# Oh, Those Achin' Muscles!

## Suggestions for Teachers

### Purpose:

The purpose of this activity is for students to design an experiment to investigate muscle fatigue. This activity is appropriate for middle level students, grades 6-8.

### Objectives:

After completing this activity, students will be able to:

(1) define fatigue
(2) understand the physiological concept of fatigue
(3) develop and answer their own questions using experimental design.

### Materials:

Students should work in pairs or small groups (2-4 students in a group)

You will need these supplies per pair:

- rubber band
- ruler
- index

### Preparation and Procedure:

It will be helpful if the students have already been introduced to the muscular system and/or the different types of muscles.

This hands-on inquiry activity will take two to three class periods to complete.

ENGAGE: The class will begin with the teacher directing the students to participate in some physical – raising and lowering their binder with one extended arm, toe presses, etc. While the class is working out, the teacher will talk with them casually. The teacher will continue to talk until the students begin to show signs of becoming tired. At this point, the students will be instructed to stop the activity and take a seat. The teacher will pose two questions: (1) How do you feel after you exercise for a period of time? (2) What do you think is happening to your muscles during exercise? At this time, all student responses should be accepted.

In groups, students will brainstorm muscle fatigue. To do this, you may choose to use either a KWL chart or a concept map. Ask each group to choose one idea and one question that they have at this point to share with the class.

For students with little or no background knowledge about muscle fatigue, you may want to give a common definition to work from. **Muscle fatigue is often defined as a failure to maintain the required or expected force.**

EXPLORE: This is a guided activity that will help students to later develop their own experiment on fatigue.

(1) Distribute materials.
(2) Question students: Now that we know fatigue is when muscles fail to maintain a certain force, how might we measure muscle fatigue in our hands using these rubber bands?
(3) Allow students time to think and generate some ideas as a team.
(4) Through questioning, lead the students to the idea of measuring muscle fatigue by putting the rubber band around their fingers and stretching the rubber band open and closed.
(5) Discuss the variables that should be controlled during this experiment: the kind of rubber band, the amount a person stretches, etc.
(6) Students will measure and record the length of their right hand from the first line on their wrist to the tip of their third finger. Next, calculate 65% of the measured hand distance. This will give each student his or her stretch distance.
(7) Each student will mark the stretch distance off onto an index card using a ruler.
(8) Students will place the rubber band around the thumb and the ring finger of their right hand. * To give a good amount of resistance, wither double the rubber band or twist it in the middle so that it loops around the gingers. *
(9) Students will measure the amount of time they can stretch the rubber band open and closed the length of their calculated stretch distance. The first time they fail to stretch the full distance, the timer calls stop and they record the time.
(10) The student should trade off timing and stretching until both have completed three trials. Each student should calculate his or her average fatigue time.
(11) Students should record their data in the table provided.
(12) Each team should draw some conclusions about muscle fatigue.
(13) Teams will present their results orally and discuss their conclusions.

EXPLAIN:

(1) Discuss the concept of muscle fatigue through readings, discussions, etc.
(2) Students will then generate new or extended questions to explore involving fatigue.

ELABORATE:

(1) In groups, students will design their own experiments to explore muscle fatigue in the hand – the y will be manipulating variables such as dominant hand vs. non-dominant hand, girls vs. boys, etc.

(2) Begin by having each team generate their own question based on what they have learned about fatigue.
(3) Students will generate a hypothesis and write a protocol to investigate their question.
(4) Students must have their protocols approved by the teacher before beginning their experimentation. * This is a great time for informal interviews to assess student understanding of experimental design. *
(5) After conducting the experiments, each team will prepare and present a poster explaining their work to the class. Each group presentation will be evaluated by the class as well as the teacher.

EVALUATE: Students will evaluate their understanding of muscle fatigue by re-evaluating their earlier ideas. Each team will be given the opportunity to add to or make changes on their KWL chart and/or their concept maps.

**Safety:**

It is a good idea to check the rubber bands that will be used for any flaws. This may prevent the rubber bands from breaking during the experiment. Students should be cautioned that rubber bands are not toys and should not be used for shooting at each other.

**Questions To Ask:**

Some questions you might ask to help students develop their own experiments are:

(1) Did everyone test fatigue at the same rate?
(2) Might there be a difference in fatigue rate in the right hand vs. the left hand? Dominant hand vs. non-dominant hand?
(3) Do you think that muscles we use more often will fatigue faster or slower than muscles that are not used as often?

**Where To Go From Here:**

This activity could be used as a wrap up to a unit on the muscular system. This activity could also be used as a lead into a unit on exercise physiology. You might also have a physical therapist, researcher, or exercise physiologist come and visit the classroom. Students might also do an independent study on how fatigue affects other muscles in the body.

