



Rocking the BBQ

Muscle Biology

Grade Level

9-12

Lesson Length

2 periods x 55 minutes

STEM Careers

- **Animal Scientist, Animal Nutritionist, and Meat Scientist**

Nebraska Science Standards

- **LS.SC12.3.1 (Structure and Function of Living Systems)**

Next Generation Science Standards

- **LS1.A (Structure and Function)**

Animal Biology Standards

- **5. (Apply Principles of physiology to cellular growth and development in sound animal management practices)**

These lessons aim to bring the science, skills of inquiry, critical thinking, and problem solving to life through an agricultural context



Learning Objectives

By the end of the unit, students should be able to:

- ✓ Provide a general description of the muscle fibril.
- ✓ Provide general description of muscle contraction process.
- ✓ Explain the relationship that exists between muscle anatomy and physiological function to meat tenderness.
- ✓ Scientifically evaluate different meat tenderization procedures and explain the chemical and physiological basis for how those procedures function.
- ✓ Evaluate methods to effectively tenderize a TOUGH steak and relate those results to the physiological state and composition of the muscle fibril.

Materials List (per student team)

- ✓ 1 large flank steak
- ✓ 1 cutting board mat
- ✓ 1 meat knife
- ✓ Meat tenderizer (dependent on experimental treatment)
- ✓ Baking Soda (dependent on experimental treatment)
- ✓ Soy Sauce (dependent on experimental treatment)
- ✓ 4 zip-lock sandwich bags
- ✓ Paper plates
- ✓ Toothpicks
- ✓ Masking tape
- ✓ Sharpie
- ✓ Cooking Appliance (grill, oven, skillet, etc.)

Preparation

- ✓ Print Power Point slides
- ✓ Print lab reports and “Rocking the BBQ” guidelines

- ✓ Collect, organize, and prepare materials to be used for the “Rocking the BBQ” experiment.



Introduction (Interest Approach)

To introduce the students to muscular system, show the 9 second video clip to the class. The video clip shows the muscle contraction happening 90 minutes after a cow has been harvested. Use the video to gain curiosity in the content and to lead into discussion using the essential questions.

<https://www.youtube.com/watch?v=QZyXVCfiUmc>

Essential Questions

- ✓ *What do you know about muscle contraction?*
- ✓ *How does muscle function affect meat tenderness?*

Learning Activity 1:

Encourage students to take notes throughout the Beef Muscle Contraction and Relaxation video produced by the Beef Checkoff over the function of muscle fibers and how chemicals and proteins affect the muscle contraction process. The information should be discussed in order to better understand how muscles function in the living animal.

<https://www.youtube.com/watch?v=9WL8x-pLMg>

Sarcomere – Smallest contractual unit of muscle

Actin- Thin filament

Myosin- Thick filament

- Please refer to PowerPoint for more information

Learning Activity 2:

Distribute the “Rocking the BBQ” guidelines, data table, and lab report to each student. Students may work in groups of 2-5 depending on class size.

Each student will complete the lab report during the experiment. This experiment allows students to investigate how different procedures affect tenderness of the meat by potentially disrupting components of the muscle fibril. Have each group define the research problem and construct a hypothesis before beginning the experiment. After approving the research problem and hypothesis, groups may begin the experiment. Groups may use the “Rocking the BBQ” guidelines as instructions for the experiment.

Remind students to fill out the data table and complete the lab report as they conduct the experiments. Upon completion of the experiment, facilitate a classroom discussion using the questions provided.



Reflection

Using the prompts below to facilitate reflection, allow each student to respond in writing to the prompts and then facilitate a whole class discussion.

1. How does muscle anatomy and physiology relate to product utilization, value, and palatability?



Apply

Use the prompts below to facilitate small group and whole class discussion.

1. How could we use knowledge of muscle anatomy and physiology to enhance consumer demand and value of meats from muscles of locomotion?
2. For BBQ, we commonly use lowly valued cuts (i.e., brisket) and convert it into highly sought, valuable retail products. What methods are incorporated into making that value and palatability transformation?

References:

- ✓ Meat Science! <https://www.education.com/science-fair/article/meat-science/>
- ✓ Beef Checkoff. Beef Muscle Contraction. [Online].
<https://www.youtube.com/watch?v=9WL8x-pLMg>
- ✓ Cow Slaughter 1:Skinned Cow-Still Twitching. [Online].
<https://www.youtube.com/watch?v=QZyXVCfiUmc>

Rocking the BBQ Guidelines

Objective:

- ✓ Evaluate methods to effectively tenderize a TOUGH steak and relate those results to the physiological state and composition of the muscle fibril.

Preparation:

- ✓ The class shall be divided into 4 teams of students.
- ✓ Each team will have a negative and positive control as follows:
 - Steak strips, cut “with the grain” (Negative Control)
 - Steak strips, cut “against the grain” (Positive Control)
- ✓ Each team should hypothesize and develop 1 additional (food safe) tenderization treatments.
 - To be applied “with the grain” and “against the grain” → 2 additional comparisons (4 total)
 - Dependent on product availability, numbers of teams, sensory space, etc., instructor may ask each team to develop 2-3 additional tenderization treatments at his/her discretion.
 - Possibilities include, but are not limited to ...
 - Baking soda rub (1 tsp rubbed over meat; allowed to sit overnight; then washed off)
 - Soy sauce marinade (cover in soy sauce; sit overnight; then remove to cook)
 - Mechanical tenderization (pound away – perhaps the “time” pounded could be a test)
 - Commercially available tenderizer – Palpain (follow instructions)
 - Cover with salt – to extract water & break down cells via osmosis
 - OTHER – What might your mom/dad do at home?
 - Do you have any “family recipe” marinades?

