

Teacher's Guide

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Note: Additional Resources are listed at the end of each Classroom Activity

This guide was developed at OMSI in conjunction with *Bone Up On Bones*, an OMSI exhibit.



Funded by
Regence BlueCross/BlueShield of Oregon (Regence BCBSO).



*Comments on how to improve this activity from teachers and students are welcome.
Please send to teachers@omsi.edu*

Exhibit Overview

Want to keep moving? Every move you make depends on the 206-odd bones in your body, yet you hardly notice them until something goes wrong. Discover the marvels of the human skeletal system and get an inside look at what makes up bones in ***Bone Up On Bones***, a hands-on health science exhibition developed and produced by the Oregon Museum of Science and Industry (OMSI).

This exhibition explores the connection between bone health and overall well being through hands-on interactives, an eight-foot bone sculpture, a fiber optic display, microscopic bone images, real bone specimens, audio and video components, computer-based activities, and impressive bone illustrations.

Visitors learn that bone health contributes significantly to their general health and that there are ways to positively affect bone strength throughout life, particularly during childhood and adolescence. Designed for families, school children, and adults of all ages, ***Bone Up On Bones*** explores bone physiology, bone function, osteoporosis, and the importance of calcium, vitamins, and exercise to build and maintain bone strength.

Introduction

Why Bone Up On Bones? Want to Keep Moving?

This introduction panel gives an overview of the importance of bones, what they need to stay healthy and last a lifetime, and that it is never too early or too late to start taking care of your bones. Find out that bones act as body armor to protect your vital organs, are the framework that support your body, and allow you to stand upright and move around. Realize also that bones are alive and repair themselves, and that they require calcium, vitamins, and exercise to build and maintain their strength.

Bone Physiology and Function

Bonescape: Your Living Bone

Stand beside a giant, colorful, eight-foot cutaway sculpture of a human femur and get an inside look at the amazing architecture of living bone. Trace veins and arteries as they snake through the bone's inner cavity and learn how blood vessels supply nutrients to, and carry wastes from, every bone cell. Discover how tendons attach muscle to bone, ligaments attach bone to bone, and cartilage cushions and lubricates the surfaces where bones meet. See the compact, concentric rings and honeycomb-like spongy tissue that combine to make bones strong, yet light.

Sticks and Stones: Bones Break! Bones Heal!

Examine X-rays of various types of bone fractures (compression, avulsion, stress, greenstick, comminuted, and pathologic) and determine how the fractures occurred and how they can be treated to heal properly. Learn that your bones can withstand very major damage and can heal more completely than any other part of your body.

Joints: Where Bones Meet

Compare the different types of joints in your body and how they work by manipulating an anatomical and mechanical model of each of the following: thumb (saddle joint), foot (gliding joints), knee (hinge joint), shoulder (ball-and-socket joint), and neck (pivot joint). Discover how joints allow your body to move freely, how the skeletal joint is constructed, and that there are different kinds of joints that determine the type and range of motion for particular bones.

Computer Stations

A large skeleton hangs over the computer area, which features three identical computer stations, each offering the same selection of interactive programs about bones:

1. *Bone Trivia* – Click onto various areas of an interactive skeleton and find out the names of the different bones in the body, as well as some general information and fun trivia about each area.
2. *Bone Building* – Set variables such as your age, calcium intake, and lifestyle and note how these factors influence the density of your bone. Watch how bone breaks down and rebuilds itself at the cellular level by viewing a computer simulation of this remarkable process. Identify what foods are high in calcium and assess your individual calcium intake by answering a series of questions.
3. *Bone Diseases* – Select from a list of some of the more common and interesting bone diseases and learn what the disease is, who gets it, what the symptoms are, and how it's diagnosed and treated.
4. *Assess Your Risk* – Take a personalized bone health quiz to assess your individual risk for getting osteoporosis and discover how such risk factors as gender, age, diet, weight, exercise, and genetics can effect your chances. A doctor specializing in osteoporosis then “talks” to you about the results of your bone health assessment quiz and gives you some general and personalized information about nutrition, exercise, risk factors, and prevention. You can even print out your “action plan” and take it home with you.

Body Puzzle

See the skeleton in context with the rest of the body by putting together a puzzle of the human body. Observe the proper placement of bones in the body and that they are surrounded by and connected to muscle. Appeals to younger visitors as well.

Spare Parts: Total Hip Replacement

Explore what happens when a hip joint wears out and is replaced by an artificial joint. Learn about the process of hip replacement surgery by viewing actual video footage of the operation. Examine an artificial prosthetic and an actual human femur that has undergone hip replacement surgery and notice how the bone has grown around the steel of the artificial hip.

Osteoporosis and Prevention

Am I Losing My Bones?

Get an overview of osteoporosis by reading this large, three-sided graphic panel. Each panel focuses on a different theme:

- 1). *About Osteoporosis* - Learn what osteoporosis is, why it occurs, what the symptoms and consequences are, and who's at risk.

