

Portable Collections Program

The Human Skeleton



BROOKLYN
CHILDRENS
MUSEUM

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Table of Contents

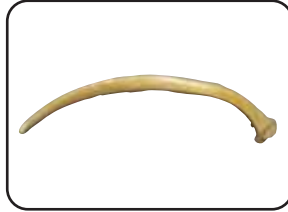
Checklist: What's in the Case? _____	1
Information for the Teacher: _____	3
How to Handle and Look At Museum Specimens	
An Introduction to the Human Skeleton	
Activities to Do with Your Students: _____	7
1 Introductory Activity: Beginning with Bones	
2 Bone Detectives	
3 Build a Bone from the Inside Out	
4 Strong Bones	
5 Joints: The Way We Move	
6 Bone Artwork	
7 Additional Activities and Curricular Connections	
Students Handouts: _____	17
Fun Bone Facts	
Working with Bones	
Resources and Reference Materials: _____	19
Vocabulary Words	
Connections with New York State Learning Standards	
Corresponding Field Trips	
Bibliography and Web Resources	

What's in the Case?

Specimens



Skull



Rib



Vertebra



Clavicle



Scapula



Ulna



Radius



Humerus



Carpals, metacarpals,
and phalanges



Pelvis



Femur



Tibia



Fibula



Patella

What's in the Case?

Tools & Resources

Miniature skeleton model

Skeleton poster

X-rays

Pictures of skeleton-themed art

Eyewitness Books: Skeleton by Steve Parker

Dem Bones by Bob Barner

Georgia's Bones by Jen Bryant

How to Handle Museum Specimens

Learning to handle specimens from the Museum's natural history collection with respect can be part of your students' educational experience of the case. Please share these guidelines with your class, and make sure your students follow them in handling specimens in the case:

- **Students may handle the bone specimens carefully, respectfully, and under your supervision.** Remind them that the bones are brittle and should not be twisted or bent.
- **Hold larger bones with two hands.** Smaller bones can be held at the ends.
- **Do not shake or twirl the bones.**
- **Temperature differences, direct sunlight, and water can be very harmful to museum objects.** Please keep them away from radiators and open windows, and keep them secure.



Notes about Object-Based Learning and Inquiry

Learning about the human body by examining a bone specimen is much different from by reading about it in a book. Specimens have the power to tell us many things, provided we are willing to look at them in detail and think about what those details mean. Encourage your students to carefully examine the bone specimens, touch them gently, and look at their physical details. Have them describe the specimen's shape, size, and color. Ask them questions about what they see, and what their observations might tell them. For example:

- What do you see in the specimens? Describe their shape, color, and structure. (It is important that your students use visual clues based on their observations when giving their answers.)
- What do you want to know about them?
- What else can you see?

You can assist this process by encouraging your students to examine individual bones in detail and think about what those details might mean. Ask them questions about what they see, and what that might tell them. As the conversation begins to grow, you can ask questions about how the specimen might have behaved and why it has the form it does:

- How big is this bone? How does it compare to the other bones in the case?
- What part of the body might it come from? How can you tell?

Providing books and Internet access for researching these and other questions encourages students to make discoveries that add to their knowledge about the natural world and its phenomena.

An Introduction to the Human Skeleton

To the teacher

The human body is a complex and mysterious thing, especially to a child. Children's bodies are growing and changing all the time, and their physical capacities and limits are still being tested. For children, the body is a frontier whose boundaries have not yet been discovered. The bones in this case are intended to help your students push those boundaries back even further by giving them a glimpse inside themselves. By handling these bones and examining them carefully, children will learn more about their own bodies and what they are capable of.

The activities and resources in this case focus on how bones relate to the structure of the human body in general, and to your students' bodies in particular. In many places we have indicated curriculum connections with other science topics, as well as math, literacy, and the arts. But these connections are only intended as a starting point for following your own and your students' interests. Your study of the human skeleton can extend in many other directions, including other bodily systems, comparative anatomy, or the evolution of human beings, to name just a few.

With the exception of the skull (which is a cast replica), the bones in this case are real, authentic human bones. They have been in the Museum's collection for so many years that we do not know how they came into our possession, or to whom they originally belonged. These bones provide an excellent teaching tool and are intended to be touched by children. However, it is important to emphasize to your students that, like all museum objects, the bones are not playthings; they were once part of a living person, and deserve to be handled and treated with respect.

What is the skeleton? What does it do?

The skeleton is the entire collection of bones inside our body. The skeletal system is one of the major systems of the human body, and has four major functions:

- It protects vital organs, such as the brain, heart, and lungs.
- It supports the body and gives us our distinctive shape. Without our skeleton, we would look more like a slug.
- It allows us to move in particular ways.
- It makes new blood cells to maintain a healthy bloodstream.

With so many important jobs to do, the skeleton is a vital part of the human body.

Putting the pieces together

When humans are born they have around 350 bones. As they grow, some bones fuse together over time to form a single bone. As a result, adults have only 206 bones.

The bones of the skeleton can be placed into two groups. The first group is called the **axial skeleton**, the bones that form our center. The bones of the axial skeleton support and protect the organs of the head, neck and trunk, including the skull, sternum, ribs, and vertebrae.

The second part of the human skeleton is called the **appendicular skeleton**. It is made up of all the bones related to our arms and legs (or appendages), including the bones of the arms, hands, legs, feet, shoulder, and hip.

