

The NASA SCI Files™
The Case of the Physical Fitness Challenge

Segment 1

In *The Case of the Physical Fitness Challenge*, the tree house detectives are excited about their school's participation in the upcoming President's Challenge. All the detectives are hoping to be physically fit in time for the competition so they can win the Presidential Physical Fitness Award. Therefore, when RJ has difficulty keeping up with the fitness routine, they go into action to help him get back on track. The detectives do some research and discover that researchers at NASA Johnson Space Center in Houston, Texas are also interested in good health and nutrition. Tony heads over to speak with Mr. William Amonette, an Astronaut Strength and Conditioning Specialist. Mr. Amonette explains the importance of physical activity and tells Tony how astronauts must exercise before, during, and after space flight. While talking with Mr. Amonette, Tony learns that physical activity is not possible without muscles, so he goes to see Dr. Don Hagan, who explains what muscles are and the various types of muscles in the body. After reading Tony's reports, the detectives are not sure what to do next. They decide to stop by to talk with Dr. D. As Dr. D works on his car, he explains how the body is similar to a car because it has many systems. Thinking of systems, the tree house detectives decide that they might need to learn a little more about the skeletal system.

Objectives

Students will

- determine the importance of physical activity to a healthy lifestyle.
- discover how the heart pumps blood throughout the body.
- locate their pulse points and calculate their heart rates.
- prove that the more active a person is, the more the heart works to supply blood to the body.
- confirm that muscle strength and endurance increase over time with good stress.
- examine the structure of skeletal muscles.
- construct an arm model.
- discover the relationship between muscles and bones.
- learn about the different kinds of body joints and how they move.
- demonstrate the need for muscle groups.
- acquire knowledge about the body and its parts.
- understand that body parts make up body systems and that each part has a specific function.

Vocabulary

aerobic activities – activities designed to increase the amount of oxygen in the blood

cardiac muscles – a special kind of involuntary muscle found in the heart (which works without a person's thinking about it)

exercise – any physical activity that raises your heart rate or makes you work hard to lift or pull an object, including your own body

joint – a place where two or more bones meet

muscles – soft, but strong tissue made of long fibers that contract or become shorter to move bones; muscles can only pull in one direction so they must work in pairs

resistive exercise – an activity that strengthens bone and muscle by generating force against resistance

skeletal muscles – a group of voluntary muscles (muscles that you can control), which are attached to bones or other muscles to help you move

smooth muscles – a group of involuntary muscles (muscles that work without conscious thought), which make up most of the body organs such as the stomach, insides of blood vessels, intestines, and others

stress – emotional tension or physical force; physical stress is created when bones and muscles work against a force

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Before viewing Segment 1 of *The Case of the Physical Fitness Challenge*, read the program overview to the students. List and discuss questions and preconceptions that students may have about physical fitness and nutrition.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. To locate the following tools on the NASA SCI Files™ web site, select **Educators** from the menu bar, click on **Tools**, and then select **Instructional Tools**. You will find them listed under the **Problem-Based Learning** tab.

Problem Board—Printable form to create student or class K-W-L chart

Guiding Questions for Problem Solving—Questions for students to use while conducting research

Problem Log and Rubric—Students' printable log with the stages of the problem-solving process

Brainstorming Map—Graphic representation of key concepts and their relationships

The Scientific Method and Flowchart—Chart that describes the scientific method process

3. **Focus Questions**—These questions at the beginning of each segment help students focus on a reason for viewing. You can print them ahead of time from the **Educators** area. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.

Video Component

Careers

astronaut
Astronaut Strength
and Conditioning
Specialist
athlete
athletic trainer
coach
exercise specialist
physical education
teacher

4. **“What’s Up?” Questions**—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. You can print them by selecting **Educators** on the web site in the **Activities/Worksheet** section under **Worksheets** for the current episode.

View Segment 1 of the Video

For optimal educational benefit, view *The Case of the Physical Fitness Challenge* in 15-minute segments and not in its entirety. If you are watching a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow

students time to answer the question.

After Viewing

1. Have students reflect on the “What’s Up?” Questions asked at the end of the segment.
 2. Discuss the Focus Questions.
 3. Students should work in groups or as a class to discuss and list what they know about physical fitness and nutrition. Have the students conduct research about how astronauts stay in shape while in space, about the types of muscles in the body and how they are used, and about the President’s Physical Fitness Challenge. Brainstorm for ideas about how they can stay healthy and be physically fit. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide them with the information needed.
 4. Have the students complete **Action Plans**, which can be printed from the **Educators** area or the tree house **Problem Board** area in the **Problem-Solving Tools** section of the web site for the current online investigation. Students should then conduct independent or group research by using books and internet sites noted in the **Research Rack** section of the **Problem Board** in the **Tree House**. Educators can also search for resources by topic, episode, and media type under the **Educators** main menu option **Resources**.
 5. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students “solve” the problem along with the tree house detectives.
 6. For related activities from previous programs, download the appropriate **Educator Guide**. On the NASA SCI Files™ home page, select the fence post that says “**Guides**.” Click on the **2002–2003 Season** tab and then click on *The Case of the Biological Biosphere*®. In the green box, click on **Download the Educator Guide**.
 - a. In the **Educator Guide** you will find
 - a. Segment 2 – *Give Me Some Skin*, page 31
 - b. Segment 2 – *Just Breathe*, page 32
 - c. Segment 4 – *Getting to the Heart of the Matter*, page 56
- To locate additional activities and worksheets on the web, click on **Activities/Worksheets** in the tool bar located at the top of the window. Scroll to the **2002–2003 Season** and click on, *The Case of the Biological Biosphere*®. In the **Activities/Worksheet** section, you will find
- a. *Body System Booklet*
 - b. *In the Beat of a Heart*
7. Have the students work individually, in pairs, or in small groups on the problem-based learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on **Tree House** and then the **Problem Board**. Choose the **2005–2006 Season** and click on *The Case of the Sedentary Students*.
 - To begin the PBL activity, read the scenario (*Here’s the Situation*) to the students.
 - Read and discuss the various roles involved in the investigation.
 - Print the criteria for the investigation and distribute.
 - Have students begin their investigation by using the **Research Rack** and the **Problem-Solving Tools** located on the bottom menu bar for the PBL activity. The **Research Rack** is also located in the **Tree House**.
 8. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.