- 2). *Living With Osteoporosis* - Peruse the biographies of five women with osteoporosis and how it has affected their lives.
- 3). *Diagnosis and Treatment* - Explore how the disease is diagnosed, treated, and prevented.

Bone Tower

Stack a hollow bone up to the top with rods that represent calcium. Then push out the rods one by one and see how much “calcium” you can lose before the tower collapses. Observe that losing a little calcium will not make your bones weak right away, but, if you lose enough, your bones could break very easily. Appeals to younger visitors as well.

Never Too Early, Never Too Late

Choose from three different videos:

- 1). *Them (not so) Dry Bones* – Check out an animated, playful song geared toward younger visitors that provides basic, pertinent information about your bones: they hold you up; protect your vital organs; are connected to your body by ligaments, cartilage, muscles, and tendons; and need calcium to keep them strong.
- 2). *Bones In Motion* – Observe X-rays of bones in motion and get an inside look at parts of your body in action: foot, wrist, spine, knee, elbow, hip, fingers, and shoulder. You can even watch a skeleton play the guitar and sing into a microphone.
- 3). *Bone Building* – Bones are alive and constantly building and rebuilding themselves. View footage from an electron microscope that demonstrates this process of renewal and witness new bones being made and older bones being destroyed. Did you know it is estimated that the human skeleton is completely rebuilt every two years?

Your Calcium Bank: Preventing Osteoporosis

See how lifetime factors and habits affect the relative density of bone at age 60 in this fiber-optic display that simulates changing bone density. Set the factors that influence bone density (gender, lifetime calcium intake, heredity, and lifestyle) and watch “bone cells” light up a femur. Change one or more of the variables and observe how that increases or decreases the density of the bone. Discover there are ages when calcium intake is particularly important to maximize “peak bone mass” potential and that there are recommended levels of calcium intake at different ages. By eating calcium-rich foods at any stage in life, you can reduce your future risk of osteoporosis.

Lost Bone: Which Femur has Osteoporosis?

Compare two actual human femurs and see if you can determine which one is healthy and which one is osteoporotic. Then lift each bone and feel the difference in weight. Notice how light and fragile the osteoporotic bone is and how much more likely it would be to fracture.

Your Visit / Field Trip

Educational research (yes, you can get a Ph.D. studying field trips) has identified the following recommendations for making the most of your field trip.

Before the Trip

- **Student knowledge of field trip setting and agenda is important.**
Studies suggest that children in a novel environment initially focus their attention on learning about the setting rather than the instructional material. Prior information about the trip agenda (how we will get there, where we will park, what we will see, what we can buy, where we will eat, etc.) will enhance your students' educational experience. In one study, this kind of information enhanced learning more than prior information about the subject of the exhibit (of course, both are valuable)!
- **Prepare students with pre-visit activities.**
See the Classroom Activities section of the guide for ideas related specifically to the exhibit. Pre-visit activities can also include vocabulary words, reading and writing assignments, classroom projects, and related activities found in existing textbooks and recommended resources.
- **Prepare your chaperones.**
Check with your field trip destination for specific expectations, such as number of chaperones per class. Before a trip, inform your chaperones about the purpose of the visit, behavior expectations, and your school's policies.

During the Trip

- **Have students use the Active Learning Log.**
The Active Learning Log (A.L.L.) is a great alternative to a conventional scavenger hunt. The questions help keep students focused and involve them in deeper exploration of the exhibits. The A.L.L. is available on the following pages along with an answer key for teachers and chaperones.

After the Trip

- **Follow-up with post-visit activities.**
Post-visit activities help to connect the museum experience to the classroom. Exhibits at the museum may spark curiosity or interest, which can be taken advantage of back in the classroom. You can also use the A.L.L. as the basis for a follow-up activity.
- **Help us evaluate your museum experiences.**
Your feedback is vital for our evaluation and improvement of our exhibits and other educational offerings. Please share your comments with us during your visit. *In fact, please send any comments from teachers and students on how to improve this activity to: teachers@omsi.edu Thank you!!!*

Active Learning Log

Hints

The active learning log may be copied and used by individual students or by small groups. For small groups, direct the students to work as a team to complete the activities. For younger children or non-readers, adult chaperones can assist with reading and recording responses. Remember to supply pencils!

- **Hint 1:** If you hand out worksheets to a large group, tell some to start in the middle and some at the end. If a particular exhibit is crowded, visit one of the other suggested exhibits to explore.
- **Hint 2:** Customize your worksheets for your class. Cut and paste from any of the activity pages to make a worksheet just for your class.
- **Hint 3:** Provide students with a writing surface (clipboard, notepad, etc.) with a pencil attached to it.

Active Learning Log Worksheet

Name: _____

- 1). Give one example of each type of joint. Where is it located in the body?