The place where two bones meet is called a **joint**. There are two different types of joints: moving joints and **fixed joints**. In a fixed joint, the bones are fixed in place and do not move at all. The skull has many of these joints. Although it looks like one solid piece



An Introduction to the Human Skeleton (continued)

of bone, it is actually made up of 28 bones fused together with fixed joints.

Moving joints allow a person to twist and bend. Some moving joints allow us to move a lot and others only allow us to move a little. There are two main kinds of moving joints. A **hinge joint** is like a hinge on a door, allowing movement back and forth in a single direction. Elbows and knees have hinge joints, as do fingers and toes. A **ball and socket joint** is made of the round end of one bone (the “ball”) fitting into a small area of another bone (the “socket”), allowing for a lot of movement in every direction. Shoulders and hips have these joints.

Bones are held together at the joints by stretchy bands of tissue called **ligaments**. In between the bones of a joint, there is a firm, rubbery tissue called **cartilage**. Cartilage supports and cushions the bones, acting like the body's natural shock absorbers. It also gives shape to boneless parts of our body like our ears and noses.

Bones are alive

The bones in this case and on display in any museum are dry, hard and dead. The bones inside a living body are very different. In a child, they are growing and changing all the time. Bones continue to grow until people are 18 to 25 years old. There are four layers to our bones:

- The outer layer of a living bone contains nerves and blood vessels that nourish the bone. On the surface there are small holes that act as portals for **blood vessels** to carry blood to and from the bone.
- The next layer is called **compact bone**. This is the smooth, hard part you see when you look at a dead skeleton or bone.
- Inside the compact bone is the **spongy bone**. Though soft, it is still very strong.
- In many bones the middle part holds **bone marrow**. Bone marrow makes new red blood cells for the body. Not all bones contain marrow.



To keep our bones strong and healthy, we should make sure to get plenty of **calcium** in our diet. Calcium is the most abundant metallic mineral element in the human body, and 99% of it is stored in the bones. Along with building strong bones, calcium also helps your heart, muscles, and nerves function. It is also important to get lots of exercise, which prevents your bones from losing calcium (and growing weak and brittle) as you get older.

Even the strongest bone can **fracture** or break with enough pressure or strain, but because the bones in the body are alive, they will heal over time. Even though the bone can fix itself, it is important to go to a doctor right away to help the bone heal. The doctor will take an **x-ray** to see how and where the bone is broken. X-rays give the doctor a map of the fracture so that she can set the bones back in their normal position. The doctor then puts a splint or cast around the injured area to keep the pieces in the correct position. Moving the broken area can cause the patient pain and can also prevent the bone from healing properly. Depending on how bad the break or fracture is, casts or splints have to be worn for a few weeks or months.



An Introduction to The Human Skeleton (continued)



Other animals' skeletons

The human skeleton is similar in design to the skeletons of other **vertebrates** (animals with an interior spinal column). All vertebrates (including mammals, birds, fish, reptiles, and amphibians) have a spine that supports their body, a skull that protects their brain, and ribs that protect their heart and lungs. As in humans, skeletons give animals their shape and ability to move in particular ways. Skeletons can give us clues about the way an animal lives. For instance, some animals (such as rabbits) need to run very fast, and have very long, large back legs compared to the rest of their body. The bones of bats and most birds are very thin and lightweight, making it easier for them to fly.

Although many animals have skeletons similar to ours, in reality vertebrates make up a tiny minority of all the animals on earth. The great majority of our fellow creatures are **invertebrates**, meaning they do not have a skeleton inside their body. A few types of invertebrates (such as insects, spiders, and crabs) have a special **exoskeleton** (a hard outer casing) on the outside of their bodies. However, most invertebrates (including mollusks, worms, and sponges) do not have a skeleton at all. □

Words in boldface have been included in the Vocabulary Words section on page 19.

ACTIVITY 1

Introductory Activity: Beginning with Bones

All Grades

Related Bone Specimens: All

Bones give us shape and help us move around, but we don't think about them very often. By looking at and comparing the bones from the case, students will become more familiar with the function and shape of their skeleton and the bones of which it is comprised.

Materials:

- Blackboard OR chart paper
- Tape measures, rulers, or meter sticks
- Paper and pencils

What To Do:

- 1 Begin with a class discussion about the skeleton. Have your students stand up, and then ask them: What part of your body allows you to stand up? When you stand up, what holds you up?
- 2 When the students sit down, continue the discussion by asking them what they know about the bones in their bodies. Have them name some of the bones they know, and write those names on the blackboard or chart paper.
- 3 Divide the class into groups of 2–4 students, remind them how to handle the bones gently and respectfully, and distribute one bone from the case to each group.
- 4 Have each group examine its bone closely, talk about it, and write a short but detailed description of it. Using a measuring tape, ruler, or meter stick, have students measure their bones for length and thickness. Ask them to notice the shape of their bone, as well as any other interesting or important aspects they see.

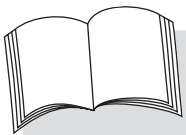
- 5 Using their own bodies as a reference, ask students to think about what part of the body their bone may be from.
- 6 While students are working in their small groups, draw a grid for recording their observations on the blackboard or chart paper. Include one row for each bone, and columns for shape, thickness, length, and what part of the body the bone comes from.
- 7 Have each group stand before the class, show their bone, and share their findings. Record their observations in the appropriate columns.