9. Have students complete a **Reflection Journal**, which can be found in the **Problem-Solving Tools** section of the online PBL investigation or in the **Instructional Tools** section under **Educators**.

10. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Resources *(additional resources located on web site)*

Books

Bolam, Emily: *Murphy Meets the Treadmill*. Houghton Mifflin Company, 2001, ISBN: 0618113576.

Christopher, Catherine: *Run for It*. Little, Brown Children's Books, 2002, ISBN: 0316349143.

Columbo, Luann: *Uncover the Human Body*. Silver Dolphin Books, 2003, ISBN: 1571457895.

Feeney, Kathy: *Get Moving: Tips on Exercise*. Capstone Press, 2001, ISBN: 0736809732.

Fraser, Kate: *Fitness and Health*. Usborne Books, 1999, ISBN: 0881102342.

Kalman, Bobbie: *Active Kids*. Crabtree Publishing Company, 2003, ISBN: 0778712753.

National Association for Sport and Physical Fitness: *Moving into the Future: National Standards for Physical Education*. McGraw-Hill Companies, 2004, ISBN: 0883149095.

Simon, Seymour: *Muscles: Our Muscular System*. William Morrow and Company, 1998, ISBN: 0688146422.

Wiese, Jim: *Head to Toe Science: Over 40 Eye-Popping, Spine-Tingling, Heart-Pounding Activities that Teach Kids about the Human Body*. Wiley, 2000, ISBN: 0471332038

Wyatt, Valerie: *Earthlings Inside and Out: A Space Alien Studies the Human Body*. Kids Can Press, 1999, ISBN: 1550745131.

Video

NASA Center for Distance Learning: *NASA CONNECT: Better Health from Space to Earth* (2003)

http://connect.larc.nasa.gov/programs/2003-2004/better_health/index.html

Grades 6–8

NASA Center for Distance Learning: *NASA CONNECT: Good Stress: Building Better Muscles and Bones* (2004)

http://connect.larc.nasa.gov/programs/2004-2005/good_stress/index.html

Grades 6–8

Discovery Communications: *Why Exercise?* (2002)

Grades 3–5

Discovery School: *Body Systems* (2004)

Grades 3–6

Discovery School: *Bones and Muscles* (2004)

Grades 3–6

Disney: *Bill Nye, the Science Guy: Bones and Muscles* (1996)

Grades 3–6

Disney: *Bill Nye, the Science Guy: Heart* (1995)

Grades 3–6

Schlessinger Media: *All about Bones and Muscles* (2001)

Grades K–4

Scholastic: *Magic School Bus: The Human Body* (2005)

Grades K–5

Web Sites

NASA Johnson Space Center

From the early Gemini, Apollo, and Skylab projects to today's International Space Station and Space Shuttle Programs, NASA Johnson Space Center, in Houston, Texas, continues to lead NASA's efforts in human space exploration. <http://www.nasa.gov/centers/johnson/home/index.html>

NASA CONNECT™

Visit the NASA CONNECT™ web site. It's a great place to learn more about how to stay fit and healthy. <http://connect.larc.nasa.gov/index.html>

National Space Biomedical Research Institute

Learn more about the body and how to keep it healthy on this fact-filled web site. Be sure to click on the Educational Materials link to access the teacher guides, *Muscles and Bones* and *Food and Fitness*. <http://www.nsbri.org/Education/index.html>

All Systems Go

Build a virtual human being to learn about the different body systems on this fun, interactive web site operated by Science Net Links. <http://www.sciencenetlinks.com/interactives/systems.html>

ScienceBob.com

Explore this web site to learn all about the body and its systems. <http://www.sciencebob.com/>

Activities and Worksheets

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	As We Are “Jointed” Together	
	With a couple of rulers and tennis balls, learn about muscles and joints and how they work together.	28
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On the Web	Calling All Body Parts	
	Play a game to learn how the various body parts work together as a system.	

Let's Get Physical

Segment 1

Purpose

To determine the importance of physical activity for a healthy lifestyle

Background

Physical activity is an important part of a healthy lifestyle. Many people today do not get enough physical activity in their daily lives. People spend much of their day being inactive, either sitting at their jobs or at school. Cars or buses have replaced walking and bicycle riding as the common types of transportation used to get from one place to another. This inactivity can lead to serious health risks. The President's Council on Physical Fitness recommends approximately 60 minutes of exercise per day for children under 18 years. Studies show that daily physical activity can help lower the risk of heart disease and obesity. People who are physically active tend to have more energy and a better body image. They are better able to deal with bad stress and overall are more relaxed. Physical activity can help tone muscles, burn extra calories to help lose weight, and can help control your appetite. Physical activity is also essential to healthy bones. Even light to moderate physical activity is better than no physical activity at all. The benefits of physical activity are great and can help you enjoy life more fully. Finding physical activities that are challenging but fun will help develop lifelong fitness habits.