Type of joint

Location in the body

(Visit: *Joints*)

- 2). How can you keep healthy bones?

(Visit: *Your Calcium Bank, Am I Losing My Bones?, Why Bone Up On Bones?*)

- 3). Where is red marrow located? What does it do?

(Visit: *Bonescape*)

- 4). What does *osteoporosis* mean?

(Visit: *Bone Tower, Am I Losing My Bones?*)

- 5). How is a bone with osteoporosis different from a healthy bone?

(Visit: *Lost Bone, Am I Losing My Bones?*)

Active Learning Log

Answer Key

Name: _____

- 1). Give one example of each type of joint. Where is it located in the body?

Type of joint

Ball-and-socket

Gliding

Hinge

Pivot

Saddle

(Visit: *Joints*)

Location in the body

Shoulders, hips

Ribs, feet, hands

Knees, elbows

Elbows, base of skull

Thumb

- 2). How can you keep healthy bones?

[Exercise, get enough calcium and vitamin D, and avoid smoking and excessive drinking.]

(Visit: *Your Calcium Bank, Am I Losing My Bones?, Why Bone Up On Bones?*)

- 3). Where is red marrow located? What does it do?

[Red marrow fills the spaces in spongy bone and produces red blood cells which carry oxygen throughout the body.]

(Visit: *Bonescape*)

- 4). What does *osteoporosis* mean?

[Porous bones.]

(Visit: *Bone Tower, Am I Losing My Bones?*)

- 5). How is a bone with osteoporosis different from a healthy bone?

[An osteoporotic bone has lost minerals, making it less dense and more easily fractured than a healthy bone.]

(Visit: *Lost Bone, Am I Losing My Bones?*)

Classroom Activities

Bring *Bone Up On Bones* to school with these hands-on classroom activities. They can be used before or after your field trip. Grade levels are intended as guides only.

Activities

- **Calcium Collage (Grades K-4)**
Students discover which foods and activities help create and maintain healthy bones. In this exercise, they assemble a collage by looking through magazines and cutting out pictures of calcium-rich food and activities that help keep bones healthy.
- **Sketch a Skeleton (Grades K-4)**
Students understand the structure of the human skeletal system by building a life-size representation. Note: This activity is best done after visiting the *Bone Up On Bones* exhibit.
- **Bendy Bones (Grades 3-5)**
Students develop an understanding of the importance of calcium for strong bones. In this experiment, the calcium from a bone or eggshell dissolves in an acid solution (vinegar), leaving the bone (or egg shell) weak or bendy.
- **Heavy Metal (Grades 5-8)**
Students come to understand the composition of bones, what happens to bones as they age, and how one can limit calcium loss. In this activity, students make artificial “sponge bones” of different strength using plaster of Paris.

Calcium Collage

Objective: To discover which foods and activities help create and maintain healthy bones.

SCIENCE TOPICS	PROCESS SKILLS	GRADE
Bones	Comparing and Contrasting	K - 4
Nutrition	Predicting	(Sophisticated 4 th graders may prefer “Bendy Bones”)

NATIONAL SCIENCE STANDARDS

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LIFE SCIENCE, Grades K - 4

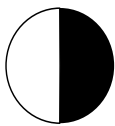
- Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light. Organisms can survive only in environments in which their needs can be met. The world has many different environments, and distinct environments support the life of different types of organisms.
- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.

SCIENCE IN SOCIAL PERSPECTIVE: PERSONAL HEALTH, Grades K - 4

- Nutrition is essential to health. Students should understand how the body uses food and how various foods contribute to health.

TIME REQUIRED

Advance Preparation



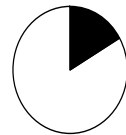
Set up



Activity



Clean Up



MATERIALS

- Construction paper (enough for each student)
- Glue
- Scissors
- Magazines for cutting
- Calcium rich foods – milk, cheese, leafy green vegetables, tofu, yogurt, etc.

ADVANCE PREPARATION

- Cut pieces of construction paper into bone shapes.
- Collect materials.

INTRODUCING THE ACTIVITY

Do all living things have bones?

No, living things such as plants, bugs, spiders, and worms do not have bones. All mammals, including humans, have bones for support, protection, and movement. Without bones, we would fall to the ground and not be able to move.

What can we do to keep our bones healthy?

Note: Let the students speculate about what makes bones healthy. Some actual examples are below. Students may know some or all of these examples.

