

Students should record these questions and ideas on their Lesson 29 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. Use students' questions to transition to the lesson by sharing that, in this lesson, we will update our initial explanations of the Module Question, *How does milk help in muscle recovery from soreness induced by intense exercise?*



## Part 2: Developing an Explanation of Recovery from Muscle Soreness

Share with students that they will now revise their initial explanation to update their answer to the Module Question, *How does milk help in muscle recovery from soreness induced by intense exercise?* As students work on their Lesson 29 Part 2: Developing an Explanation of Recovery from Muscle Soreness, circulate the room to informally assess their explanations and provide feedback by asking questions about their work.

### FORMATIVE ASSESSMENT OPPORTUNITY

Students **revise an explanation using evidence** to show how the body uses **feedback mechanisms to maintain stable internal conditions when those conditions begin to change**.

#### Assessment Artifacts:

- Students' revised explanations of the Module Question: *How does milk help in muscle recovery from soreness induced by intense exercise?* (Lesson 29 Student Guide Part 2: Developing an Explanation of Recovery from Muscle Soreness).

#### Look Fors:

- Students revise their explanations based on the new evidence they have gathered about mechanisms that help to recover stable conditions in muscles. (CEDS-H2, LS1.A-H4).
- Students use evidence from a variety of sources, including data sets and the Science Theater model (CEDS-H2).

- Explanations include how feedback mechanisms stabilize muscle changes post-workout to return them to a normal state. (LS1.A-H1, SC-H3).

### Assessment Rubric:

	Emerging	Developing	Proficient
<b>Sample Student Response</b>	Exercise makes the muscle fibers get microtears. But then they recover because they use protein to make them stronger, and the cells repair themselves.	<p>When someone does intense exercise, muscles get sore due to microtears occurring in the muscle. This happens when a muscle lifts a weight, for example. The muscle fibers contract after they get a signal from the nervous system and the brain. The muscle fibers experience small tears in them called microtears, which make the muscle fibers damaged.</p> <p>The body has a number of feedback responses it takes to help the body recover from the microtears in muscle fibers and to make the soreness go away. Immune cells move through the bloodstream to the site of the muscle microtears. Immune cells help clear away damaged cells and reconstruct new muscle fiber cells. Satellite cells in the muscle fibers are also activated; these cells move into the area of the damaged muscle cells and undergo cell division to differentiate into new muscle fiber cells.</p>	<p>When someone does intense exercise, muscles get sore due to microtears occurring in the muscle. This happens when a muscle lifts a weight, for example. The muscle fibers contract after they get a signal from the nervous system and the brain. The muscle fibers experience small tears in them called microtears, which make the muscle fibers damaged. We saw evidence of this when we saw in the research study by R M Cramer 2007 that under a microscope, the muscle fibers looked highly structured and organized before exercise, then, after exercise, their structure was really changed and distorted.</p> <p>The body has a number of feedback responses it takes to help the body recover from the microtears in muscle fibers and to make the soreness go away. Immune cells move through the bloodstream to the site of the muscle microtears. Immune cells help clear away damaged cells and reconstruct new muscle fiber cells. Satellite cells in the muscle fibers are also activated; these cells move into the area of the damaged muscle cells and undergo cell division to differentiate into new muscle fiber cells. We have evidence of this from the research study Masschelein 2020 where scientists observed that the green-stained satellite cells would move into the area with the damaged muscle cells. Finally, the muscle cells themselves increase their rate of protein synthesis, which uses the amino acids in the bloodstream (from the digestion of proteins in milk) to</p>

			help rebuild muscle proteins such as the actin and myosin proteins in the muscle fiber cells. We saw that in the Cameron J, 2015 study that the amount of muscle protein synthesis went from 0.02 %/hr to above 0.05%/hr after drinking a protein recovery drink after exercise.
<b>How to Achieve This Level</b>	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:

As students work in groups, approach each group to look at their work. If students need additional support in developing their explanations, consider:

- Asking the following questions:
  - What evidence from the previous lessons did you find to add to your explanation?
  - What new ideas did you add to your explanation? What are you trying to describe?
  - How is stability defined and described in your explanation? How will that help us explain feedback mechanisms in body systems?
- Providing students with time to organize the evidence they found, come up with a list of evidence as a class, and discuss which pieces of evidence are most relevant, explaining how our muscles recover after exercise.
- 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.