Discussion Questions:

As they are looking at their bones, ask your students:

- Are the bones long or short? Thick or thin? Big or small? Strong or flexible?
- Where can you feel the bones in your own body? What do they feel like?
- How are the bones alike and different? Are any of them the same?
- Why are bones different shapes and sizes? Why do some have knobs at the end, while the others are tapered?
- What if all your bones were perfectly straight? What would your head look like?
- What if all your bones were the same length? What would your hand look like?
- What if all your bones were round? What would your legs look like? How would you walk?

See page 20 for details on how this activity meets New York State Learning Standards.



MATH EXTENSION: GRADE 3–5

Distribute copies of the “Bony Deductions” worksheet (one per student) and tape measures or meter sticks. Have students measure themselves and fill in the worksheet. For older students, try plotting the students’ answers (such as total height or femur length) on a graph on the blackboard to demonstrate how much variation may exist between their bodies.

Bony Deductions

Your approximate height can be measured from fingertip to fingertip when arms are stretched out wide. Use a tape measure and have someone measure your height from fingertip to fingertip and then from head to toe.

My arm span length: _____

My height (head to toe): _____

Difference (if any): _____

The biggest bone in the skeleton is the femur (thigh bone), which measures about $\frac{1}{4}$ of a person's height. How long is your femur?

Length of my femur: _____

My height divided by 4: _____

Difference (if any): _____

About half your bones are in your hands and feet. If you have 206 bones, approximately how many bones are in your hands and feet?

Number of bones in my hands and feet: _____

Your skeleton makes up about $\frac{1}{5}$ of your total body weight. Approximately how much does your skeleton weigh?

My skeleton weighs: _____

ACTIVITY 2 Bone Detectives

Grades 3–5

Related Bone Specimens: All

Students will reinforce their understanding of the bones and shape of the human skeleton by building a skeleton with the bones provided in the case.

Materials:

- Skeleton poster (from the case)
- Miniature skeleton model (from the case)
- X-rays (from the case)
- A large piece of chart paper with the full-size outline of an adult body traced on it (ask a colleague to trace you)
- Large pieces of chart paper as tall as your students, one per student
- Pencils for tracing
- Crayons, colored pencils, or other art materials

What To Do:

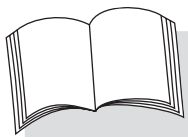
- 1** Hang the skeleton poster at the front of the classroom, pose the miniature skeleton model on a table, and set out the packet of x-rays. Students may refer to these resources during the activity.
- 2** Place the piece of paper with the outline of an adult-size body on the floor, and gather the class around it in a circle. Explain to your students that they are going to help you lay the bones in the case on top of the outline, placing each one as it would appear in the body.

- 3** Starting with the skull, hold up each bone specimen one at a time, asking students to tell you where the bone should go. Talk about the size and shape of each bone, and have students compare it to the skeleton poster or model to figure out its proper place.
- 4** Repeat step 3 with each of the bones, until all the bones have been arranged on top of the adult outline.
- 5** Break students into pairs and have them trace each other's bodies onto large piece of chart paper. Ask students to draw their own skeletons in the outline, using the bones, skeleton poster, or miniature skeleton model for reference. (You may want to have younger students fill in only a few key bones.) Encourage students to personalize their drawings and be creative!
- 6** Hang students' skeletons around the classroom for the duration of the unit.

Discussion Questions:

- How do you know which bone is which? Point out each one on the poster or model.
- Which bones come in pairs and which ones are unique?
- If it was difficult at first to figure out which bone it was, what made it difficult to tell? Did it look like it could have been a different bone? Which one?
- Which bones in your body can you feel? What are their names?