Materials

Physical Activity worksheet
(page 20)
pen or pencil
markers
poster board

Procedure

1. Use the Physical Activity worksheet to survey people about their physical activities. Ask people that you know what physical activity they participate in most often and why and how many minutes a day they are physically active.
2. In the chart on the worksheet, record their responses.
3. To graph your results, first determine the categories of the various physical activities given. Categories might include sports, leisure activities (walking, running, shopping), no activity, and so on.
4. Create two graphs. **Example:** The first graph might be a pie graph that shows the types of physical activities in which people participate. Be sure to include those inactive people who responded "no" to physical activity. The second graph might be a bar graph to show the reasons why people are physically active.
5. Calculate the average number of minutes of physical activity performed by the people surveyed.
6. Share your results with your class or partner.
7. Create a class graph of all results and calculate the average number of minutes of physical activity for all people surveyed by the class. Find the mean, median, and mode.
8. After looking at the results, discuss the overall physical fitness level of those surveyed. Are most people who were surveyed getting enough physical activity?
9. Conduct research to learn more about the benefits of physical fitness.
10. Based on your survey and what you have learned about the importance of physical activity, create a poster, PowerPoint presentation, or a 30-second public service announcement to explain the importance of physical activity to a healthy lifestyle.

Discussion

1. Based on your survey results, how much value do you think people in your community place on physical fitness?
2. What was the most common reason people you interviewed chose to become physically active?
3. What are some of the benefits of physical activity?
4. How do you feel about physical activity?
5. What are some popular activities students can do to improve physical fitness?

Let's Get Physical

Extensions

1. Monitor your own physical activity for a week. Keep a log of all the activities you do. To track how you feel before and after physical activity, create a scale. Use this scale each day to indicate your overall feelings (energy level, attitude, and so on). Be sure to record your scores. After a week, take a close look at your activities. Are you physically active on a daily basis? Do you need more physical activity? Brainstorm for ways to add more physical activity to your life. The following week, try adding some of your ideas into your normal routine. Continue logging all your activities for the week. After a week, did you notice a difference in the way you felt? What are you going to do to make sure that you are more physically active on a daily basis?
2. Contact the President's Council on Physical Fitness and Sports, the American Heart Association, a local physical fitness center, or your family doctor to learn more about physical fitness and its importance. Create a report on your findings.
3. Learn about a pedometer and explain how to use physical activity. Use this instrument to monitor physical activity.

PHYSICAL ACTIVITY WORKSHEET

[illegible]

Pumping Up the Stress

Segment 1

Purpose

- To discover how the heart pumps blood throughout the body
- To prove that the more active a person is, the more the heart works to supply blood to the body
- To locate your pulse points and calculate your heart rate

Background

The heart is a muscle in your body. It is located slightly to the left of the middle of your chest and is about the size of your fist. The heart's job is to send blood throughout your body. Blood gives your body the oxygen and nutrients it needs and carries away waste products. The heart is like a double pump. The right side of the heart receives the oxygen depleted blood from the body and pumps it to the lungs. The left side of the heart receives the oxygen rich blood from the lungs and pumps it to the body. It takes your heart less than 60 seconds to pump blood to every cell in your body. As your heart pumps, valves inside your heart open and close. This opening and closing makes a distinct sound known as your "heartbeat." You can hear the heartbeat by using a stethoscope, a medical tool used to hear sounds within the body. Your heart will beat slower when your body is at rest and faster when it is active. This increase in heartbeat occurs because the more active you are, the more oxygen rich blood your body needs. Your heart must pump faster to accommodate the increase in need. Your heart rate is the number of times the heart beats per minute.

Aerobic activities are designed to make your heart beat faster and increase the amount of oxygen in the blood. According to the Center for Disease Control (CDC), aerobic activities improve the function of the heart, may help lower blood pressure, help control weight, and increase a person's overall feeling of well-being.

Materials

- bicycle tire pump
- 1 m of rubber tubing
- 2 funnels
- masking tape
- timer (stopwatch or clock with second hand)
- Heart Stress Test chart (p. 23)
- pen or pencil
- colored pencils
- science journal

Procedure

1. To demonstrate the pumping action of the heart, pull the handle up on the bicycle tire pump and push it down. Repeat several times and feel the air that is pumped through the hose.
2. Think about how this pump is similar to a heart. Instead of pumping air, the heart pushes blood throughout the body. In your science journal, describe how you think the heart works.
3. To listen to the sound your heart makes as it works, make a simple stethoscope.
 - a. Attach a funnel to one end of the rubber tubing with masking tape.
 - b. Repeat and attach the second funnel to the other end of the rubber tubing. See diagram 1.
4. Sit still for about 3 minutes in a quiet location.
5. Tightly hold one funnel up to your ear.
6. Hold the other funnel up to your heart or a partner's heart (remember the heart is located slightly to the left of the middle of your chest).
7. While continuing to sit, listen carefully until you hear the sound of the heart beating. See diagram 2.
8. Using the timer, count the number of heartbeats in 10 seconds. Record the number in your science journal.
9. To find the number of beats per minute, multiply the number of beats in 10 seconds by 6. Record the answer in the Heart Stress Test chart for Trial 1. Note: Another way for older students to find a pulse is to locate the pulse in the inner wrist, neck, or temple and to place two fingers over the pulse. As they feel the pulse beat, they can count the number of beats for 15 seconds and multiply by four.
10. Repeat steps 5–9 for two more trials. See diagram 3.
11. Find the average of the three numbers and record it in the chart. This number is your average sitting heart rate.

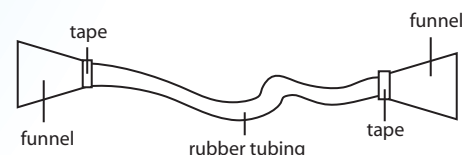


Diagram 1



Diagram 2

Pumping Up the Stress

Segment 1

12. Predict what will happen to your heart rate after you begin physical activity and as activity is increased. Record your predictions in the space provided at the bottom of the chart.

13. To find your standing heart rate, stand up and wait about a minute. Repeat steps 5–11 while standing.

14. Use steps 5–11 as a guide to determine your heart rate while performing the following activities.

a. In an open area away from objects and people, swing your arms back and forth for 20 seconds.

b. Wait 2 minutes to allow your heart rate to return to normal and then walk briskly around the room for 30 seconds.

c. Wait 2 minutes and then hop 25 hops around the room.

d. Wait 2 minutes and then run in place for 30 seconds.