### Part 3: Revising the Effects of Exercise and Recovery Models

Ask students to reorient to the Driving Question for the unit, ***How can milk help athletes recover from physical exercise?*** Share with students that they will now collect their ideas about 1) what changes happen to the body during exercise, and 2) how the body recovers from exercise with the help of milk into the two class models the class will continue to revise throughout the unit. Share with students that they can take the explanations they wrote in Part 2 of this lesson to help inform how to build these models. Allow students time to write their ideas for revision on their Lesson 29 Student Guide Part 3: Revising the Effects of Exercise and Recovery Model.

**TEACHER SUPPORT**

Here, students should be adding on to the Class Consensus Models from Lesson 23, which should be displayed as large murals on a class wall or saved digitally for projection for the entire class.

Hold a whole-class discussion in which the class adds to the two existing Effects of Exercise and Recovery Models. Walk students through the class consensus discussion steps below so they can create the Class Consensus Models.

1. Each group should select one or more reporters to share one part of their explanations to add to the models. Have the first group share one idea to add to the consensus models. This can be one component, arrow, relationship, or any other feature the group wants to select.
2. The next reporters can agree with, disagree with, or revise parts of the model that have already been added, or they can add new parts. Continue this process until both of the full Class Consensus Models are fully built.
3. As students share, some strategies you can use to help the class build the consensus model are:
  - a. Helpful sentence starters such as:
    - i. We agree with \_\_\_\_\_'s group, and we also want to add \_\_\_\_\_.
    - ii. We disagree with \_\_\_\_\_'s group because \_\_\_\_\_
    - iii. We would like to change \_\_\_\_\_ because (evidence).
  - b. Use discussion prompts such as asking the class:
    - i. Is there anything else that needs to be added to this component before we move on?
    - ii. How does this idea fit with what is currently on the model?
    - iii. What new body systems are we introducing? Which organs are included in these systems?
    - iv. How are we showing the movement of matter in this model? The movement of energy? How are milk nutrients shown in this model?
    - v. What specialized cells are a part of this organ, and what are their functions?

As you are building the class model, if you find disagreements, follow these steps to help resolve the disagreement:

1. Summarize the two sides of the disagreement.
2. Ask the students to pause and reflect on their reasoning to be on that side.
3. Prompt students to again re-discuss the area of disagreement.
4. If students still disagree, suggest that we can represent areas of disagreement on the class model with question marks or other annotations of uncertainty.