- *Eating calcium rich foods, such as milk or other dairy products, some fish, dark green vegetables, tofu, etc.*
- *Eating foods that help us absorb calcium such as vitamin C (orange juice), vitamin D (in milk or from sunshine).*
- *Weight bearing exercise such as walking, running, carrying things, lifting weights.*
- *Getting outside during the day because the sun on our skin for a few minutes each day helps our bodies to make vitamin D to help us absorb calcium.*
- *Reducing the amount of foods that contain things that hinder the absorption of calcium into your body. Foods that reduce calcium absorption include oxalic acid (in chocolate).*
- *Reducing the amount of foods that contain things that cause you to lose calcium from your body. Foods that increase the loss of calcium from the body include phosphorus (very high in soft drinks) and extremely high amounts of protein, like an exclusively meat diet.*

Many foods contain calcium. Talk about different calcium rich foods with your students. As you talk about calcium rich foods, place the examples you have (milk, cheese, tofu, leafy greens, yogurt, etc.) in front of the students so they can see them. Pass out the supplies.

ACTIVITY PROCEDURE

1. Look through the magazines and have the students cut out pictures of calcium rich food and activities to help keep bones healthy.
2. Glue the cut out pictures to the paper bone.

DISCUSSION

What kinds of foods did you find?

Milk, cheese, yogurt, etc.

Was it easy or hard to find bone healthy foods advertised in the magazines?

Answers will vary with each student.

EXPLANATION

Calcium is a mineral that your body needs. Most of the calcium in your body is stored in your bones and teeth and helps make them strong. People get the calcium needed for healthy bones from the foods that we eat. Milk is one good source since it is mostly calcium, milk sugar (lactose), and other nutrients dissolved in water.

OPTIONAL EXTENSIONS

- Have students look up the calcium content of their favorite foods. (They could bring in the product labels or look it up in books or on web sites.)
- Students could visit a dairy, cheese, or ice cream factory to see where milk comes from and how dairy products are made.
- Have students work in pairs to trace their body outline onto a piece of butcher paper. Students can then draw in the major bones of the body.

CROSS CURRICULAR LINKS

Math

Students could conduct a survey of what calcium rich foods students like to eat and compare the data.

ADDITIONAL RESOURCES

Powerful Bones, Powerful Girls

<http://www.cdc.gov/powerfulbones/index2.html>

Got Milk

<http://www.got-milk.com/better/>

Food Pyramid Game

<http://www.scottforesman.com/resources/health/hpyramid.html>

Sketch a Skeleton

Objective: To understand the structure of the human skeletal system by building a life-size representation. Note: This activity is best done after visiting the *Bone Up On Bones* exhibit.

SCIENCE TOPICS	PROCESS SKILLS	GRADE
Human Body	Observing	K - 4
Skeletal System		Sophisticated 3 rd and 4 th graders prefer “Bendy Bones”

NATIONAL SCIENCE STANDARDS

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LIFE SCIENCE, Grades K - 4

- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.

TIME REQUIRED

Advance Preparation



Set up



Activity



Clean Up



MATERIALS

- Books of the human skeletal system
- X-rays if available
- Butcher paper
- Crayons, markers, etc.
- Scissors

ADVANCE PREPARATION

- Cut one piece of butcher paper per student. Make all the pieces longer than the tallest student.
- Set out paper and crayon stations in the classroom. Make sure there is enough room for each group to lie down on the ground.

INTRODUCING THE ACTIVITY

Who can name some parts of their body? How about some part inside your body?

We have bones and muscles, blood, etc.

We have ears, eyes, hair, feet, hands, belly buttons, fingers, knees, etc., outside our bodies. Inside our body we have a heart, lungs, stomach, brain, muscles, bones, liver, etc. (Optional – have students sing and move with the “Head, Fingers, Knees, and Toes” song.)

With all these body parts, which body part helps hold us together?

Our bones help give our bodies shape by providing places for the muscles to hold onto and providing a safe area for delicate organs such as the brain (skull) and the heart and lungs (ribs) to be.

Are all bones the same size? Are they all the same shape?

Some bones in our bodies are long while others are short. There are fewer bones in the legs and arms but they are long, big bones. The longest bone in the human body is the thighbone, or the femur. Your fingers and feet have many bones in them but they are very small. The smallest bones in the body are found in your ear! In general, the more flexible an area is, the more bones there are. Imagine how hard it would be to write or color a picture if you had long, solid bones for fingers. Also, not all bones are straight like your finger and leg bones. Can you think of some bones that are not straight (ribs and cranium)? These curved bones help to protect delicate organs.

ACTIVITY PROCEDURE

1. Break the class into groups of two. Depending upon your class, it might be best to pair up boys with boys and girls with girls.
2. Have the pairs find a spot on the floor.
3. Have one student lie down on the floor on top of the butcher paper, with their legs and arms out to the edge of the paper, while the other student uses a crayon to trace around their body.
4. Label the outline with the student's name.
5. Repeat with the other partner.
6. Using books with pictures of the skeleton, draw the major bones – arms, legs, ribs, hips, vertebrae, and skull onto the paper outline. Add simple drawings of hands and feet.
7. Have students cut the outline of their body out.
8. Cut the body into pieces creating a puzzle.

DISCUSSION

Does my puzzle look like me?

How is it the same, how is it different?