15. Make a graph to show how your heart rate changed during each of the activities. Be sure to include your sitting heart rate on the graph.

16. Compare your data to that of other students in your class. How do you compare?

17. Using each student's data, calculate the class's average heart rate for each activity and graph the results. Discuss results, looking for patterns.

18. Create a new graph to compare the heart rates of boys versus girls.

a. Choose two different colored pencils.

b. Calculate the average heart rate for the girls for each activity and graph the results in one color.

c. Calculate the average heart rate for the boys for each activity and graph the results on the same graph but using a different color.

19. Compare the graphs of the average heart rate for the various activities between the girls and the boys in your class and discuss any similarities or differences between the two sets of data.

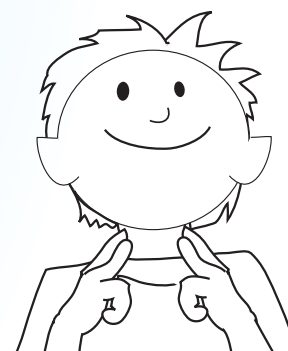
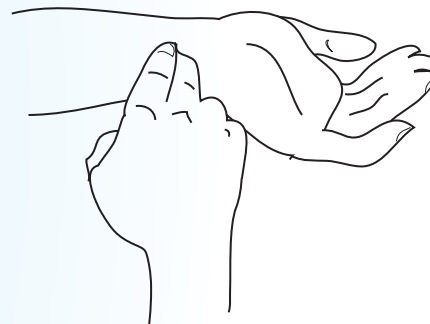


Diagram 3

Discussion

1. When was your heart rate the slowest? When was it the fastest?
2. Did your heart rate increase with physical activity? Why or why not?
3. How do you think an extended period of physical activity would affect your heart rate?
4. Was there a difference between the heart rate of the girls versus the heart rate of the boys? Why or why not?
5. Why is aerobic activity important?

Extension

1. Extend the various activities for a longer period of time. Record the new heart rates and the length of the activity.
2. Research to learn more about the heart and its parts. Make a diagram of the inside of the heart.
3. Build a 3-D model of the heart. Use the Internet and the library as resources to help make your model.
4. Have a teacher or parent contact a grocery store meat department or meat packing plant to obtain a cow or pig heart for dissection.

Pumping Up the Stress

Segment 1

Heart Stress Test Chart

Activity	Trial 1 Beats per Minute	Trial 2 Beats per Minute	Trial 3 Beats per Minute	Average * Beats per Minute
Sitting				
Standing				
Swinging Arms				
Fast Walk				
Hopping				
Running				

* Note: To calculate the average number of beats per minute, add the three numbers for each activity and divide that number by three.

What will happen when activity is increased?

Prediction: _____

Stress This*

Segment 1

Purpose

To confirm that muscle strength and endurance increase over time with good stress

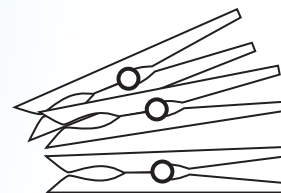
Background

When you think of stress, you usually think of something bad that is happening. Too much bad stress can harm your health, but not all stress is bad. Actually, stress is an important part of a healthy life. Walking, carrying heavy items, and climbing are all physical stresses. Reading, playing a board game, and doing your homework are all mental stresses. Our bodies require some physical and mental stress to be healthy and to grow. Physical stress happens when bones and muscles work against a force. Stress from physical activity is necessary for healthy, strong muscles. Physical stress is extremely important during the growing years, from birth until about age 25. Even after you stop growing, bones need physical stress to maintain thickness and strength. Muscles rebuild and grow as a result of physical stress. Stress can change muscle strength or muscle endurance (the ability to perform an activity for a long time without becoming tired). Muscle endurance is built through repetition. The more frequently muscles perform the same task, the better they become at completing the task and the longer they can perform the task before becoming tired or weak. High-intensity, short duration exercises (or stresses), such as weight lifting, cause muscles to increase in strength. Low-intensity, long-duration activities, such as running and swimming, cause muscles to increase in stamina.

Being fit and healthy means performing physical activities that will improve endurance, flexibility, and strength. When beginning a physical activity, it is important to do the right amount. Doing too much too soon might cause injury. Physical activities should be challenging, but not painful or exhausting.

Materials

spring-hinge clothespin
Stress This Table (p. 25)
pencil
timer (stopwatch or clock
with second hand)
science journal



Procedure

1. Write the date in the first row in the Stress This Table.
2. Predict the number of times you will be able to click the clothespin between your thumb and index finger in your dominant hand for a 1-minute period. (Your dominant hand is usually the hand you use to write.)
3. Record your prediction for trial 1 in the table.
4. Hold the clothespin in your dominant hand between your thumb and index finger.
5. Have your partner time 1 minute for you as you count the number of times you are able to click the clothespin.
6. Record the result for trial 1 in the table.
7. Rest for 1 minute.
8. Make a new prediction for the number of times you will be able to click the clothespin between your thumb and index finger in your dominant hand for a 1-minute period.
9. Record your prediction for trial 2 in the table.
10. Repeat step 5–7 for trial 2.
11. Repeat step 8–9 for trial 3.
12. Repeat step 5–7 for trial 3.
13. Switch roles with your partner and repeat steps 1–12.
14. Predict what would happen if you used your nondominant hand. Record your prediction in your science journal.
15. Repeat the experiment with your nondominant hand.
16. In your science journal, describe what happened over the course of the 3 trials.
17. Repeat steps 1–19 every other day for 2 weeks (7 more times). Record your data in the Stress This Table.



Stress This*

Segment 1

18. In your science journal, describe what happened over the course of the entire experiment.
19. Graph your results over the 2-week period.
20. Compare the results of the boys and girls in your class. Discuss any similarities and/or differences.

