

Objectives

1. Explain the sliding filament theory.
2. Explain muscle contraction.
3. Describe muscle fatigue.

Activity 1: Sliding Filament Theory

- A. Fill in the blanks using the word bank provided below.
- B. Arrange the following statements in the correct order:

****Assume muscle is in the relaxed state before starting the cycle****

- a) A(n) _____ molecule binds to the myosin head. This causes the myosin head to detach, causing muscle _____.
- b) _____ attach to _____ causing them a change in conformation (shape).
- c) _____ on _____ (thin/thick) filaments bind with actin binding sites on thin filaments, forming a cross bridge, causing muscle _____.
- d) _____ moves away, exposing myosin binding sites on the actin _____ (thin/thick) filaments.
- e) When a nerve impulse arrives at the _____, calcium ions are released from the _____.

Calcium ions	Troponin Tropomyosin	Place the statements in order:
Thin	Myosin head Thick	
ATP	contraction relaxation	
Neuromuscular junction	Sarcoplasmic reticulum	

Activity 2: Sliding Filament Theory Model

Using the material provided, create a model showing the sliding filament theory in action and be prepared to explain it to your TA. You may use videos or images to guide you. For example, a group of red pipe cleaners can represent the myosin filament.

STRUCTURES TO SHOW IN YOUR MODEL:		
<ul style="list-style-type: none"> • Myosin • Myosin head • Actin 	<ul style="list-style-type: none"> • Actin active site • Troponin • Tropomyosin 	<ul style="list-style-type: none"> • Ca²⁺ • ATP • SR (does not need to be shown but discuss what it does)

Upon discussing your model with your TA, answer the following questions:

- a. *Which ion stimulates contraction?*
- b. *Where does this ion bind to?*
- c. *Where is it released from?*
- d. *Which filament moves, and which does not move?*

Activity 3: Contraction of Glycerinated Muscle with ATP

For muscles to contract they need a combination of both ATP and salts. In this activity, you will add a drop of an unknown solution to a thin piece of muscle under the microscope and note its reaction, which should occur within ten seconds of placing the drop. After observing the reaction, or lack thereof, predict which solution was contained in the dropper: **0.2% ATP in distilled water**, **0.2% ATP + KCl + MgCl₂**, or **KCl + MgCl₂**.

Materials:

- Microscope
- Petri dish with
- 3 unknown solutions
- 3 microscopic slides
- Tweezers

Place your predictions here:

Solution labeled "1" is:
Solution labeled "2" is:
Solution labeled "3" is:

- a) With which solution did the muscle contract the most? Why?

Activity 4: Muscle Fatigue

Problem: How does muscle fatigue affect the amount of work that muscles can do?

Background: As skeletal muscles contract and relax, they move bones in your body. This work requires energy. Muscles get energy from ATP molecules made during the process of cellular respiration. During continuous activity, the muscles begin to use up their energy supply and oxygen and start to accumulate waste products. As a result, the muscles become fatigued, losing their ability to contract. In this lab, you will observe how muscle fatigue affects the amount of work that muscles can do. Make a prediction about how exercise will affect the amount of work that muscles can do.

Procedure: One person from your group will be completing the exercise, another will be the stopwatch, and the third person will count each rep that is done. Take turns doing the exercises. Record the data in the data table.

Exercise 1: Arm Flexors and Extensors (Bicep Curl)

- Keeping the palm of your hand upward, stretch out your arm. Use your non-writing hand. Raise your hand by bending your arm at the elbow. Then lower your hand by straightening your arm. Try to keep your upper arm steady as you move your hand up and down.
- Continue raising and lowering your hand for 1 minute. Move it as rapidly as you can without straining yourself or losing control of the motion. Have your partner count and record the number of times you can raise and lower your hand in 1 minute.
- Repeat step 2 seven more times. (You will be doing this for eight minutes STRAIGHT). **Do not stop between trials.**
- After performing the exercises, record how long it takes for the burning sensation to go away.

NEVER STOP EXERCISING. REALLY PUSH IT. DO NOT STOP BETWEEN TRIALS

Data:

Name	1 st min	2 nd min	3 rd min 4 th min 5 th min	6 th min 7 th min	8 th min

- How long did the burning sensation last for?
- What was the rate in the first minute? (Divide the number of curls by 60 seconds) What was the rate in the 8th minute?
- After how many trials did your arm muscles become obviously fatigued? How does the data show this? Describe how your muscles felt.

Exercise 2: Foot Plantar Flexors and Dorsiflexors (Calf Raise)

- A. Stand with your legs shoulder width apart. You will raise your heels and stand up on your toes. And then relax your heels back to the ground. (A calf raise) 2. You are to record the number of calf raises in your Data Table every 10 seconds, but you are NOT TO STOP between trials.
- B. You will be performing this exercise without stopping for 100 seconds. 4. After performing the exercises, record how long it takes for the burning sensation to go away.

NEVER STOP EXERCISING. REALLY PUSH IT. DO NOT STOP BETWEEN TRIALS.

Data:

Name	10 sec	20 sec	30 sec	40 sec	50 sec	60 sec	70 sec	80 sec	90 sec	100 sec

- a) How long did the burning sensation last for?
- b) What was the rate in the first ten seconds? (divide the number of raises by 10 seconds)
- c) What was the rate in the 100th second?
- d) By looking at your results of your calf raises, pinpoint when you first had a lot of lactic acid buildup. How do you know?
- e) Explain how resting for 10 minutes between trials (for both exercises) would have affected your results. What would occur in the body?