EXPLANATION

Our skeleton is made up of over 200 bones. Together, these bones support our body, help us move, and protect our organs. As you grow, your bones grow with you becoming larger and stronger. To help your bones grow, it is important to eat food high in calcium such as milk, cheese, and green vegetables.

OPTIONAL EXTENSIONS

- Students can label the major bones of their skeleton.

- Cut X-rays into pieces to make a more detailed puzzle.
- Students can assemble a plastic skeleton model.

CROSS CURRICULAR LINKS

Language Arts

Have students read, or read aloud, books about skeletons:

Eyewitness: Skeleton

By Steve Parker, Philip Dowell

Magic Color Skeleton: Incredible Animal Discovery

By Shaheen Bilgrami, Treve Tamblin, Mike Phillips

The Skeleton Inside You (Let's-Read-and-Find-Out Science 2)

By Philip Balestrino

Skeleton Hiccups

By Margery Cuyler, S.D. Schindler

ADDITIONAL RESOURCES

Mr. Bones

<http://www.enchantedlearning.com/crafts/halloween/bones/template.shtml>

The eSkeleton

<http://wnt.utexas.edu/%7Eeskeletons/>

Bendy Bones

Objective: To understand the importance of calcium for strong bones.

SCIENCE TOPICS	PROCESS SKILLS	GRADE
Human Body	Hypothesizing	3 - 5
Nutrition	Observing	Grades 6 – 8 may do this as a supplement to “Heavy Metal”
	Predicting	
	Questioning	

NATIONAL SCIENCE STANDARDS

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LIFE SCIENCE, Grades K – 4

- Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light. Organisms can survive only in environments in which their needs can be met. The world has many different environments, and distinct environments support the life of different types of organisms.
- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.

LIFE SCIENCE, Grades 5 – 8

- The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control and coordination, and for protection from disease. These systems interact with one another.
- All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.

SCIENCE IN SOCIAL PERSPECTIVE: PERSONAL HEALTH, Grades K - 4

- Nutrition is essential to health. Students should understand how the body uses food and how various foods contribute to health.

SCIENCE IN SOCIAL PERSPECTIVE: PERSONAL HEALTH, Grades 5 – 8

- Food provides energy and nutrients for growth and development. Nutrition requirements vary with body weight, age, sex, activity, and body functioning.

TIME REQUIRED

Overall activity takes about two weeks

Advance Preparation



Set up



Activity



Clean Up



MATERIALS

- Dish washing detergent and water
- Plain vinegar (about 8 oz. per student—enough to cover half an egg shell or bone in a jar)
- Small jars with lids (large enough to fit a bone or egg shells)
- Paper towels

Option A:

- Chicken bones

Option B:

- Brief access to a microwave
- Eggshell

ADVANCE PREPARATION

- Collect enough bones or eggshells for each child to have one (or have students work in groups and have one bone or eggshell for each group).
- Gently soak or wash the bones or eggshells in dishwashing detergent to eliminate the chance of contamination from Salmonella bacteria. If using eggshells, microwave the empty egg carton for 10 seconds while the eggshells are being washed so that any Salmonella will be killed before the clean eggshells are returned to the carton for storage or transport.
- Collect small jars, enough for one per child or group.
- For each child or group, set out a jar with lid, a bone or eggshell, tape or labels.

INTRODUCING THE ACTIVITY

How many bones are in the body? 206

Have you ever broken a bone? Or do you know someone who has broken a bone?

You can compare the number of bones in your body to the number of bones that you have broken. Students will very quickly realize that bones do not break easily.

What makes bones strong?

Note: Let the students speculate about what makes bones strong. Some actual examples are below. Students may know some or all of these examples.

- *Eating calcium rich foods, such as milk or other dairy products, some fish, dark green vegetables, tofu, etc.*
- *Eating foods that help us absorb calcium such as vitamin C (orange juice), vitamin D (in milk or from sunshine).*
- *Weight bearing exercise such as walking, running, carrying things, lifting weights.*
- *Getting outside during the day because the sun on our skin for a few minutes each day helps our bodies to make vitamin D to help us absorb calcium.*
- *Reducing the amount of foods that contain things that hinder the absorption of calcium into your body. Foods that reduce calcium absorption include oxalic acid (in chocolate).*
- *Reducing the amount of foods that contain things that cause you to lose calcium from your body. Foods that increase the loss of calcium from the body include phosphorus (very high in soft drinks) and extremely high amounts of protein, like an exclusively meat diet.*

What is calcium? Where do you find calcium in your body? In the world around you?

Calcium is a whitish mineral found in teeth, bones, eggshells, rocks, and even water (the white ring in a bathtub). It is also found in many foods, especially in milk, cheese, bones, and many dark green vegetables.

Explain to students that one of the things that makes our bones strong is a mineral called calcium and it comes from some of the foods we eat.

We are going to put our bones, or eggshells, in vinegar (an acid!) and observe.

