Activity Six: Muscle Fibers

Muscles and Bones

Activities Guide for Teachers

National Space Biomedical Research Institute
Houston, Texas

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CONCEPTS
- Muscles are made of fibers within fibers.
- The structure of muscles makes them strong.

OVERVIEW
Students will learn about the structure of muscles by comparing yarn and cooked meat.

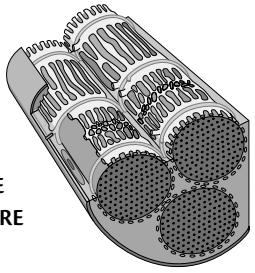
SCIENCE, HEALTH & MATH SKILLS
- Observing
- Modeling
- Inferring

6. Muscle Fibers

Background
Despite our amazing skeletons, without muscles, we would not be able to stand, balance ourselves or move. Every person has more than 600 muscles thoughout his or her body.

Movement happens when muscles contract and become shorter. As seen in the previous activity, the contraction moves the two places of muscle attachment closer together. These types of contractions take place countless times each day in the body.

Skeletal muscles (the ones responsible for movement of the body) are made of bundles of progressively smaller fibers. The largest fiber bundles can be seen with the unaided eye in a piece of muscle tissue or meat. The "strings" that can be teased (pulled) apart are bundles of fibers.



MUSCLE STRUCTURE

Within these large bundles are numerous muscle cells (also called fibers). Each muscle cell is filled with hundreds of even smaller strands (myofibrils). The myofibrils contain the smallest muscle elements of all—tiny units (sarcomeres) that become shorter by sliding one set of protein molecules over another. Added together, all of the minute contractions shorten the length of the entire muscle.

This activity introduces students to the structure of muscles by having them compare and contrast the structure of yarn to the structure they can observe in a cooked piece of beef stew meat or other coarse meat.

Time
20 minutes for set-up; 45 minutes to conduct activity

Materials
Each group will need:
- 12-in. section of yarn
- 4 toothpicks
- plastic knife
- cube of cooked beef (stringy or fibrous cuts such as brisket, flank steak or stew meat work best); approximately 1/2 pound is sufficient for an entire class
- copies of "A Simple Yarn" student page

Set-up and Management
Cook beef brisket or stew meat in advance for students. Each group should have at least one, 1-inch cube of cooked meat to observe. Place all materials in a central location for students. Have students work in groups of 2–4.

Procedure
1. Ask students, *Have you ever seen muscle? What does it look like?* If necessary, remind students that "meat" is muscle tissue and that many different kinds of muscle are on display at

Human Muscle Facts!

There are 30 different muscles in your face that allow you to do things like smile, frown and raise your eyebrows.

Muscle attached to bone (called skeletal muscle) is the most abundant tissue in the bodies of vertebrates (animals with backbones).

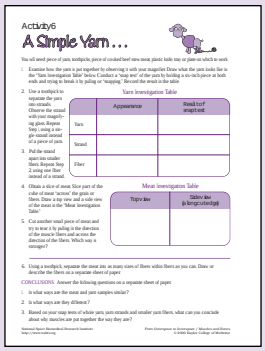
Training with weights can double or triple a muscle's size. Disuse, such as during space travel, can shrink a muscle by as much as 20% in just two weeks.

As people age, their muscle mass shrinks. By age 50, skeletal muscle often is reduced by around 10%. By age 80, almost half of a person's muscle mass can be lost.

the grocery store. Follow by asking, *Which characteristics of muscle help make it strong?* Tell students that they will be investigating one aspect of this question.

2. Give each group of students a length of yarn, toothpicks and a small cube of cooked beef brisket or stew meat.

3. Have students follow the instructions on the "A Simple Yarn" page to observe the structure of yarn. They should progressively tease apart and test the relative strength of the strands comprising the length of yarn. Have them use a "snap" test, in which they hold the strand between both hands and quickly pull or "snap" it, to estimate the strength of each size of strand.


Activity6

A Simple Yarn . . .