Discussion

1. Compare the number of clicks on the first day to the number of clicks after 2 weeks. Describe any pattern.
2. How did your results compare with your predictions?
3. What does this activity tell you about physical stress and the body?
4. Was there a difference between the boys and girls? Why or why not?

Extension

Based on what you learned from this activity about muscle strength and endurance, do the following activities:

1. Time yourself as you write your full name 10 times. Time yourself again as you write your full name 10 times backwards. Record the time it took you for both trials in your science journal. Why do you think there was a difference in the two times? Practice writing your name backwards several times over the next few days. What happens to the time needed to write your name? Explain any differences between times.
2. In a large, open space, stand with your feet flat on the ground. Long jump as far as you can. Measure the distance you jumped and record it in your science journal. Repeat this activity 3–5 times. What happens to the distance you are able to jump? Practice this jump every other day for a week. Now record the distance you are able to jump. Explain any differences in jumps.
3. Time yourself as you stand on one foot. Stop the timer when you can no longer hold your leg up. Record the time in your science journal. Repeat this activity several times. What happens to the length of time you are able to stand on one foot? Why?

Stress This Table

Date	Trial 1				Trial 2				Trail 3			
	Prediction		Actual		Prediction		Actual		Prediction		Actual	
	Dom	Non	Dom	Non	Dom	Non	Dom	Non	Dom	Non	Dom	Non

(In the table, Non stands for nondominant and Dom refers to dominant.)

* This hands-on activity was adapted from activities in *From Outer Space to Inner Space/Muscles and Bones: Activities Guide for Teachers* created by Baylor College of Medicine for the National Space Biomedical Research Institute under NASA Cooperative Agreement NCC 9-58. The activities are used with permission of Baylor. All rights reserved. For additional activities visit http://www.nsbri.org/Education/Elem_Act.html

A Simple Yarn*

Segment 1

Purpose

To examine the structure of skeletal muscles

Background

Even though our skeleton supports our body, we could not stand, balance, or move without muscles. There are over 600 muscles throughout the body. Muscles are responsible for every movement. Muscles are classified as smooth muscle, cardiac muscle, or skeletal muscle. Smooth muscles work automatically without the need to think about or plan the movement. Breathing and blinking are examples of your smooth muscles at work. Cardiac muscles are found only in your heart. These muscles are responsible for making your heart pump. Skeletal muscles follow commands from your brain to help move your bones. When you run, climb, or chew, you are using your skeletal muscles. Movement happens when muscles contract and become shorter. Muscles are made of bundles of fibers that are similar in structure to a piece of yarn. Individual fibers may be easily torn or destroyed, but the bundles help make the muscles stronger and more durable.

Materials

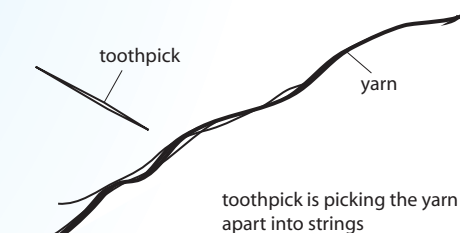
piece of yarn
toothpicks
cooked beef stew meat
plastic knife
tray or plate
magnifying glass
Muscle Investigation
Worksheet (p. 27)
ruler
scissors
pencil
science journal
plastic gloves

Teacher Prep

Cook several cubes (2.5-cm cubes) of beef stew meat. Cool thoroughly. Students may wish to wear plastic gloves when handling the meat.

Procedure

1. Using your ruler and scissors, cut a piece of yarn 15 cm long.
2. Examine the piece of yarn with your magnifying glass.
3. Draw a picture of what the yarn looks like in the Yarn Investigation Table.
4. Perform a snap test on the yarn by holding the yarn at both ends and trying to break it by pulling or snapping it.
5. Record the result of the snap test in the Yarn Investigation Table.
6. Using a toothpick, separate the yarn into strands.
7. Observe a strand of yarn with your magnifying glass.
8. Draw a picture of what the strand looks like in the Yarn Investigation Table.
9. Repeat steps 4 and 5 on the strand of yarn.
10. Pull the strand apart into smaller fibers.
11. Observe the fiber with your magnifying glass and illustrate.
12. Place a piece of stew meat on a tray. Observe and note the meat fibers.
13. Using the plastic knife, slice the meat across the grain of the fibers.
14. Draw a top view and a side view of the meat in the Meat Investigation Table.
15. Cut another small piece of meat and try to tear it by pulling in the direction of the muscle fibers and then again across the direction of the fibers. Record your observations in your science journal.
16. Using a new toothpick, separate the meat into as many sizes of fibers within fibers as you can. Draw or describe the fibers in your science journal.



A Simple Yarn*

Segment 1

Discussion

1. Thinking about the snap tests on the yarn, what did you learn about the strength of muscles? Why are muscle fibers "bundled?"
2. In what ways are the meat and yarn similar?
3. In what ways are they different?
4. How do muscles help with physical activity?

Extension

Observe various other types of cooked meat (chicken, pork, or others). Conduct similar tests on these meats. Compare and contrast the meats. Describe how the results are similar and/or different to those you found with the beef stew meat?

Muscle Investigation Worksheet

Yarn Investigation

	Appearance	Result of snap test
Yarn		
Strand		
Fiber		

Meat Investigation

Top View	Side View

* This hands-on activity was adapted from activities in *From Outer Space to Inner Space/Muscles and Bones: Activities Guide for Teachers* created by Baylor College of Medicine for the National Space Biomedical Research Institute under NASA Cooperative Agreement NCC 9-58. The activities are used with permission of Baylor. All rights reserved. For additional activities visit http://www.nsbri.org/Education/Elem_Act.html

As We Are “Jointed” Together*

Segment 1

Purpose

- To construct an arm model
- To discover the relationship between muscles and bones
- To learn about the different kinds of body joints and how they move

Background

There are three main body parts responsible for moving bones: ligaments, tendons, and muscles. Ligaments are strong, elastic bands of tissue that connect bones together. Tendons are special cords made of tough tissue that attach muscles to bones. Muscles move the bones. These muscles are either attached directly to the bones or by tendons to the bones. Muscles make the joints move by contracting or becoming shorter and pulling two bones closer together. Muscles can only move in one direction. They can only pull, not push. For this reason, muscles must work in pairs. One muscle or group of muscles will bend one part of a joint while a different muscle or muscle group will pull it back to its original position. The place where the muscle is attached to the bone affects the amount of movement the bone can make. There are many muscles for every bone. The movement of a muscle and joint is comparable to a simple machine; for example, the arm is like a lever.