What do you think will happen to the bone in vinegar?

Encourage students to make a hypothesis or prediction of what will happen. Have them write down their hypothesis. Have them write why they predicted what they did. If they have any previous knowledge about bones, eggshells, or vinegar, have them write down what they know.

ACTIVITY PROCEDURE

Option A. Experiment using Bones:

1. Label your jar with your name and the date.
2. Observe the bone and write your observations.
3. Put your bone in your jar.
4. Add vinegar until the bone is covered.
5. Screw the lid on tightly.
6. Wash your hands.
7. Observe the bone over two weeks. Write down your observations.
8. After two weeks remove the bone from the vinegar.
9. Observe the bone.
10. Record your observations in your journal.
11. Compare your observations to your observations of the bone before it was placed in vinegar.

Option B. Experiment using Eggs:

1. Label your jar with your name and the date.
2. Observe the eggshell and write your observations.
3. Gently put your eggshell in your jar.
4. Add vinegar until it is covered.
5. Screw the lid on tightly.
6. Wash your hands.
7. Observe the eggshell over four days. Write down your observations.
8. After four days, carefully pour out the vinegar and replace with water.
9. Remove the eggshell and place on a paper towel.
10. Observe the eggshell.
11. Record your observations in your journal.
12. Compare your observations to your observations of the eggshell before it was placed in vinegar.

DISCUSSION

What is vinegar?

Acetic acid, it is used for cooking and cleaning.

What happened to your bone or egg? Did it do what you hypothesized or predicted?

What changes did you observe?

What would happen if your bones dissolved or became bendy?

You would have trouble moving and standing straight.

What can you do to help keep your bones strong?

Eat foods full of calcium. Have the students make a list of foods high in calcium. Have them check food labels, as well as other sources.

EXPLANATION

Calcium is found in many rocks, as well as eggshells, bones, and seashells. Calcium can dissolve in water. When water rushes over calcium-rich rocks, the calcium can dissolve in the water and the water becomes “hard water.” Hard water can deposit the white calcium minerals into your bathtub, causing a white ring to form on the inside of the tub.

Most of the calcium in your body is stored in your bones and teeth and helps make them strong. You get the calcium to build strong bones from your diet. Milk is one great source of calcium. Milk is mostly water with calcium, milk sugar (lactose), and other nutrients dissolved in the water. That makes milk a good source of dietary calcium.

In the experiment, the calcium from a bone or eggshell dissolved into the acid solution (vinegar) leaving the bone (or eggshell) weak. Imagine if you did not have enough calcium in your body to make strong bones. This can happen if you eat very little calcium or if your diet is missing some nutrients that help you absorb and use calcium. This is especially true if you are missing vitamin D in your diet. Vitamin D can be found in certain foods, especially vitamin D enriched milk. (Check your milk carton at home to see if it has vitamin D added.) Vitamin D is also made by your body if you spend a few minutes every day with a few inches of skin exposed to the sun (even on a rainy, cloudy Oregon winter day, there is enough sun coming through the clouds to help your body make vitamin D!) During the early days of the Industrial Revolution, children had to work inside (out of the daylight) all day. Many of these children were not able to use calcium to build strong bones because they lacked vitamin D. The children ended up with a disease called rickets. This disease is characterized by short, weak, bowed out, leg bones. As the children would walk, their legs would bend under the weight. This disease could not be reversed in adulthood.

OPTIONAL EXTENSIONS

- Have students look up the calcium content of their favorite foods. (They could bring in the product labels or look it up in books and web sites). Try the math extension below.

CROSS CURRICULAR LINKS

Language Arts

Have students write descriptive stories about a character with bendy bones or all the places calcium travels when it is washed off a rock in a streambed.

Social Studies

Have the students report on rickets and child labor in the Industrial Revolution.

Math

Have students calculate the calcium content of their diet for one or more days. Calculate the class averages, find the mean, median, and mode. Have students determine the percentage they met of the recommended daily allowance (1200 mg.) Graph the numbers for the class over time.

Art

Have students create a poster to encourage others to eat calcium-rich foods.

ADDITIONAL RESOURCES

Powerful Bones, Powerful Girls

<http://www.cdc.gov/powerfulbones/index2.html>

Got Milk

<http://www.got-milk.com/better/>

Food Pyramid Game

<http://www.scottforesman.com/resources/health/hpyramid.html>

Heavy Metal

Objective: Students will understand the composition of bones, what happens to bones as they age, and how one can limit calcium loss.

SCIENCE TOPICS	PROCESS SKILLS	GRADE
Human Body, Skeletal System	Comparing and Contrasting	5 - 8
Nutrition	Controlling Variables	This is also good as a teacher-
Minerals	Formulating Models	lead demonstration for
	Graphing	grades 3 - 4
	Hypothesizing	
	Inferring	
	Interpreting Data	
	Measuring	
	Observing	
	Predicting	
	Questioning	

NATIONAL SCIENCE STANDARDS

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LIFE SCIENCE, Grades 5 - 8

- The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control and coordination, and for protection from disease. These systems interact with one another.
- All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.