You will need: piece of yarn, toothpick, piece of cooked beef stew meat, plastic knife, tray or plate on which to work

1. Examine how the yarn is put together by observing it with your magnifier. Draw what the yarn looks like in the "Yarn Investigation Table" below. Conduct a "snap test" of the yarn by holding a six-inch piece at both ends and trying to break it by pulling or "snapping." Record the result in the table.
2. Use a toothpick to separate the yarn into strands. Observe the strand with your magnifying glass. Repeat Step 1 using a single strand instead of a piece of yarn.
3. Pull the strand apart into smaller fibers. Repeat Step 2 using one fiber instead of a strand.

Yarn Investigation Table

	Appearance	Result of snap test
Yarn		
Strand		
Fiber		

4. Obtain a slice of meat. Slice part of the cube of meat "across" the grain or fibers. Draw a top view and a side view of the meat in the "Meat Investigation Table."
5. Cut another small piece of meat and try to tear it by pulling in the direction of the muscle fibers and across the direction of the fibers. Which way is stronger?

Meat Investigation Table

Top view	Side view (a long cut ending)

6. Using a toothpick, separate the meat into as many sizes of fibers within fibers as you can. Draw or describe the fibers on a separate sheet of paper.

CONCLUSIONS: Answer the following questions on a separate sheet of paper.

1. In what ways are the meat and yarn samples similar?
2. In what ways are they different?
3. Based on your snap tests of whole yarn, yarn strands and smaller yarn fibers, what can you conclude about why muscles are put together the way they are?

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4. After students have made their yarn observations, direct their attention to the cooked piece of meat. Have a student in each group slice the meat across the grain using a plastic knife. Students should observe and draw the meat cross section on their sheets. They will note that the muscle looks stringy. The strings are the large fibers of the muscle. They may see white, rubbery tendons attached to the muscle, or fat, which is a source of energy, along with the fibers.

5. Next, have students tease a section of meat into progressively smaller fibers. Have students observe the fibers using their hand lens and draw the fibers on their student page. Have students explore the strength of the meat by pulling it in two different directions (along the grain and across the grain).

6. Discuss students' observations with the class. Ask, *In what ways were the yarn and muscle sections similar? Did the fiber-within-fiber design of the yarn make it stronger or weaker? Why? What does this imply for the structure of muscles?*

7. Conclude by discussing how muscles contract. Point out that unlike the yarn fibers, which are not very stretchy, muscle fibers can shorten. To demonstrate, have students extend their arms and feel the muscle (biceps) in their upper arms. Ask them to bend their arms at the elbow and notice any changes that occur in their muscles. Help them understand that muscles become short and fat when they contract. Explain that, unlike yarn, muscles are made of a series of fibers packaged inside each other. The largest fibers were the ones the students were able to observe in class. Inside each larger fiber are smaller and smaller fibers. Finally, inside the smallest fibers are tiny filaments that make the whole muscle change shape. The number of filaments determines how big and strong the muscle is.

Extensions

- Have students compare other meats to the one observed in class. The color of uncooked meat (redder or whiter) depends on the kinds of fibers present. Red or "dark" muscle has more fibers that are specialized for long-term or repetitive activity without fatigue. These muscle fibers release energy from stored fat. White muscle has more fibers specialized for very fast contractions. These fibers, however, provide power for only a short period of time before they become fatigued from lack of oxygen and accumulation of waste products. White muscle uses energy from sugar.

Animals with endoskeletons also need muscles to

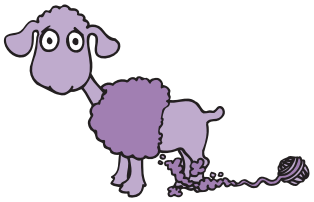
move wings, legs and jaws. Even clams and oysters have powerful muscles that open and close the two halves of their shells.

Safety Note

You may want students to wear disposable, plastic gloves when they handle meat samples.

Activity 6

A Simple Yarn . . .



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Meat Investigation Table

Top view	Side view (along cut edge)

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CONCLUSIONS. Answer the following questions on a separate sheet of paper.

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