The place where two bones meet is called a joint. Some joints can move, while others do not. Joints that do not move are called fixed joints. Your skull has fixed joints. Moving joints allow you to move your body to walk, eat, and play a video game. Some joints move a lot while other joints move very little. Joints in your spine have very minimal movement. Joints in your arms and legs have a broader range of motion. There are two basic moving joints in the human body: the hinge joint and the ball and socket joint. The hinge joints are in your elbows and knees and allow you to bend and to straighten your arms and legs. The joints are similar to the hinges on a door. Most doors can only open in one direction. It is the same with your arms and legs. They can only move in one direction. There are smaller hinge joints in your fingers and toes. The ball and socket joint is in your shoulders and hips and is made up of a round end of bone that fits into a small, cup-shaped area of another bone. Ball and socket joints allow you to move in more than one direction.

Teacher Prep: Cut a tennis ball in half and remove inside material.

Materials

- 2 rulers with holes for a 3-ring binder
- 1 paper clip
- 50-cm string
- 1 brad
- clear tape
- protractor
- metric ruler
- marker
- Arm Model Chart (p. 30)
- large construction paper
- tennis ball cut in half
- foam ball slightly smaller than a tennis ball
- pencil
- science journal

Procedure

- Place the rulers so that the smooth sides are together.
- Using the brad, fasten the end holes on both rulers together.
- Fold the ends of the brad flat against one ruler.
- Tape only the ends of the brad in place. See diagram 1.
- The attached rulers represent the upper and lower arm. The brad represents the joint, or in this case, the elbow.
- Open the paper clip into the shape of an “S” to make a hook.
- Place the string on a flat surface.
- Smooth out one end of the string and measure 5 cm from the end. Mark the distance with a colored marker.
- Tie the unmarked end of the string to one end of the paper clip. The paper clip represents a tendon connecting muscle to bone. The string represents a muscle. See diagram 2.
- Position the arm model into an “L” shape.
- Place the model on a flat surface, such as a table, so that one ruler lies horizontally and the other ruler is vertical. The joint should rest off the edge of the flat surface to allow the rulers to move freely.
- Hook the paper clip through the farthest hole from the joint in the ruler resting on the table.

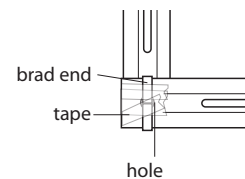


Diagram 1

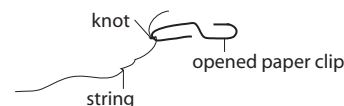


Diagram 2

As We Are “Jointed” Together*

Segment 1

13. Thread the marked end of the string through the top hole of the vertical ruler. See diagram 3.
14. Slowly pull the string through the hole in the vertical ruler, stopping at the 5-cm mark. Be sure to hold the elbow joint to keep the rulers steady. The horizontal ruler should rise up off the flat surface.
15. Measure the distance between the tip of the bottom ruler and the flat surface.
16. Record your measurement on the Arm Model Chart.
17. Ask a friend to place a protractor on the table, lining up the center of the protractor with the hinge joint (brad).
18. Measure the angle of the lifted arm and record this measurement.
19. Return the arm model to the “L” position.
20. Move the paper clip into the middle hole of the horizontal ruler.
21. Predict what will happen when you move the string. Record your prediction in your science journal.
22. Repeat steps 15–19.
23. Move the paper clip into the hole closest to the joint on the horizontal ruler.
24. Predict what will happen when you move the string. Record your prediction in your science journal.
25. Repeat steps 15–19.
26. In your science journal, draw a picture of the arm model. Use arrows to show the range of motion for a hinge joint.
27. To demonstrate a ball and socket joint, carefully stick the sharp end of a pencil into the foam ball. The pencil and foam ball represent the rounded end of a bone that fits into the socket.
28. Place the foam ball (round bone) into one half of a tennis ball (socket).
29. Practice moving the bone around in the socket.
30. In your science journal, draw a picture of the bone movement. Use arrows to show the range of motion for the ball and socket joint.

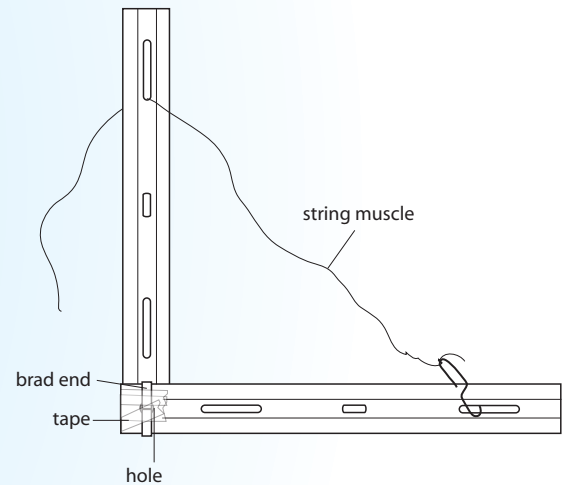


Diagram 3

Discussion

1. Based on your observations of the arm model, how does the placement of the muscle affect the movement of the bone?
2. Where would you expect the ends of a muscle to be attached if the objective was to achieve the most movement for the least amount of effort? Why?
3. Which joint gives you the greatest range of motion?
4. What are the advantages/disadvantages of a hinge type joint?
5. What are the advantages/disadvantages of a ball and socket joint?
6. Describe the role joints have in physical activity.