SCIENCE IN SOCIAL PERSPECTIVE: PERSONAL HEALTH, Grades 5 - 8

- Food provides energy and nutrients for growth and development. Nutrition requirements vary with body weight, age, sex, activity, and body functioning.

SCIENCE AS INQUIRY, Grades 5 - 8

- Abilities necessary to do scientific inquiry.
- Understandings about scientific inquiry.

TIME REQUIRED

Overall activity takes about three days

Advance Preparation



Set up



Activity*



* plus two days drying time

Clean Up



MATERIALS

- Slightly moist sponges (not dry and brittle) enough for 3 cm. by 8 cm. (1.2 in. by 3.2 in.) sections for each student or group of students. It is important that all students use the same type and size of sponge so that comparisons can be made.
- Scissors
- Masking tape, labels, or permanent markers
- Plaster of Paris
- Measuring cups
- Tablespoons
- 16-oz. disposable mixing containers, one for each student or group of students (e.g., yogurt or cottage cheese containers)
- Water
- Stirring sticks, one for each student or group of students
- Weighing scale
- Old newspapers to protect work space

ADVANCE PREPARATION

- Collect supplies.
- Practice the experiment if you have not done so before.
- Prepare a table on the board, chartpak, overhead, or another shared location. At the table assign various quantities of plaster of Paris to each student or group of students. For example:

<i>Student Group</i>	<i>Amount of Plaster of Paris in 8 oz. (1 cup) of water</i>	<i>Weight of Dry, Hardened Sponge Bone (in grams)</i>	<i>Weight Bone Supports Before It Breaks or Cracks (in grams)</i>
Group 1: Joey, Ross, and Chandler	1 tbsp.	3.75 <i>(our sample data, do not enter)</i>	1800 <i>(our sample data, do not enter)</i>
Group 2: Monica, Phoebe, and Rachel	2 tbsp.		
Group 3: George W., Bill, and Ronald	3 tbsp.		
Group 4: Hillary, Tipper, and Laura	4 tbsp.	9.5 <i>(our sample data, do not enter)</i>	3000 <i>(our sample data, do not enter)</i>
Group 5: Peter, Paul, and Mary	6 tbsp.		
Group 6: Hawkeye, B.J., and Radar	8 tbsp.	14.5 <i>(our sample data, do not enter)</i>	3500 <i>(our sample data, do not enter)</i>

CAUTION: Plaster of Paris should not be rinsed or disposed of in sinks because it can harden and clog the plumbing.

INTRODUCING THE ACTIVITY

If bones are made of mineral, like we find in heavy metals, why are they so light?

If our skeleton was a steel frame, like a building or a bridge, we would seldom break our bones. On the other hand, we would weigh too much to move easily. Minerals do play an important role in structure of the body, but the main skeletal minerals, calcium and phosphorus, are deposited in a spongy matrix that provides strength without being too heavy. Birds' bones are even lighter and spongier to help them fly.

How do we build up calcium in our bones?

There are several ways to build strong bones.

- 1. Eat foods with a lot of calcium, such as dairy products, some fish, and some dark green vegetables.*
- 2. Eat foods that help us to absorb calcium from our foods, such as vitamin C, lactose, and vitamin D.*
- 3. Do regular weight-bearing exercise, like weight lifting or walking.*

How do we lose calcium from our bones?

Minerals in our bodies serve many purposes beyond structure and strength. For example, calcium regulates the transport of important substances in cells, including nerve cells. Calcium also is part of collagen, the glue that holds cells together. And calcium plays a role in blood clotting and heart regulation.

Whenever the body needs calcium for these important roles, it pulls calcium out of the bones. This weakens the bones if the calcium is not replaced. Under normal conditions, calcium is going in and out of our bones all the time. During pregnancy a woman typically loses more than 2% of the calcium from her leg bone in order to supply the growing baby with enough calcium.

There is another way to lose calcium--to pee it out. Because calcium functions as a partner with phosphorus in the body, where calcium goes, phosphorus is involved. So, if your diet is too high in phosphorus from soft drinks (diet or regular) or a high meat diet, the body will need to excrete (pass in the urine) the extra phosphorus. It will excrete calcium at the same time because calcium and phosphorus travel and function together in the body. This loss of minerals from our bones will weaken our bones if we are not taking in plenty of calcium in our diet.

In this activity we are going to make artificial bones of different strengths by adding mixtures of plaster of Paris into a sponge and letting them harden. Like bones, plaster of Paris is a calcium-based substance (calcium sulfate), which forms a hard cement when water is added. Plaster of Paris got its name because it was first developed near Paris, France. Carefully record the concentrations of plaster of Paris you use and carefully weigh your sponge bones before you test their ability to hold weight. The data you collect will be used to draw some conclusions about the strength of bones compared to their mineral content.