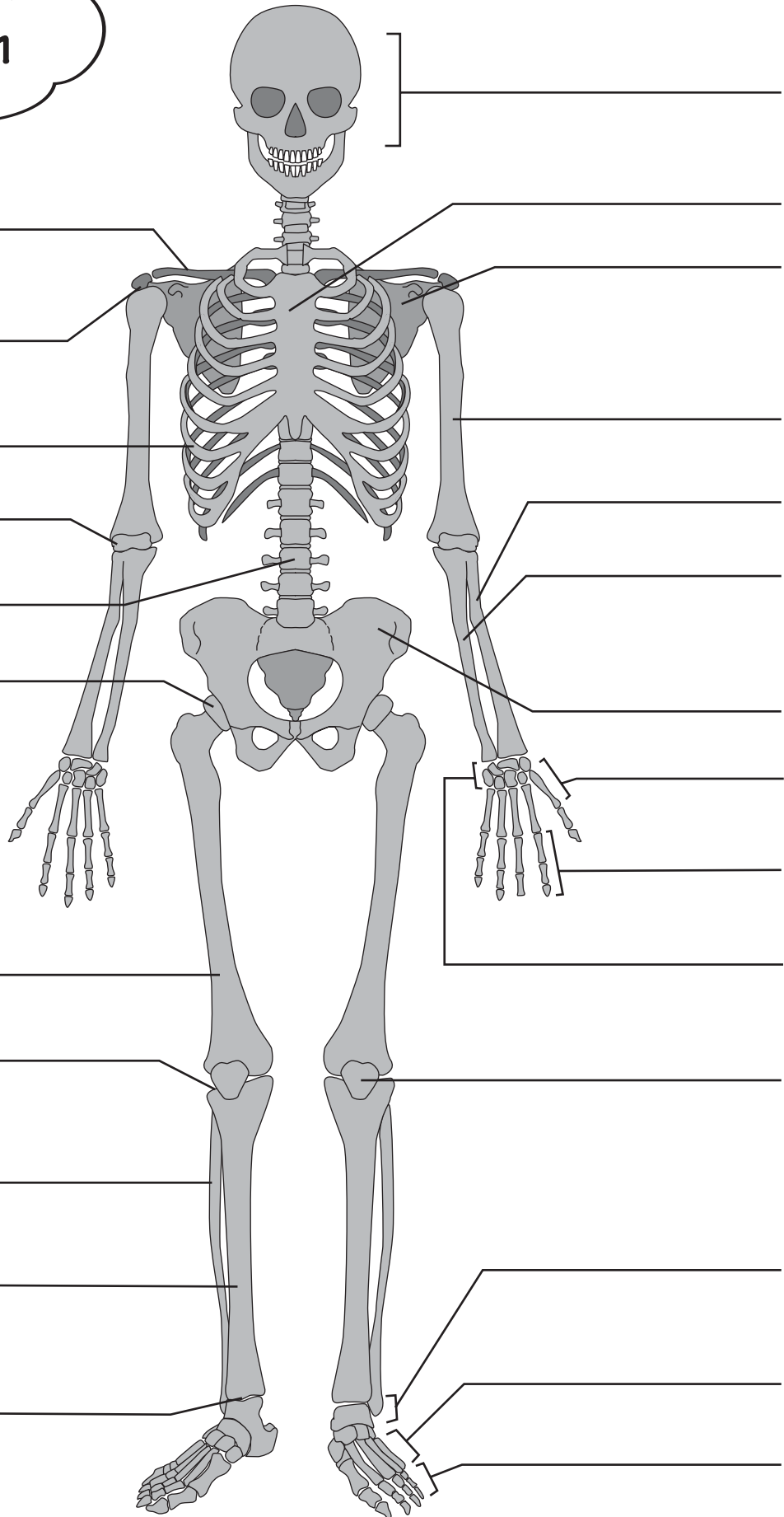
See page 20 for details on how this activity meets New York State Learning Standards.



**SCIENCE
EXTENSION:
GRADE 3–5**

Working independently or in small groups, have students fill out the names of the bones on the skeleton diagram (see following page). You may ask them to use the bones' scientific names, common names, or both.

Skeleton Diagram



ACTIVITY 3

Build a Bone From the Inside Out

Grades 3–5

Related Bone Specimens: Femur, humerus

Unlike the hard, dry, dead bones in the case, the bones in our bodies are alive. There are four layers to living bones:

- The center of the bone holds **bone marrow**.
- Around the bone marrow is the **spongy bone**.
- The next layer is **compact bone**, the smooth and hard part you see when you look at a skeleton or bone.
- The outermost layer is a thin **membrane** containing nerves and blood vessels that nourish the bone. These are not visible on a dry, dead bone.

In this activity, students will learn about the different layers inside a bone by creating a model of a living bone.

Materials:

- Play dough in four colors (we suggest blue, white, yellow, and red)
- Plastic knives or spatulas for shaping play dough
- Copies of the “Living Bone Diagram” (see following page), one per student OR one transparency to use with an overhead projector

What To Do:

- 1 Start a discussion about the inside of bones. Ask your students: Are bones alive when they’re inside of us? How do you imagine they live and grow? Describe to your students the layers inside a bone, particularly how each layer works to nourish the bones and help them grow or stay strong.
- 2 Distribute copies of the “Living Bone Diagram,” which displays a cross-section showing a bone’s interior layers.
- 3 Pass out the two largest bones from the case, the femur and humerus. Have students examine them closely, looking for evidence of the formerly living layers of bone (that is, for the spongy parts and outer pockets or holes for blood vessels). What can they see, if anything? Have them share their findings with the class. [Note: Students should be able to see the smooth compact bone quite easily. On the edges and ends where they bones have been chipped, they can also see the spongy bone layer. They may also be able to see small round holes where blood vessels from the outer membrane penetrated the bone’s interior.]