As We Are “Jointed” Together*

Segment 1

Extension

1. Devise a way to connect another string muscle to the ruler arm model that would straighten the arm back out. Remember that muscles can only pull, not push.
2. Learn about other joints in the body, such as fixed or unmovable joints and pivot joints. Make models of the different joints and explain how they work.
3. Imagine if your body had only one type of movable joint. What would you be able to do if you only had hinge joints in your body? What would you be unable to do? What could you do if you had only ball and socket joints in your body? What would you be unable to do?

ARM MODEL CHART

Ruler Position	Distance ruler is raised from table (cm)	Angle ruler is raised from table (number of degrees)
Position 1: farthest hole from “joint”		
Position 2: middle hole		
Position 3: closest hole to the “joint”		

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Pairing Up

Segment 1

Purpose

- To construct an arm model
- To demonstrate the need for muscle groups

Background

Muscles move by contracting. Muscles can only pull, not push. For this reason, muscles must work in pairs to move bones in multiple directions. The biceps and triceps are muscles located in the upper arm. The biceps are attached on one end to a bone in the shoulder and on the other end to a bone just below the elbow. You can feel these muscles in the inside of the upper arm. When they contract, they pull the lower arm up towards the shoulder. The triceps are on the back side of the upper arm. One end of the triceps is attached to a bone in the shoulder, and the other end of the triceps is attached to a bone just below the elbow. You can feel these muscles on the outside of the upper arm. When the triceps contract, they pull the lower arm back down, away from the shoulder. Without the biceps or triceps, the lower arm could not move up and down.

Materials

- 6 sheets of newspaper
- metric ruler
- masking tape
- large safety pin or paper clip
- clip
- hole-punch
- 2 long, thin-shaped balloons
- string
- 1 disposable glove
- scissors
- science journal

Teacher Prep

Partially inflate two long, thin-shaped balloons. Do not over inflate them because they need to bend easily. Tie the ends of the balloons securely. To make inflation easier, use a hand-held air inflator.

2 sheets of newspaper cut to length

****Caution – Use care when working with balloons. Adult supervision required.**

Procedure

1. Estimate the length of your upper arm and the length of your lower arm.
2. Write your estimations in your science journal.
3. Measure the length of your upper arm. Record the measurement in your science journal.
4. Measure the length of your lower arm. Record the measurement in your science journal.
5. To create a model of your arm bones, roll 2 sheets of newspaper together to make a tube. Cut the tube so that it is about the same length as your upper arm bone.
6. Tape the ends of the tube closed with masking tape.
7. Roll 2 more sheets of newspaper to make a second tube and make this tube about the same length as your lower arm bone.
8. Repeat step 7 to make an identical tube for the lower arm. (You should have 3 paper tubes in all.)
9. Put the 2 lower arm bones side by side.
10. Using masking tape, tape the ends of the tubes together so that there is a small space between the two arm bones. See diagram 1.
11. Using the hole-punch, make a hole in one end of the upper arm model.
12. Punch another hole in one end of the lower arm model.
13. Stick the pin or paper clip through the holes to connect the upper and lower arm bone models. See diagram 2.
14. Label the tube for the upper bone "humerus."
15. Label the tube on the lower inside of the arm "ulna."
16. Label the tube on the lower outside of the arm "radius." See diagram 3.

Humerus

Diagram 1

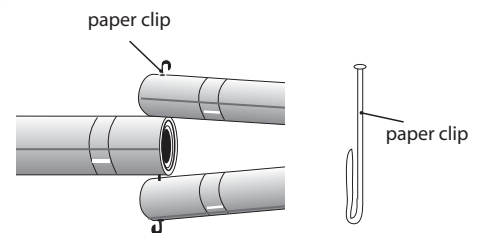


Diagram 2

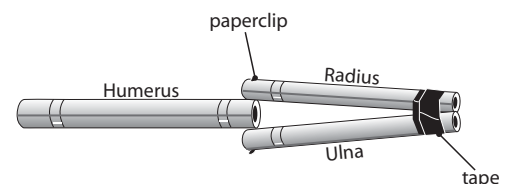


Diagram 3

Pairing Up

Segment 1

17. Get two long, inflated balloons. They represent the upper arm muscles. **Note:** Your arm contains more than two muscles, but for this activity you will only use two to model the movement of the arm muscles.
18. Using string, tie the end of one balloon to the top of the upper arm bone model. This balloon represents the biceps muscle.
19. Tie the other end of the same balloon to the top of the lower arm model just below the elbow. See diagram 4.
20. Tie the second balloon to the top of the upper bone model on the opposite side of the model. This balloon will represent the triceps muscle.
21. Tie the loose end of the balloon to the top of the lower arm model just below the elbow, keeping the balloons parallel. See diagram 5.
22. Attach the disposable glove to the bottom (nonjointed end) of the lower arm bone to represent the hand. See diagram 6.
23. Practice moving the model arm carefully. Observe the joint and the muscles as the model arm moves.
24. Move one of your own arms up and down. With your other hand, feel the movement of the biceps and triceps muscles.
25. In your science journal, describe what you feel. Compare and contrast what you feel to what you see in the arm model.

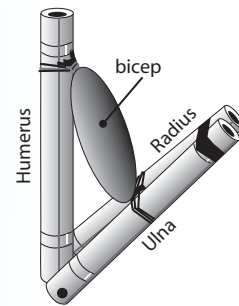


Diagram 4

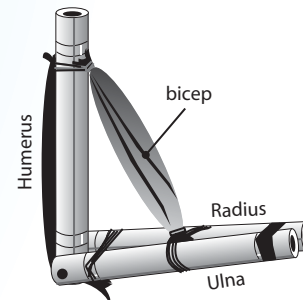


Diagram 5

Discussion

1. What happens to the model biceps when the model arm is lifted? What happens to the model triceps when the arm is lifted?
2. What happens to the biceps and triceps models when the arm is lowered?
3. What do you think would happen if you attached the model muscle (the balloon) farther down on the lower arm bone model? Higher up?