**CCSS SUPPORT**

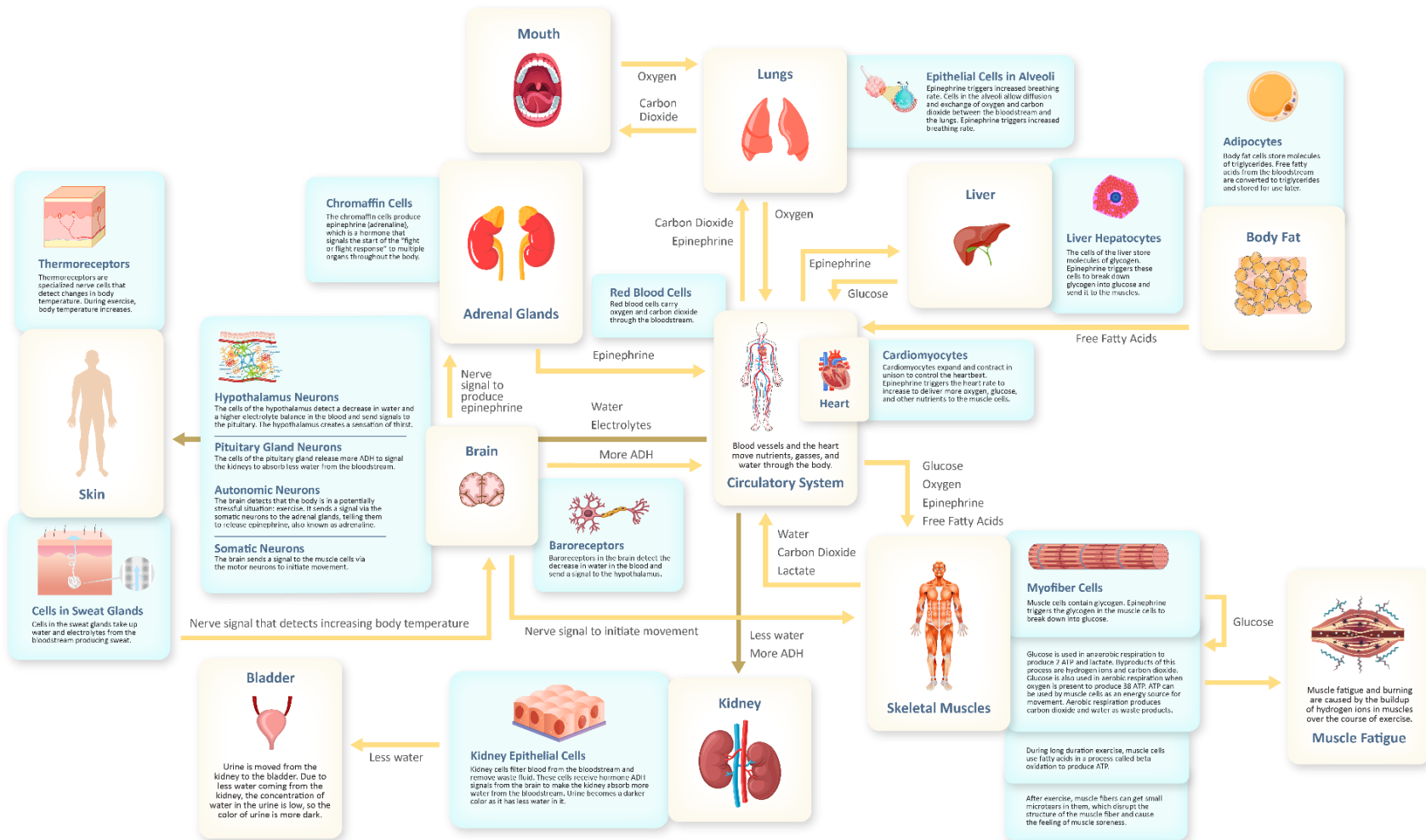
**SL 9-10.1(d):** Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.

Because student explanations may differ, it is important to emphasize that the revisions to the model are being made based on evidence. You may want to ask students to discuss the difference between evidence vs. opinion when discussing what components to include in the Class Consensus Models.

The following pages show an example of what the Class Consensus Models may look like, though you will want to follow the ideas of your class rather than drive them to this exact model.