Instructions (per team; assuming 4 comparisons;)

1. Wash hands and prepare a clean food preparation area.
2. Place steak on clean cutting board. Identify the lines of fiber on the meat (“grain”). Remove 4 slices of steak (~ ½ in wide, ~ 3 in long), cutting in the same direction as the “grain”.
3. Label 2 zip-lock sandwich bags “with the grain”. Also, include your team name/number.
4. Into each of the two labeled “with the grain” sandwich bags, place 2 slices of steak.
5. Cutting against or across the “grain”, remove 4 more slices of steak (~ ½ in wide, ~ 3 in long).
6. Label 2 zip-lock sandwich bags “against the grain”. Also, include your team name/number.
7. Into each of the two labeled “against the grain” sandwich bags, place 2 slices of steak.
8. Apply your treatment comparison to one of the bags containing 2 “with the grain” slices of steak and to one of the bags containing 2 “against the grain” slices of steak. Add additional labeling to

- outside of bags to identify team name/number and treatment.
9. Double-check samples appropriately labeled with team name/number and treatment assignment.
 10. Place all treatments in refrigerator, overnight.
 - Do NOT leave samples overnight at room temperature; this would be a food safety risk!
 11. When done, wash all utensils including knives and cutting mats.
 12. Wash hands! Always wash hands after handling raw meat.
 13. Assign each of your 4 comparisons a randomized treatment code or number (1-4).
 - For your team, this number will identify the treatment.
 - For everyone else in the class (your test subjects), this number functions to hide the treatment and remove their bias for or against particular treatments.
 - Write the assigned treatment code (1-4) and actual treatment down; do NOT lose.
 14. For each person in the class (who is NOT on your team), you will need to provide 4 labeled toothpicks; #1, #2, #3, and #4. Scientifically, you should NOT test your own treatments, because you bring bias into the evaluation knowing the treatments.
 - Using masking tape & a sharpie; label an appropriate number of toothpicks with #1, #2, #3, and #4. Place labeled toothpicks in cup and store until needed for sensory evaluation.
 15. Approximately 24-48 hrs later, cook steak pieces.
 - Almost any cooking appliance (excluding microwave) should work, but it is important that all meat slices be cooked the same! Since, all slices should be thawed and of approximately the same size, cooking each for the same amount of time (provided your appliance has good heat uniformity), should provide consistency of cooking across treatments.
 16. Once cooked, cut each 3-inch long slice of steak into an appropriate number of smaller, uniformly sized pieces for classmates to evaluate. Insert a properly labeled (#1, #2, #3, #4) toothpick into each piece of steak.
 17. Classmates will complete a subjective tenderness evaluation of each steak using a 15-cm continuous scale. Sensory participants will simply mark a line anywhere on that continuum from 0 to 15 to indicate their relative perception of tenderness.
 18. Data Evaluation and Analysis – To evaluate results, student teams will measure and record the length of the line from 0 to 15 cm; this represents the response. Average and compare responses for each of the four treatments. Complete lab report.

Subjective Tenderness Evaluation Form for Team _____

Instructions: Please evaluate each of the four samples for their relative tenderness using a 15-cm continuous scale. Simply mark a line anywhere on continuum from 0 to 15 to indicate your relative perception of tenderness for the sample.

NOTE – Will need 1 copy of this form for each sensory evaluation participant

	0		15
Sample 1	_____		
Sample 2	_____		
Sample 3	_____		
Sample 4	_____		

Subjective Tenderness Evaluation Form for Team _____

Instructions: Please evaluate each of the four samples for their relative tenderness using a 15-cm continuous scale. Simply mark a line anywhere on continuum from 0 to 15 to indicate your relative perception of tenderness for the sample.

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	0		15
Sample 1	_____		
Sample 2	_____		
Sample 3	_____		
Sample 4	_____		

Data Analysis Table

Team: _____

Evaluator	Treatment 1	Treatment 2	Treatment 3	Treatment 4
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
Average				

Treatment 1 =

Treatment 2 =

Treatment 3 =

Treatment 4 =

What was the average of “with the grain” compared to “against the grain”?

What was the average of your supplemental treatment (with & against the grain) compared to control (with & against grain)?

Rocking the BBQ

Discussion Questions

1. Which was tougher, cut “with the grain” or “against the grain”? Why?
2. Describe your supplemental treatment, added to two of the four samples of meat?
3. Did your supplemental treatment enhance tenderness?
 - a. If so, can you explain why or how?
4. If you were to conduct these same treatments on the Psoas Major (tenderloin) muscle, would you expect the same level of change? Why or why not?
5. How does muscle anatomy and physiological purpose affect tenderness?

Name:

Lab Report

Please complete the following report during the design and implementation of your experiment.

Research Problem

- ✓ Describe what you are investigating and justify why you are investigating the problem.

Hypothesis

- ✓ Formulate one or more hypotheses for your experiment.

Procedures

- ✓ Create the steps you will follow for your experiment.

Data Collection

- ✓ Describe the data that you will collect during your experiment.
- ✓ Provide graphs, tables, charts, and raw data as necessary.

Results

- Explain your results.

Conclusion

- Based on your data:
 - What can you conclude?
 - Were your hypotheses supported?
 - Were there limitations to your experiment?
 - What are new research questions that derived from this study?