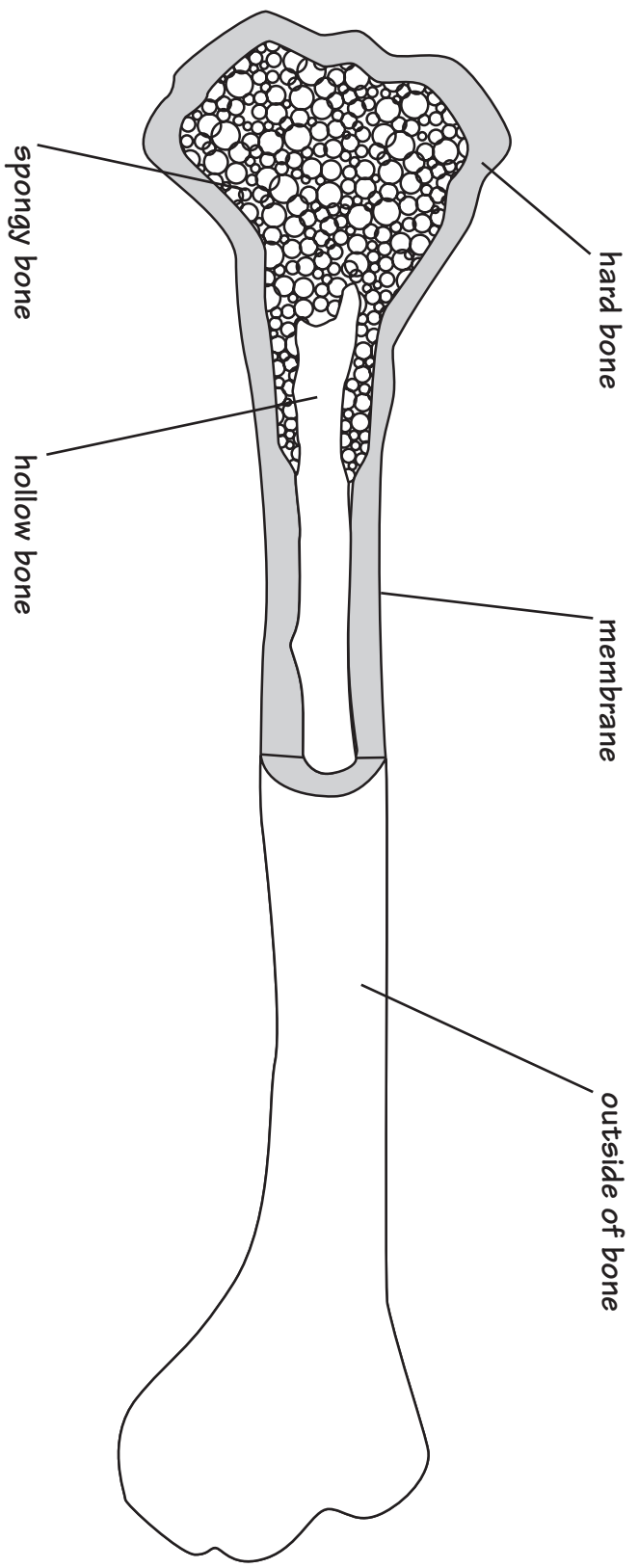
- 4 Once the bone specimens have been returned, pass out the play dough (one lump of each color for each student). You may want to have students protect the surfaces of their desks with brown paper.
- 5 Start the students on building a bone in layers, from the inside out. Make sure they understand that they want to create a cross-section like the one shown on the “Living Bone Diagram.” (This may be easier for them to understand if you make an example in advance.)
- 6 First they should roll out a thin snake of red play dough, representing the bone marrow.
- 7 Next have students roll out a flat, thin, roughly rectangular piece of yellow play dough, just a little longer than the round red bone marrow snake. They should place the red marrow section on top of the yellow spongy section, and shape the yellow play dough around one side of it. Make sure the red marrow section still shows!
- 8 Next have students roll out a flat, thin, roughly rectangular piece of yellow play dough, just a little longer than the round red bone marrow snake. They should place the red marrow section on top of the yellow spongy section, and shape the yellow play dough around one side of it. Make sure the red marrow section still shows!
- 9 Finally, have students add a very thin blue layer of play dough to their model, representing the outer membrane. Once their bone models are complete, students should place them aside to dry and harden.

Discussion Questions:

- What kinds of textures do you see or feel on the bones?
- Are bones hollow? What is inside them?
- What do you see in the ends of the bones or where the surface has chipped away?
- How do bones grow? When they grow, do they get longer or thicker?
- Are bones separate from the rest of the body? How are they attached?
- How does the bone feed the body and vice-versa?

See page 20 for details on how this activity meets New York State Learning Standards.

Living Bone Diagram



ACTIVITY 4 Strong Bones

All Grades

Related Bone Specimens: All

Calcium is the most important mineral for maintaining overall bone health. We take in calcium by eating foods or supplements with lots of calcium in them (such as dairy products, nuts, and leafy green vegetables). As we digest our food, the calcium it contains gets absorbed into our bloodstream and carried to the bones, where it is stored. Adult humans have about 1 kilogram (or 2.2 pounds) of calcium in their bodies. Calcium is vital to the human body because it helps the heart, muscles, and nerves function. Most importantly, though, if we do not get enough calcium in our diet, our bones will become weak.

By performing the easy science experiment below, students will learn about the importance of calcium for maintaining strong bones. Calcium reacts with strong acids like vinegar. If a bone is placed in a jar of vinegar, the vinegar removes the calcium that makes the bone hard, and leaves the bone soft and rubbery.

Materials:

- Clean turkey or chicken rib or leg bones, one per student
- Vinegar
- Lidded glass jars, one per student
- Masking tape
- Paper and pencils

What To Do:

- 1 Begin by talking about bone health. Ask your students to identify some ways they can keep their bones strong and healthy. Should they exercise regularly? Can they name any foods that promote bone health? What do these foods have in common? (Hint: They are all rich in calcium.)
- 2 Tell students they will be performing an experiment to test the importance of calcium in maintaining healthy bones. They will set up the experiment and record their observations along the way.
- 3 Bring in (or have students bring from home) chicken or turkey bones that have been cleaned of any meat. Wash each bone carefully and dry it.