ACTIVITY PROCEDURE

1. Line your workspace with newspaper (about 10 sheets thick).
2. Label your lab notebook or data sheet with your name, the date, and the amount of plaster of Paris you have been assigned to add to your sponge “bone.” Create a data collection table in your lab notebook or on your data sheet. (You can see the teacher’s data table for an example.)
3. Cut a 3-centimeter (1.2 inches) by 8-centimeter (3.2 inches) rectangle from your sponge. This will be your “sponge bone.”
4. Label a 16-oz. or larger disposable container with your name, the date, and the quantity of plaster of Paris you have been assigned.
5. Measure 8 oz. (1 cup) of water into your container.
6. Measure your assigned quantity of plaster of Paris into your container and stir.
7. If your solution has settled at all, stir the solution again. Then submerge the sponge bone in the solution for 15 seconds. At this time, invert the sponge (turn it over) in the solution and let it sit another 15 seconds.
8. Remove and set on the newspaper to dry for 48 hours (over the weekend works well).
9. Do not dump your plaster of Paris solution. Instead, let the plaster of Paris dry in your container, pour off the liquid on top, and then dispose of the cup and dried solid in the trash.

CAUTION: Plaster of Paris should not be rinsed or disposed of in sinks because it can harden and clog the plumbing.

10. When the bone is dry, weigh it and record the weight on the class table and on the table in your lab notebook or on your data sheet.
11. Move two desks or flat surfaces close together so that they are about 2 ½ inches (about 7 cm.) apart. Position your dried sponge so that it bridges the gap between the desks, with an equal amount of sponge on each surface.
12. Test the amount of weight your bone can support without cracking or breaking by suspending an empty gallon milk jug from the bone “bridge” with a string. Does the bone break?
13. Next, add one cup of water at a time to the milk jug, making observations of your bone after each addition. Continue adding water until the bone cracks or breaks. Write the results on the class table and on the table in your lab notebook or on your data sheet.

DISCUSSION

Which sponge bones broke the most easily?

Were there any unexpected results? If so, why do you think they occurred?

Note that students may have measured wrong, let things dry for different amounts of time, or somehow conducted their trials differently. Any change in variables can impact the results. Discuss how to answer questions that remain (more trials, control variables, etc.)

How might this be similar to real bones?

Persons with insufficient calcium in their bones often suffer from fragile, brittle, easily broken bones. Examples include bones formed with insufficient calcium in the diet (osteomalacia), insufficient absorption of calcium due to lack of vitamin D (rickets), or loss of calcium, especially in old age, due to low calcium diets or low weight-bearing activity over many years (osteoporosis.) It is common for older people to suffer from broken bones, especially hipbones, due to osteoporosis. The doctors often say that the person's bone broke, and then they fell. That is because the impact on a weak, brittle bone during walking can actually break the bone of a person with osteoporosis, causing them to fall. Another sign of osteoporosis can be a hunched back from the backbone weakening.

Does anyone know an older person who has broken a hipbone?

EXPLANATION

When we age, the minerals that are part of our bones are depleted making them more porous, less dense, and more brittle. Our bones become less heavy and less strong. This activity demonstrates a model of the physiology of bones and can be used to compare the strength of bones when the amount of calcium in the bones is decreased. In older individuals, it is common for bones to lose calcium if the diet is insufficient in calcium over many years. The body responds to low dietary calcium by pulling calcium from the bones to maintain the needed calcium levels in the rest of the body. As a result, women often lose bone density with each pregnancy as the calcium is pulled from the pregnant mother's bones to build bones and teeth in the growing baby. Similarly, bone density will be lost if a person eats a diet with a lower than needed calcium level for an extended time. As a result, older people often have weak bones that break easily, and they often have stooped shoulders as their weak bones sag. An average person will say, "My poor grandmother fell down and broke her hip!" Doctors sometimes say, "My patient broke her bone and then she fell," meaning that the hipbone was so weak that the impact of walking caused it to break, thus causing the elderly person to fall.

OPTIONAL EXTENSIONS

- Do the experiment “Bendy Bones” to see what happens to the bone when the calcium is removed.
- Show students X-rays and scans of healthy bones versus bones of older people.

CROSS CURRICULAR LINKS

Social Science

Students could research osteoporosis, rickets, or osteomalacia and its affects.

Math

Have students graph the data and transform it into different charts. Have them convert measurements between English and Metric systems.

ADDITIONAL RESOURCES

Bones, Muscles, and Joints

http://kidshealth.org/parent/general/body_basics/bones_muscles_joints_p2.html

Medical Encyclopedia: Aging changes in the bones - muscles - joints

<http://www.nlm.nih.gov/medlineplus/ency/article/004015.htm>