Extension

1. Reattach the ends of the model muscle on the lower arm bone model. Try different locations both higher and lower on the lower arm bone model. What happens when the model muscle is attached lower and higher? Why?
2. Look at your lower arm as you wiggle your fingers. Observe the muscles move as you wiggle your fingers. Illustrate the muscle movement.
3. Conduct research to learn more about the muscular and skeletal systems. How do these two systems work together?
4. Create a class chart to compare the arm bone measurements of all students. Make a table or graph to display the data. Compare the class data you collected to find any correlations between boys, girls, height, or other traits and characteristics.

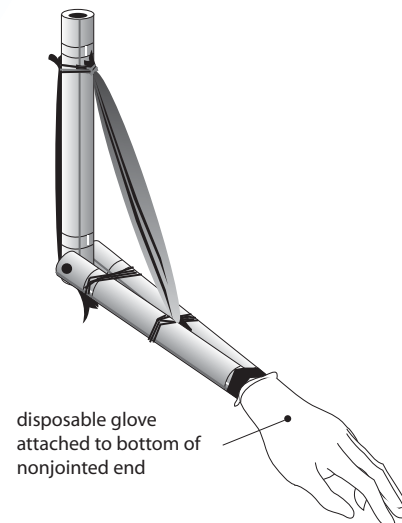


Diagram 6

Answer Key

Segment 1

Let's Get Physical

- Answers will vary, but students should conclude that value is demonstrated by an increased involvement in physical activities.
- Answers will vary.
- Answers will vary but may include the following: Physical activity can help tone muscles, burn extra calories, build healthy bones, and help control your appetite. People who are physically active tend to have more energy, are better able to deal with stress, and have a better body image. Physical activity can help lower the risk of heart disease.
- Answers will vary.
- Answers will vary, but may include riding a bicycle, swimming, playing sports, or running.

Pumping Up the Stress

- Your heart rate is slowest when sitting or resting. It will be fastest during high levels of physical activity.
- Yes. As you increase your level of physical activity, the body needs more oxygen, so the heart must pump faster to bring that oxygen to the cells that need it.
- Your heart rate will increase as the physical activity begins, but it will reach a plateau. It will continue beating at the faster rate to supply oxygen to the body; however, your heart rate will not continue to climb.
- Answers will vary.
- Aerobic activity helps to keep our heart and body healthy. It literally pumps energy around the body. As the pulse rate rises, an increase in blood and oxygen is supplied to muscles and vital organs. Endorphin levels rise, helping to calm the mind. Metabolism increases as well. Aerobic activity conditions the heart and skeletal muscles, making us more efficient at using energy.

Stress This

- The number of clicks should increase throughout the 2-week period.
- Answers will vary.
- The activity explains that muscle endurance and strength are increased by frequently requiring muscles to perform the same task. The muscles become better at completing the task and can perform the task for longer periods of time without becoming tired or weak.
- Answers will vary. Differences may be seen most among groups that are involved in physical activities that require the use of their hands.

A Simple Yarn

- The snap test showed that the greater the number of fibers, the greater the strength of the muscle. As you pulled the muscles apart, it took less and less energy to break the strands. Muscles have to be strong to contract and lift the bones, making movement possible. Without the extra strength of the muscle fibers, a task as simple as picking up a book might cause a muscle to tear.
- Both the yarn and the meat are made up of smaller strands and fibers that are bound together to make them stronger.

- The meat fibers are actually muscle tissue that stretches, allowing the fibers to contract or shorten to do their job. These meat muscles are bundles of fibers packaged inside one another. Each bundle is filled with hundreds of even smaller strands. The yarn fibers are not very elastic; they hold the same shape. Yarn fibers are the same size, woven together to make a thicker strand.
- Muscles help the body stand, balance, and move. Smooth muscles work automatically to help with functions such as breathing, and cardiac muscles keep your heart beating.

As We Are "Jointed" Together

- The farther from the joint that the muscle is attached, the smaller the amount of bone movement; however, the closer the muscle is attached to the joint, the greater the effort needed to move the bone.
- Answers will vary, but students should understand that muscle placement balances the movement of the bone with the effort of the muscle, so large amounts of movement can occur with a relatively small amount of contraction.
- A ball and socket joint gives the greatest range of motion.
- A hinge joint provides strength and stability but only allows movement in one swinging direction.
- A ball and socket joint gives the user more flexibility, allowing movement in several directions, but does not provide stability. If your knees, for example, were ball and socket joints, your lower legs would move all around but would not be stable enough to hold up your body.
- Joints provide a way for the bones to move in different directions so that activities like riding a bicycle or throwing a ball are possible.

Pairing Up

- As the model is raised, the biceps muscle will contract and become relaxed and loose while the triceps muscle is stretched tightly.
- When the arm is lowered, the opposite occurs. Now the biceps muscle is stretched tightly and the triceps muscle contracts and becomes relaxed and loose.
- Answers will vary, but students should understand that the muscle is attached in a place that provides the most efficient movement. Changing the location of the muscle will change the amount of movement allowed and the amount of energy required to move the bone.

On the Web

Calling All Body Parts

- Body systems work together, like a machine, to make physical movement possible. Muscles and joints move bones; bones support the body as it moves; the heart pumps oxygen-rich blood throughout the body, supplying energy for movement.
- Answers will vary, but students should understand that some organs are essential, like the heart, but that physical activity is still possible if one is missing a leg or a finger.
- The President's Council on Physical Fitness reminds us to be physically active every day, to eat a nutritious diet, to get preventative screenings, and to avoid risky behaviors.