In Vitro Muscle Contraction

Jean Richardson
Summerville High School
Summerville, SC

Research Host:

George Cooper, IV, M.D.
Medical University of South Carolina

1998

Grade Level:

High School

In Vitro Muscle Contraction

Purpose:
Engage Grades 9-12 students in exploring muscle contraction.

Objectives:
Students will be able to:

- determine solution(s) needed for a muscle contraction.
- calculate percent contraction of a muscle fiber.
- design and perform an experiment to test a condition that affects percent muscle contraction.
- generate a data table and a graph to display results.
- prepare and participate in a group poster presentation of an experiment.

Materials for six groups of four students:

- Glycerinated Muscle Kit – Item #20-3525 Carolina Biological Supply. Call (1-800-334-5551) to order. $17.10; includes live skeletal muscle, solutions, background information and suggestions. This will be enough for one class and possibly two if your students are conservative. Item #20-3520 –Muscle only - $12.85 Item #20-3530 - Solutions only - $4.85

Per Group of four students:

- compound light microscope
- three microscope slides
- two dissecting needles
- one pair forceps
- one metric ruler
- one petri dish containing 3-4 cm length piece of live skeletal muscle
- one dropper bottle of glycerol

Materials at a central location in the lab:

- ATP solution in dropper bottle(s)
- saline solution in dropper bottle(s)
- ATP + saline solution in dropper bottle(s)

Add these materials to the central location for Part B:

- thermometers (Celsius)
- ice, warm water, hot water and freezer zipper-lock bags
- pH Buffers (5, 7,9)
- 1.0M solutions of MgCl2, NaCl, and KCl

Variables Students Could Select: temperature, pH, type of saline, ATP concentration (increase drops, one drop is the control), saline concentration (increase drop, one drop is the control), ATP/Saline Drop Ratio (1/1 is the control).

Preparation and Procedure:

- Lab time - one 90-minute period (or two 45-minute periods). Presentation time will also take one 45-90 period.
- Students should have already mastered microscopy, calculating percentages, designing data tables and graphs, and understanding a controlled experiment.
- Solutions can be prepped ahead of time and refrigerated. The muscle should be stored in the freezer and cut into desired lengths just before the lab.
- Students should read and discuss the Sliding Filament model of a skeletal muscle contraction before this lab activity.

Safety:

Students should wear goggles and aprons if using the pH buffers or hot water.

Questions to Ask:

1. What is needed for the skeletal muscle to contract?
2. How is skeletal muscle like cardiac muscle?
3. What are some applications in medical fields for improving contractile function in cardiac and skeletal muscle?
4. What is rigor mortis? Why does it sometimes occur?

Where to Go From Here:

This lab would fit well into a physiology unit when you are teaching the muscular system. I find it extremely helpful to teach nerve impulses and hormone action before muscle contraction. A physical therapist would be an excellent guest speaker after completion of this lab.

References and Resources:

1. Carolina Biological Instructions with Muscle and Solutions Kit
2. Campbell, Neil. *Biology*, Benjamin/Cummings Publishing Company, Menlo Park, California. Fourth Edition, 1996. Chapter 45, pp. 1048-1053.

Suggestions for Assessment:

- A group poster-presentation with all members contributing.
- a postlab quiz essay question such as:
    - design a controlled experiment in which you could test the effects of some condition on muscle contraction.

In Vitro Muscle Contraction

Student Sheet

Procedure A:

Put your answers on a separate sheet of paper.

1. On your lab table you will find a petri dish containing a bundle of mammalian skeletal muscle fibers. Gently, using dissecting needles, try to place one fiber on a slide. Do not let the fiber dry out. Pipette glycerol from the petri dish if needed. Do not use a coverslip. Observe under low power. Notice the striations. Sketch.
2. You will probably notice that you have more than one fiber. Continue separating fibers and put one fiber on each of the three microscope slides you have at your lab table. Keep fibers moist with glycerol.
3. Measure the length of each fiber in millimeters and record these lengths.
4. While observing through the microscope, add one drop of ATP solution to one fiber. What happened? Remeasure length and record.
5. Repeat Step 4 with another fiber using the saline solution.
6. Repeat Step 4 with the third fiber using the ATP + saline solution.
7. Calculate percent contraction for each fiber.

Questions:

1. Why was the ATP solution needed?
2. Why was the saline solution needed?
3. Which fiber(s) contracted? Why?
4. How does the contracted fiber look different from the uncontracted fibers?

Procedure B:

1. Your group should now select a condition that could affect muscle contraction. Look at materials at the front lab table for possible suggestions. Design a controlled experiment to test the effects of this condition. Be sure to get your teacher's approval before beginning the experiment.
2. Before you begin:
    1. State your problem.
    2. What is your independent variable? Dependent variable? Controlled variables?
    3. Form a hypothesis.
    4. Do you have a control? Why do you need a control fiber?
    5. Why should you test only one condition at a time?
    6. Why do you need replicates? Ask your teacher how many replicates you may do.
    7. Design a data table to record your results.
    8. Get approval from teacher.
3. Conduct experiment.
4. Graph the results.
5. Make a group poster presentation to the class.