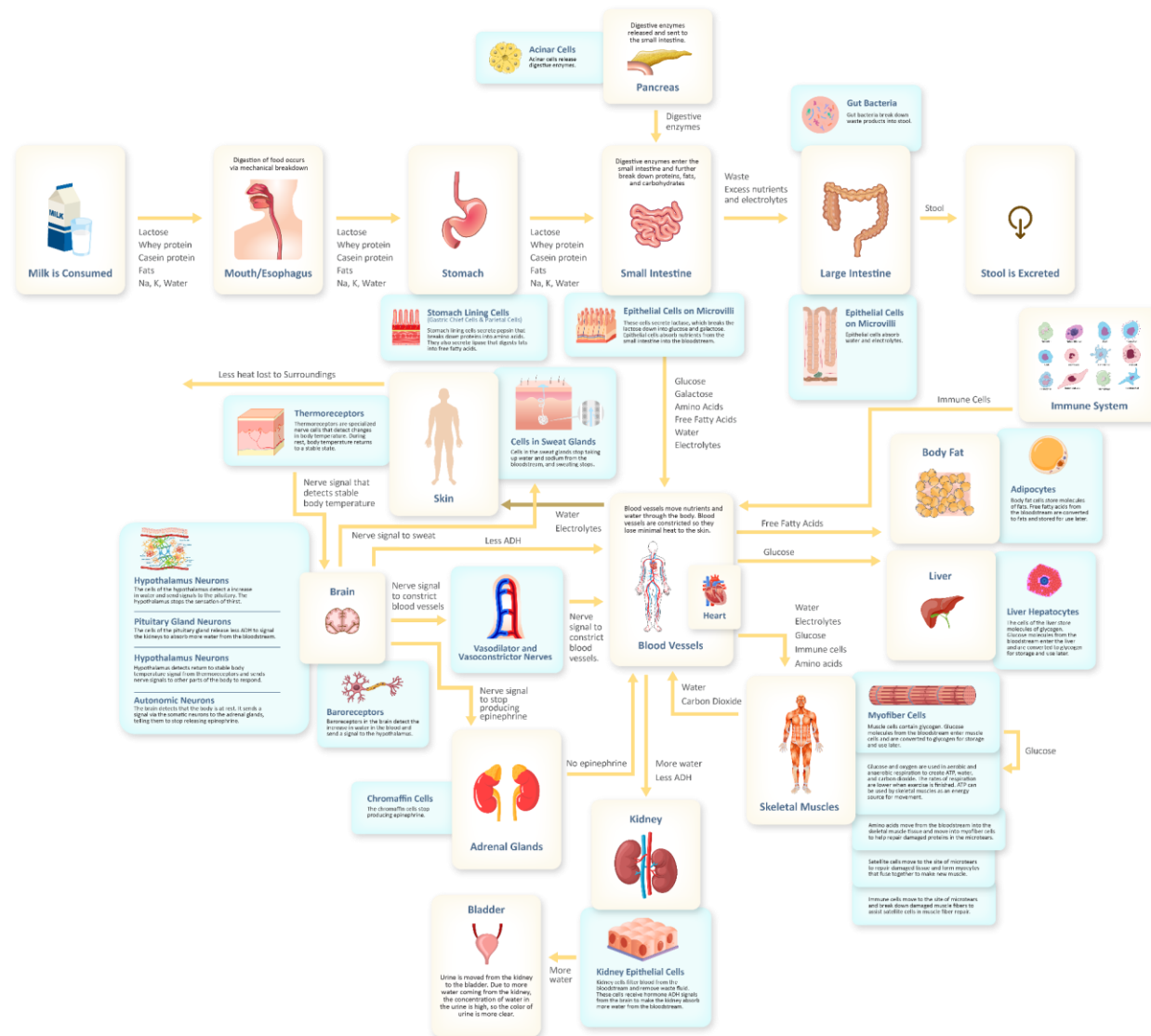
**Example Class Consensus Model**

## Effects of Exercise Model





## Recovery Model





## Part 4: Asking New Questions

As a final step in this lesson, students will create a new list of questions that can help them determine what additional information they need to know to help them figure out more about muscle repair and recovery. They can write these questions on their Lesson 29 Student Guide Part 4: Asking New Questions. Add these questions to the “Exercise and the Body” 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 sweat, thirst, urine, and exercise.
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:

- We are still curious how some people “build” muscle from exercising.
- Why are proteins important to muscle growth?
- How do we get stronger from exercise rather than just build the muscle cells back as they were before?