

**BIO 131 PAL**  
**Week 6 - PROBLEM SET 2**

**Don't overdo it!**

**A Case Study Exploring Muscle Physiology by Larissa Eiselein**

**Part I – Moving in**

Cathy recently bought a new house and has finally begun to settle in. Her only grievance is the backyard. It still needs a lot of work! Luckily Cathy has inherited the green thumb and handy-gene from her father, so she decides to stop complaining and get to work. She draws out a sketch on a napkin while she sips some coffee. Then she heads to the home-improvement store and spends several hours acquiring the necessary materials. For the ---th time, she is glad to have listened to her dad's advice to get a pickup truck. She helps the man from the store load big boulders, concrete blocks, a pick, shovel, piping for a drip system, and an assortment of small and large plants onto the bed of the vehicle and silently wonders how she will unload all the stuff by herself when she gets home.

**Questions:**

- 1. Draw an EMG comparing muscle contraction when Cathy lifts a boulder by herself compared to when she is lifting it together with the man from the store. What does an EMG measure?**
- 2. Indicate how contraction force of the biceps changes when lifting a small plant, medium sized plant, and large plant. How is this accomplished - that is, what factor(s) influence(s) how forcefully a skeletal muscle can contract?**
- 3. Draw a graph indicating how intracellular Ca<sup>++</sup> levels affect the force of contraction of a skeletal muscle fiber.**
- 4. Draw a graph indicating the amount of actin/myosin overlap in a muscle fiber for increasing intracellular Ca<sup>++</sup> concentration. Then differentiate between a twitch, summation, and tetanus.**

**Part II – Yard Work**

Cathy is hard at work for the next several days. On day one she spends a lot of time tilling the ground with a machine she borrowed from her neighbor and digging out trenches for her drip system. Towards the end of the day she notices soreness in her chest and both of her arms. "Nothing a good night's rest can't fix", she surmises and heads for the shower and bed.

The next day, she wakes up unable to lift her arm above her head and has to grab a button-up blouse, forgoing her "yard work-sweater", since the blouse is easier to put on. But she is not discouraged. The work needs to get done before her summer break is over. Once she starts working at her new job, she will most likely not have time to worry about the yard. "I'm sure once I get going, my muscles will loosen up", she tells her cat and then scarves down a quick breakfast.

Today Cathy is busy digging many large holes in the ground to plant the trees and shrubs she bought. About midday, Cathy notices that while carrying a big bag of fertilizer her arms begin to shake uncontrollably. Cathy puts down the bag and rubs her sore muscles. "I can do this!", she tells herself and pushes on well into the evening.

#### **Questions:**

- 1. What is asynchronous recruitment? What causes the shaking of Cathy's muscles?**
- 2. What are the different types of muscle fibers? What are their characteristics – it might be helpful to summarize your thoughts in a table.**
- 3. Which of the fiber types do you think is recruited first? Can you make an assumption on differences in thresholds for V-gated channels in the trigger zone for the neurons supplying the different muscle fiber types?**

#### **Part III – At the doctor's office**

When Cathy wakes up the next morning, her muscles around the elbows, arms, shoulders, and anterior chest are swollen and very sore. When trying to brush her teeth, she notices that she can barely lift her arms to her face. "This is not good," she tells the cat. "If it's not better by tomorrow, I think I need to see a doctor." She spends the day laying down grass and putting in more plants and falls weakly into bed that night.

The next morning her condition has not improved. Luckily her new job means that she now – for the first time in her life - has great health insurance, so she calls the doctor's office and is on her way to be seen shortly after.

The doctor examines Cathy and notices the swelling around her arms and chest, and that all muscles in the area are tender to the touch. She asks Cathy a few more questions: "Do you experience any difficulty breathing? Any numbness of your hands? Can you move your fingers and wrist normally? Have you noticed your urine being darker than usual?"

Cathy admits that her urine does look darker than usual, but reports that she is breathing normally and does not experience any numbness.

The doctor explains that she is worried that Cathy's hard work might have caused traumatic myositis – an inflammation of the muscles after traumatic injury or over-exertion. To test this theory, she orders blood tests to check for CPK levels (an enzyme found in skeletal muscle, involved in converting leftover ATP into phosphocreatine so it can be stored in muscle and used again later). In addition, kidney tests are performed to assay BUN (A BUN –blood-urea-nitrogen- test is done to see how well your kidneys are working. If your kidneys are not able to remove urea from the blood normally, your BUN level rises). "Sometimes muscle injury can cause the muscle cells to spill their proteins into the circulation. These proteins can then get trapped in and clog the kidneys", she explains. "That's why we have to test if your kidneys are functioning normally." Cathy is asked to return the next day to discuss test results.

**Questions:**

1. **Why did the doctor ask about Cathy's breathing and numbness in her hands? In each case, what is the doctor concerned about?**

**Part IV – Test Results**

Lab results:

BUN: Still in the normal range

Blood CPK level: 10x normal

Urine test: traces of myoglobin in the urine

**Questions:**

1. **Interpret the test results. Do they support the initial diagnosis of traumatic myocitis?**
2. **What is myoglobin?**