

TEACHER GUIDE

ELABORATE LESSON 30



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

What We Figure Out:

We figure out that when muscles recover from exercise, they also become larger and stronger in the process. This happens through the release of several molecules called growth factors that send growth signals to the muscle cells. The process of the body increasing its strength in response to exercise is known as adaptation because the body adapts to the stress placed on it. The body also has several additional adaptations to exercise, such as increased lung capacity, cardiac output, and capillary density.

3D Learning Objective:

Students **summarize the central ideas from scientific literature** to describe how **specialized cells contribute to changes in the size and function of muscles as they adapt to exercise.**

Time estimate:

50 minutes

Materials:

Lesson 30 Student Guide
Lesson 30 Student Handout Data Set
Lesson 30 Student Handout *How Do Muscles Grow?* Article

Targeted Elements

SEP:

INFO-H1:

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a

DCI:

LS1.A-H1:

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

CCC:

SC-H1:

Much of science deals with constructing explanations of how things change and how they remain stable.



text by paraphrasing them in simpler but still accurate terms.

Directions



Part 1: Our Motivation

Return to 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:

- How do satellite cells contribute to making our muscles stronger after we exercise?
- How do we get stronger after exercise?
- Does the recovery process help muscles get stronger after exercise?
- Do proteins from milk help you get stronger?

Students should record these questions on their Lesson 30 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 or about the remaining questions they have had that arose in the module.



Part 2: Observing a New Phenomenon

Share with students that they will now observe a new phenomenon to help them figure out if and how muscles could get stronger after exercise. Distribute the Lesson 30 Student Handout Data Set and share with students that they will now analyze three pieces of data from a scientific journal article in which scientists studied the changes to muscles that took place after two different kinds of workouts: an endurance workout and a resistance training workout. Share with students that they should record what they notice about the changes in muscles that occur in each piece of data on their Lesson 30 Student Guide Part 2: Observing a New Phenomenon.

Allow students time to analyze the data presented. As students work, circulate the room to press students' thinking. Ask questions such as:

- What were the objectives of the three different experiments? How are they similar/different?
- What changes do you notice to the muscles in each figure?
- Do you think the outcomes of the three studies are similar?

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:

- In each of the studies, resistance training produced a greater change to the muscles. The muscles that experienced resistance training had a greater increase in muscle fiber size, muscle size, and muscle strength compared to changes that occurred in muscles after endurance exercise.

After agreeing on their observations from the video and data set, introduce the questions students will investigate in this lesson, “*How do muscles increase their size and strength in response to resistance exercise? How can milk help with this process?*” Allow time for students to write these questions on their Lesson 30 Student Guide Part 2: Observing a New Phenomenon.



Part 3: Obtaining Information from Scientific Texts

Share with students that they will gather evidence from a scientific text to help figure out how the body’s muscles increase in size after exercise and how they get stronger. Students will read the Lesson 30 Student Handout *How Do Muscles Grow?* article. Instruct students that they will read the text and try to choose and summarize three central ideas from the text that best help answer the investigation questions. Students can write these summaries on their Lesson 30 Student Guide Part 3: Obtaining Information from Scientific Texts.

Allow time for students to read the text to find and determine which central ideas they will choose to record and summarize. As students work, circulate the room and ask pressing questions such as:

- Why did you choose this as a central idea? How does it help answer our investigation questions?
- What changes does the text say are occurring to the muscle cells as they recover and grow larger/stronger?

FORMATIVE ASSESSMENT OPPORTUNITY

Students **summarize the central ideas from scientific literature** to describe how **specialized cells contribute to changes in the size and function of muscles as they adapt to exercise.**

Assessment Artifacts:

- Evidence from a scientific text to help figure out how the body’s muscles increase in size after exercise and how they get stronger gathered by students. (Lesson 30 Student Guide Part 3: Obtaining Information from Scientific Texts).

Look Fors:

- Students choose three central ideas from the text and summarize/paraphrase them in simpler but still accurate terms (INFO-H1).
- Students describe how changes to the muscle cells can occur, including what molecular changes cause observable changes to muscle size and strength (LS1.A-H1, SC-H1).

Assessment Rubric:

	Emerging	Developing	Proficient
Sample Student Response	Resistance training leads to microtears in muscle cells. Satellite cells and protein synthesis contribute to muscle growth and adaptations, such as muscle growth.	Resistance training leads to microtears in muscle cells <ul style="list-style-type: none"> • Cells in the muscle change due to the microtears. Satellite cells contribute to muscle growth <ul style="list-style-type: none"> • Muscle fibers grow in size because the satellite cells help them. Protein synthesis is helpful in muscle growth <ul style="list-style-type: none"> • Muscle growth occurs whenever protein synthesis occurs. Adaptations such as muscle growth take time <ul style="list-style-type: none"> • It can take several weeks or months for hypertrophy to occur with consistent resistance exercise. 	Resistance training leads to microtears in muscle cells <ul style="list-style-type: none"> • When muscles undergo intense exercise, as from a resistance training bout, the muscle fibers undergo microtears. • The microtears activate satellite cells in the muscle. • Satellite cells multiply and fuse to muscle fibers to form new muscle fiber strands. Satellite cells contribute to muscle growth <ul style="list-style-type: none"> • Growth factors such as hepatocyte growth factor, and insulin-like growth factor stimulate satellite cells to produce gains in muscle fiber size. Protein synthesis is helpful in muscle growth <ul style="list-style-type: none"> • Muscle growth occurs whenever the rate of muscle protein synthesis is greater than the rate of muscle protein breakdown. • Growth hormone and testosterone can increase the uptake of amino acids into muscles. • Exercise stimulates protein synthesis for up to 24 hours after the workout. Adaptations such as muscle growth take time <ul style="list-style-type: none"> • It can take several weeks or months for hypertrophy to occur with consistent resistance exercise. • Muscle growth from resistance exercise could slow or reverse the muscle loss that occurs due to aging.

How to Achieve This Level	Student completes 0 out of 2 Look Fors	Student completes 1 out of 2 Look Fors	Student completes 2 out of 2 Look Fors
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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 finding central ideas in the text, consider:

- Using a partner-reading protocol, such as a Read-Aloud-Think-Aloud, to have students unpack the text together.
- Redirecting students' attention to parts of the article they may have missed or overlooked.
- Providing a text annotation strategy for students to help students read and process the text.
- Having students record terms they are uncertain of and having the class build definitions for these terms together.
- 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.

TEACHER SUPPORT

The first several paragraphs of this text describe the mechanisms by which muscle fibers undergo damage during resistance exercise and how they recover from this damage. This content should be a review for students from Lessons 25-29 and can serve as a helpful summary of these processes for students who may have previously struggled.

After students have completed their reading and recorded central ideas from the text, use a sharing routine such as a Mingle-Pair-Share Routine for students to share the different central ideas they have found with their peers. Students should record additional central ideas they hear from their peers during this time.

1. Students will move around the classroom and find a peer who is not a part of their usual group.
2. Students will take turns sharing their explanations.
3. Students will then find a new peer and share their explanations once again.

After students have finished the sharing protocol, hold a whole-class discussion for students to share what they found. Facilitate the conversation so that students agree on the following key ideas from the article:

- When muscles undergo intense exercise, as from a resistance training bout, the muscle fibers undergo microtears.
- The microtears activate satellite cells in the muscle.

- Satellite cells multiply and fuse to muscle fibers to form new muscle fiber strands.
- Growth factors such as hepatocyte growth factor and insulin-like growth factor stimulate satellite cells to produce gains in muscle fiber size.
- Muscle growth occurs whenever the rate of muscle protein synthesis is greater than the rate of muscle protein breakdown.
- Growth hormone and testosterone can increase the uptake of amino acids into muscles.
- Exercise stimulates protein synthesis for up to 24 hours after the workout.
- It can take several weeks or months for hypertrophy to occur with consistent resistance exercise
- Muscle growth from resistance exercise could slow or reverse the muscle loss that occurs due to aging.

Build off student responses to confirm that the size of the muscles and muscle cells can increase in response to exercise due to the action of molecules called **growth factors**. The name of the process by which the body changes in response to a new stimulus, such as lifting a heavier weight than usual, is called an **adaptation**. The body undergoes adaptations so that, if it encounters the stimulus again, it is more prepared to handle the stimulus. In other words, the muscles will be more prepared to lift the heavier weight the second time.

STUDENT SUPPORT

Consider asking students what other kinds of adaptations their body goes through when faced with a stimulus, including both exercise and other stimuli. Examples of additional exercise adaptations include improved cardiorespiratory fitness and improved mood and cognition.

Examples of adaptations to other stimuli might include their skin color becoming more tan when exposed to the sun, sensory adaptations such as encountering a strong smell or sound and the smell or sound becoming less intense over time, or pupils dilating or constricting in response to light conditions in a location.

Note that the body can adapt to some stimuli quickly and others more slowly. Some of these examples require less time for the body to adapt, and others require more time. Muscular adaptations to resistance training are an example of the latter.



Part 4: Constructing an Explanation

Share with students that they will now create an explanation for the questions they set out to investigate: “*How do muscles increase their size and strength in response to resistance exercise? How can milk help with this process?*” Students should record their explanation on their

Lesson 30 Student Guide Part 4: Constructing an Explanation. As students work, circulate the room to informally assess their explanations and provide feedback by asking questions about their work.

Hold a whole-class share out for students to share their explanations with each other. Facilitate the conversation so that students agree that:

- Muscles grow in size when being repaired from the microtears that occur. The muscles undergo an adaptation to increase their size to be prepared to lift the weight if it is encountered again. Molecules called growth factors help the muscle cells grow. The growth factors stimulate additional protein synthesis and stimulate additional satellite cell activity to help the muscle cells repair and grow. Amino acids from milk can help to encourage further protein synthesis in the muscle cells.

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.