- 4 Distribute a jar to each student. Have students place a piece of masking tape on their jar and write their name on it as a label.
- 5 Instruct students to create a data collection sheet for their experiment by folding a piece of paper in half. On one half will be a description of the bone before the experiment has begun, and on the other will be a description of their bone after the experiment is complete. On each side they should record the following information: the date, the type of bone they are using, and a description of the bone (including its flexibility, color, texture, smell, and so on).
- 6 Instruct students to try to bend their bones, but carefully so as not to break them. Does the bone bend or flex at all? Have students to document their results on their data sheet.
- 7 Have students place their bones in their jar. Pour vinegar into each jar, making sure it covers the bone. Have students secure the lid onto their jars, and set them aside.
- 8 After two weeks, have students remove the bones from the jars and rinse them with water.
- 9 Instruct students to try bending their bones. How far will the bones flex? (If the bones are still too stiff to bend, place them back in the vinegar for another week.) Have students document the flexibility, color, texture, smell, and other characteristics of their bones.
- 10 As a class, discuss how the vinegar bath changed the consistency of the bones by leaching out the calcium. At the bottom of their data collection sheets, have students write the conclusion of their experiment.

Discussion Questions:

- What happened to the bone when it was left in vinegar? How does vinegar affect bones?
- What adjectives best describe the look, smell and feel of the bone after it has been in vinegar?

See page 20 for details on how this activity meets New York State Learning Standards.



HEALTH EXTENSION:

Have students research foods that are high in calcium. As a class, create a lunch menu that includes foods that are high in calcium. Bring your class to the cafeteria to talk to the staff there about how they include high-calcium foods in the school lunches.

ACTIVITY 5 Joints: The Way We Move

Grades 3–5

Related Bone Specimens: All

There are two different types of joints: fixed joints and moving joints. Fixed joints are fixed in place and don't move at all. Moving joints allow a person to twist and bend. There are two main kinds of moving joints: the hinge joint and the ball and socket joint. By exploring the bone specimens and moving their own bodies, students will become familiar with the different types of joints in the human body.

Materials:

- Miniature skeleton model from the case

What To Do:

- 1 Start this activity by having the class survey how their body moves. Students should stand in a circle with plenty of room between them. Have them wiggle their heads; rotate their shoulders, elbows, wrists, and fingers; stand on one foot and move their legs from the hip and the knee; rotate their ankles; and wiggle their toes.
- 2 Ask the students what they notice about the ways their joints move. Do all their joints move in the same way? What different types of movements can they make?
- 3 Introduce the different types of joints in the human body. Demonstrate their movement using the miniature skeleton model or your own body.
- 4 Using the humerus and the ulna, point out the place where one bone meets the other. Ask students to describe the two different ends of the humerus. What

clues do the ends offer about how the joint moves? Repeat with other sets of bones, such as the femur/tibia and sternum/clavicle, focusing on the shape of each set of bones and how they move together.

- 5 Split students into groups of 3–4, and assign each group member a different moving joint. Tell students they are not to reveal their assigned joints to the other members of their group. Each student should take a turn moving his or her bodies using only the assigned joint. Other group members should try to guess which type of joint that student was assigned.

Discussion Questions:

- Imagine what it would be like to have a different joint than the one you have in your hands, hips, shoulders, etc.
- What if your shoulder was a hinge joint? How would you move? Would this be an advantage or disadvantage?
- How do the ends of the bones differ if the joints do different things?

See page 20 for details on how this activity meets New York State Learning Standards.



MOVEMENT EXTENSIONS:

- Tie a yardstick to a student's arm or leg so that the elbow or knee cannot bend. Have the student try to move about or perform everyday tasks without the use of that joint. As a class, discuss the adjustments that people with physical disabilities caused by paralysis must make.
- Ask your students to think of any movements they can make without moving a joint (such as wiggling their noses or ears, blinking their eyes, or moving their tongues).
- Split the class into groups, and have each one choreograph a dance highlighting one type of movable joint. Let students choose the music for their dance and give them time to work on it. Have a performance day when each group can show off their dance. Have the rest of the class try to guess which joint that group was assigned.

ACTIVITY 6 Bone Art

All Grades

Related Bone Specimens: All

Bones have been an inspiration to many artists, from the Renaissance master Leonardo da Vinci to modern artists like Georgia O’Keeffe. Da Vinci drew intricate studies of bones and muscles in his study of the human body. O’Keeffe painted skulls and bones she found on her ranch in Arizona. These two artists provide just a few examples of bone-related art, but there are many more such works by less famous artists.

In this activity, students will learn about the aesthetic aspects of bones, and about artists who use bones as a subject in their work. Using the skeleton in the case for inspiration, they will create their own piece of bone-themed art.

Materials:

- [Georgia’s Bones](#) by Jen Bryant
- Bone art images (from the case)
- Draping cloths or large sheets of colored paper
- Water color paper and paints
- Paintbrushes
- Alternatively: Crayons, pastels, colored pencils, etc.
- Natural or man-made objects suitable for arranging a still-life scene

What To Do:

- 1 Introduce the project of making art that is based on or incorporates bones, skulls, or skeletons. Read [Georgia’s Bones](#) to the class, and show students examples of works featuring human and animal bones by O’Keeffe and other artists. Ask students to talk about how the bones, skeletons, or skulls are used in the works. Are they shown with other objects? What do students think they might mean in the work? What aspects of the bones do the artists emphasize?
- 2 Set up several still-life scenes on tables around the classroom. (If appropriate, have students help you do this.) The still-lives can be of different kinds. For example, one still life can simply be a single bone

resting on a piece of plain colored paper. Another might be a few bones grouped together, perhaps one on top of another or at angles to each other. A third might be a bone posed on a pile of books draped with a cloth, with or without a few other objects around it.

