STUDENT GUIDE EXPLORE 2 LESSON 27



Part 1: Our Motivation

Record what we were trying to figure out that led to this investigation.

- Do amino acids help in muscle cell recovery?
- How do proteins in milk help with muscle recovery?
- What other body systems play a role in muscle recovery?
- Is muscle recovery a form of homeostasis?
- How does milk help repair muscle damage?

We figured out what makes muscles sore after exercise, but we haven't yet figured out how they recover.

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Part 2: Analyzing and Interpreting Data

Choose a data set to analyze to determine how the body responds when muscle cell fibers are damaged as a result of intense exercise. The data set options are:

- Rates of Protein Synthesis
- Response of Satellite Cells
- Inflammation Response

Review the experiments conducted by scientists in the two studies on changes in the body after consuming protein/exercising. Analyze the data sets provided to determine their findings and if the findings are consistent with one another.

Example Student Response - Data Set A: Rates of Synthesizing New Muscle Proteins

<u>Study 1:</u>

Scientists had a group of men drink two different kinds of protein shakes and took samples of their muscle tissue at different times before and after drinking the protein shakes. They measured the amount of protein synthesis occurring in the cells of the muscle biopsies at different times. The data shows that following ingestion of both milk protein and whey protein, muscle protein synthesis rates increased. I think this is what the muscle cells do to help repair themselves.

Study 2:

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Page 2

amount of protein synthesis occurring in the cells of the muscle biopsies at different times. The data shows that after exercise, rates of protein synthesis in both men and women increase. It also shows that the rates of protein synthesis increase after exercising and consuming 25 g of protein the next day. I think this helps bring the muscle cells back to a more stable state because the damaged muscle proteins are being repaired.

Are the Findings Consistent?

The first study showed WMP was a little more effective than whey protein. The second study only looked at whey protein and compared men to women. FSR increased above the resting rate for all. Men's and women's rates reacted differently at different times. It wasn't obvious if there was more of an advantage for one sex or the other.

Both studies showed that drinking protein drinks (at least for healthy people) increases the rate of FSR above rest. They both showed that FSR remains increased for at least 210 minutes after in one and 28 hours in the other. I would say that these findings are consistent with one another.

Example Student Response - Data Set B: Rates of Synthesizing New Muscle Proteins

<u>Study 1:</u> A sample of people completed leg exercises and had muscle biopsies taken before exercise, G hours after exercise, and 24 hours after exercise. They then analyzed the muscle biopsies to determine how many active satellite cells were in the muscle. The amount of satellite cells that were measured to be present in muscle fibers increases 24 hours after exercise.

<u>Study 2:</u> Scientists had mice run on treadmills, either doing an easy run or a hard run. They killed the mice and took samples of their muscles. They looked at the muscles under a microscope to determine if satellite cells were present in the muscles. In the three different muscles sampled, more satellite cells were detected in the muscles when the mouse took part in the intense exercise.

Are the Findings Consistent?

Comparing and contrasting the two studies, the findings are consistent in showing that resistance exercise increases the number of satellite cells in the active muscles over time in animals. Study 2 was longer term, and we can't see results in numbers, just pictures. Study 1 showed effects at 6 hours post-workout and 24 hours post-workout in humans. Study 2 showed greater amounts for mice who exercised and even more for those who exercised with resistance for mice after eight weeks. Study 1 looked at age and sex, but Study 2 did not. Both of the studies showed that satellite cells are more active in the muscle cells after exercise, so 1 think the results of the studies are consistent with one another.

Example Student Response - Data Set C: Inflammation Response

<u>Study I:</u>

Scientists had mice run on treadmills until fatigued, which was judged by the refusal of the mouse to continue moving on the treadmill belt for more than 10 seconds. Blood samples were taken from the mice and analyzed for their total numbers of three different types of leukocytes. The total number of neutrophils, monocytes, and lymphocytes in the blood increased after exercise.

<u>Study 2:</u>

Scientists took ten well-trained male runners and had them run downhill on a treadmill at a gradient of 10% for 45 min at 60% VO2max. Their blood was sampled immediately before (PRE) and after (POST), 1 h (1 h POST), and 24 h (24 h POST) after exercise. Blood samples were analyzed for the number of leukocytes and neutrophils present. The total number of leukocytes and neutrophils in the blood increased after exercise.

Are the Findings Consistent?

Comparing and contrasting the two studies, the things that were measured in both studies were the changes in the number of white blood cells in the blood between rest and at intervals after a workout in animals (mice for 1 and humans for 2). Both studies looked specifically at neutrophils and were pretty consistent. The numbers were higher at 6 and 12 hours. The slight difference between the two is that for mice, the number was still higher than baseline at 24 hours, but it looks like the human numbers had returned to baseline by then. Even though the studies were performed in different organisms, rats and humans, they both seemed to show that more cells of the immune system were present in the bloodstream after exercise.

Record the findings of your peers when you meet with them or during the whole-class share-out.

Rates of Protein SynthesisResponse of Satellite CellsInflammation Response	Rates of Protein Synthesis
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These studies indicated that protein synthesis increases in the muscles after consuming protein.	These studies showed that satellite cells, which fuse with muscle cells, are more active in the muscle cells after exercise.	These studies show that more cells of the immune system were present in the bloodstream after exercise.

Part 3: Asking New Questions

What new questions do you have that you think can help us make progress towards answering the Module Question, *How does milk help in muscle recovery from soreness and weakness induced by intense exercise?*

- Why does our body need to make more proteins in protein synthesis after we exercise?
- What do satellite cells do when they fuse to the muscle cells?
- How do the immune cells help the muscles to recover?