**References and Resources:**

This activity was developed with the help of Ms. Julianne Clancy, graduate student in the department of molecular physiology and biophysics at Baylor College of Medicine.

Resources for teachers on fatigue:
Handbook of Physiology: Section 10-Skeletal Muscle, American Physiological Society, Bethesda, MD 1983.

**www.uspra.com/inst8.html**

Resources for students:
**www.uspra.com/inst8.html**
**www.brianmac.demon.co.uk/lactic.htm**

### Suggestions for Assessment:

Assessment can be made through several techniques:

(1) Informal group observations and questioning
(2) KWL chart and/or concept map
(3) Rubrics (student and teacher)

## STUDENT ACTIVITY

Your task is to explore muscle fatigue in the hand. Be prepared to discuss your result at the end of class.

Question: Do all individuals experience muscle fatigue at the same time when following the same exercise protocol?

Hypothesis: (Your team's proposed answer to the research question)

Materials: rubber band, ruler, index card

Protocol:

(1) Measure and record the length of your right hand from the first line on your wrist to the tip of your third finger. Next, calculate 65% if the measured hand distance. This will give you your individual stretch distance.
(2) Mark the stretch distance off onto the index card using your ruler.

(3) Place the rubber band around the thumb and the ring finger of your right hand the way that your teacher demonstrated.
(4) Measure the amount of time you can stretch the rubber band open and closed the length of your calculated stretch distance. The first time you fail to stretch the full distance, the timer calls stop and you will record the time.
(5) You will trade off timing and stretching until both you and your partner have completed three trials. Each person should calculate their average fatigue time.
(6) Record your data in a data table in the space provided.
(7) Construct a graph to display your results.
(8) Draw some conclusions about muscle fatigue.
(9) Each team will preset their results orally and discuss their conclusions.

Results: (Include a data table and graph to show the results of your experiment.)

Data Table:

Graph:

Conclusions: (What have you learned about fatigue? Were you able to answer the research question? Was your hypothesis correct? Would you change anything about this experiment? What are some questions you have now?)

## Teacher Rubric

0= not included
1= poor
2= needs some work
3= acceptable
4= good work
5= excellent

**EXPERIMENTAL DESIGN**

| | | | | | | |
|---|---|---|---|---|---|---|
| Research question is clear | 0 | 1 | 2 | 3 | 4 | 5 |
| Question is measurable | 0 | 1 | 2 | 3 | 4 | 5 |
| Hypothesis attempts to answer the research question | 0 | 1 | 2 | 3 | 4 | 5 |
| Protocol clearly written | 0 | 1 | 2 | 3 | 4 | 5 |
| Data was collected and correctly displayed in a data table | 0 | 1 | 2 | 3 | 4 | 5 |
| Data collected was also displayed in a graph | 0 | 1 | 2 | 3 | 4 | 5 |
| Graph type was correct (bar vs. line) | 0 | 1 | 2 | 3 | 4 | 5 |
| Graph was correctly constructed | 0 | 1 | 2 | 3 | 4 | 5 |
| Conclusions were logical (fit the data collected) | 0 | 1 | 2 | 3 | 4 | 5 |

**POSTER**

| | | | | | | |
|---|---|---|---|---|---|---|
| Poster is neat and organized | 0 | 1 | 2 | 3 | 4 | 5 |
| All team members spoke clearly | 0 | 1 | 2 | 3 | 4 | 5 |
| Good presentation style (posture, voice, eye contact) | 0 | 1 | 2 | 3 | 4 | 5 |

Grade = $\frac{\text{points earned}}{\text{points possible}} = \frac{\quad}{60}$

**STUDENT RUBRIC**

0= not included
1= poor
2= needs some work
3= acceptable
4= good work
5= excellent

**ESPERIMENTAL DESIGN**

| | | | | | | |
|---|---|---|---|---|---|---|
| We understood the question | 0 | 1 | 2 | 3 | 4 | 5 |
| The hypothesis was an attempted answer to the question | 0 | 1 | 2 | 3 | 4 | 5 |
| We could follow the protocol and reproduce the experiment exactly | 0 | 1 | 2 | 3 | 4 | 5 |
| Data table was easy to read and understand | 0 | 1 | 2 | 3 | 4 | 5 |
| The graph was easy to read and understand | 0 | 1 | 2 | 3 | 4 | 5 |
| The conclusion was clear | 0 | 1 | 2 | 3 | 4 | 5 |

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**POSTER**

| | | | | | | |
|---|---|---|---|---|---|---|
| The poster was neat | 0 | 1 | 2 | 3 | 4 | 5 |
| The poster was easy to see | 0 | 1 | 2 | 3 | 4 | 5 |
| The team was easy to hear and understand | 0 | 1 | 2 | 3 | 4 | 5 |

Grade = $\frac{\text{points earned}}{\text{points possible}} = \frac{\quad}{45}$