- 3 Have students walk around the classroom and choose a still life on which to base their work. Hand out art supplies (or have students choose the supplies they want to use).
- 4 Have students paint or draw an artwork based on a bone or skull, using the still lifes as a starting point. Their work can be realistic or abstract. It can have a narrative or be a design. They can repeat the image of one bone over and over to make a design. The bone can take up the whole image, as it does in O’Keeffe’s work, or it can be one element among many. Encourage them to be creative, use their imaginations, and make individual artistic choices.
- 5 Have students present their works to each other, and explain why they chose that particular bone to draw and what they are trying to convey about it.
- 6 Arrange an exhibition of the students’ work in the classroom or hallway.

Discussion Questions:

- Why do you think artists use bones in their work?
- What different things can bones, skeletons, or skulls mean when they are used in art?
- How could bones be used decoratively or humorously in art?
- How do artists’ individual styles affect the way that bones look in different artworks?
- How do the bone-themed artworks you’ve looked at help you see bones in a different way?

See page 20 for details on how this activity meets New York State Learning Standards.



LITERACY EXTENSION:

Have students write an “artist’s note” describing their artwork and what it represents.

ACTIVITY 7

Additional Activities and Curricular Connections

All Grades

Music and Social Studies: “Dem Bones”

Read [Dem Bones](#) to your class. Ask your students if they are familiar with this traditional African-American song. Play a recording of the song for them. Then pass out copies of the lyrics (or for younger students, teach them the song orally), play the recording, and have them sing along. For song lyrics and a free download of the music, visit www.niehs.nih.gov/kids/lyrics/bones.htm.

All Grades

Literacy and Movement: Simon Says

Help your students practice new vocabulary by playing “Simon Says” using the scientific names of bones. For example, “Simon Says wiggle your phalanges!” Have students take turns being Simon, and let them refer to diagram if they need to. (As an alternative, younger students who are still learning the parts of the body may use common name instead of scientific names to identify the bones.)

All Grades

Health and Literacy: Broken Bone Biographies

Ask your students if any of them has broken a bone, or if they know anyone who has broken a bone. If there is a child who has had a broken bone, ask them to share their experience with the class. Have older students go home and interview a family member about their broken bone, or write up a story about how they broke a bone themselves. Talk about ways to prevent broken bones (such as good nutrition, exercise, and basic safety).

Grades 3–5

Science: Examine an X-ray

X-rays provide a ghostly image of the human skeletal structure as it exists inside our bodies. Show your class the x-rays from the case. Ask your students: How are x-rays different from photographs? Why do doctors use x-rays?

Grades 2–5

Music and Social Studies: “Bone Imagery”

As a class, brainstorm a list of places your students might see images of skeletons (such as on Halloween, on pirate flags, or on bottles of rat poison). Ask your students: Why do you think bones and skeletons are used to

decorate for Halloween? How about on pirate flags? Why do you think bones are used to warn people about poison? What do you think of when you see bones? Discuss the negative connotations bones often carry, and then have students brainstorm ways bones could be used in a positive way. For example, they might draw a picture or create a design in which bones are used in a positive way. Have them write a description or story about their positive bone or skeleton design. As an alternative to an art activity, have students write a story in which bones are represented in a positive way. Are the bones magical? Is the main character a skeleton? Encourage students to use their imaginations!

All Grades

Social Studies: Day of the Dead

Introduce your students to the Mexican holiday *Día de los muertos* (Day of the Dead). Explain how skulls and skeletons are used to represent loved ones who have passed away. To add humor to the holiday, it is traditional to write *calavera* (skeleton) poems that poke fun at important dead people, or talk about your own or a friend’s death in a funny way. Read a *calavera* poem to the class. You can search for them on the Internet, or use the examples below:

Roses are dead and violets are too,
If you kiss me you will be too!

George ate ice cream.
He never stopped.
He ate and ate and ate ‘til
His body froze off.

Have students write a *calavera* poem of their own, and draw a skeleton to illustrate it.

See page 20 for details on how these activities meet New York State Learning Standards.

Fun Bone Facts

Name that bone...

Each bone has two names: a common name (like kneecap) and a scientific name (like patella).

The skull is much more than it seems!

Did you know the skull has a total of 28 bones? The cranium has eight bones, the face is made up of fourteen bones, and the ear has three bones.

Which has more bones: the hand or the face?

The human hand has 27 bones; the face has 14.

What are the biggest and smallest bones?

The biggest bone in the skeleton is the femur (thigh bone), which measures about one-fourth of a person's height. The smallest bone is the stirrup bone in the ear, which can measure one-tenth of an inch.

Does your neck have as many bones as a giraffe's?

Humans and giraffes have the same number of bones in their necks. The giraffe's vertebrae are just a lot bigger.

Where are half of the bones in your body located?

In the hands and feet! Your hands each have 27 bones, and your feet each have 26 bones, for a total of 106.

The funny bone isn't really a bone.

It's a sensitive spot on your elbow, where a nerve runs over the end of a bone and passes uncomfortably close to the skin. When you hit your funny bone, it's not your bone that hurts—it's a nerve ending!

How much does your skeleton weigh?

Your skeleton makes up less than one-fifth of your total weight. Divide your weight by five and you'll know approximately how much your skeleton weighs

You may actually shrink as much as a half-inch in height each day.

As you go through the day, the cushioning cartilage between the vertebrae in your spine gets squashed down as it supports the weight of your torso. At night when you lie down and take the weight off, the cartilage recovers. As you age, that recovery is reduced, and your spine may shorten as a result.

Working with Bones

Do bones fascinate you? Did you know that you could get a job studying, fixing, or looking for bones? Here is a list of some bony jobs:

Archaeologist

An archaeologist studies past cultures. He or she does this by locating, excavating and analyzing material remains and bones. The archaeologist looks for clues to how past societies lived, worked, and played.

Paleontologist

A paleontologist studies animals from the past. He or she does this by locating, excavating and analyzing bones and fossils left behind. The paleontologist looks for clues to what past animals looked like and how they lived.

Radiologist

A radiologist is a doctor who specializes in using x-rays to diagnose internal illness. This person takes special pictures of your bones using an x-ray machine. These pictures allow doctors to see your bones without surgery.

Orthopedic Surgeon

An orthopedic surgeon is a special kind of doctor who helps reconstruct your skeletal frame. Some people are born with bone deformities and this kind of doctor can often help correct misshapen bones.

Chiropractor

Chiropractors are doctors who relieve back, neck, shoulder, hip, and foot pain caused when bones get shifted slightly out of place. They do this by carefully moving parts of the body until the bones are back in their proper alignment.



Vocabulary Words

axial skeleton:

the central part of the skeleton, including the head and spine.

appendicular skeleton:

the part of the skeleton made up of appendages, including the arms and legs.

ball and socket joint:

a joint in which the rounded end of one bone (the "ball") fits into the cuplike end of another bone (the "socket"), allowing for a wide range of motion. The hip and shoulder are both ball and socket joints.

blood vessel:

an artery or vein through which blood circulates in the body of an animal.

bone marrow:

a soft tissue, rich in blood vessels, that fills the hollow parts of most bones.

calcium:

a silver-white mineral found in foods like dairy products. By eating foods rich in calcium, we can keep our bones strong and healthy.

cartilage:

a firm, rubbery tissue that supports and cushions bones at the joints, acting like the body's natural shock absorbers.

compact bone:

the outermost layer of a bone, which is hard, solid, and ivory in color.

exoskeleton:

a hard, shell-like covering found over the bodies of insects, spiders, and crustaceans.

fixed joint:

a joint where two bones meet but cannot move.

fracture:

the breaking of a bone.

hinge joint:

a joint that allows motion back and forth in only one direction, like the hinge of a door. The knee and elbow are both hinge joints.

invertebrate:

an animal with no backbone.

joint:

a place where two bones come into contact. There are several kinds of joints.

ligament:

a stretchy band of tissue that connects bones and holds them in place.

moving joint:

any joint where two bones meet and can move (including hinge joints and ball and socket joints).

skeletal system:

a hard structure (including bones and cartilage) that provides a frame for the body of an animal.

spongy bone:

the loose, light, innermost layer of bone, which contains the marrow.

vertebrate:

an animal that has a backbone.

x-ray:

a type of radiation used to create images of things inside the body; or, one of the images created using this technology.



■ RESOURCES AND REFERENCE MATERIALS ■

Correlations with New York State Learning Standards

The activities included in this guide meet the following New York State Learning Standard Performance Indicators for elementary students (K–5):

New York State Learning Standard Performance Indicators (Elementary Level)					Activity						
Standard Area	Standard #	Subject	Letter	Students will	1	2	3	4	5	6	7
Arts	1	Dance	c	Create and perform simple dances based on their own movement ideas					•		
Arts	1	Visual Arts	a	Experiment and create art works, in a variety of mediums (drawing, painting, sculpture, ceramics, printmaking, video, and computer graphics), based on a range of individual and collective experiences		•	•			•	•
Arts	1	Visual Arts	b	Develop their own ideas and images through the exploration and creation of art works based on themes, symbols, and events						•	•
Arts	1	Music	b	Sing songs and play instruments, maintaining tone quality, pitch, rhythm, tempo, and dynamics; perform the music expressively; and sing or play simple repeated patterns (ostinatos) with familiar songs, rounds, partner songs, and harmonizing parts							•
English Language Arts	1	Listening & Reading		Gather and interpret information from children's reference books, magazines, textbooks, electronic bulletin boards, audio and media presentations, oral interviews, and from such forms as charts, graphs, maps, and diagrams		•		•	•		
ELA	1	Listening & Reading		Ask specific questions to clarify and extend meaning	•	•	•	•	•	•	•
ELA	1	Speaking & Writing		Present information clearly in a variety of oral and written forms such as summaries, paraphrases, brief reports, stories, posters, and charts	•			•		•	•
ELA	1	Speaking & Writing		Select a focus, organization, and point of view for oral and written presentations	•			•		•	•
ELA	1	Speaking & Writing		Use details, examples, anecdotes, or personal experiences to explain or clarify information	•		•	•		•	•
ELA	1	Scientific Writing		Observe basic writing conventions, such as correct spelling, punctuation, and capitalization, as well as sentence and paragraph structures appropriate to written forms	•			•		•	•
ELA	2	Scientific Writing		Create their own stories, poems, and songs using the elements of the literature they have read and appropriate vocabulary							•
ELA	2	Scientific Writing		Observe the conventions of grammar and usage, spelling, and punctuation	•			•		•	•
ELA	4	Scientific Writing		Listen attentively and recognize when it is appropriate for them to speak	•	•	•	•	•	•	•
ELA	4	Scientific Writing		Take turns speaking and respond to other's ideas in conversations on familiar topics	•	•	•	•	•	•	•
Math, Science, & Technology	1	Scientific Inquiry		Ask "why" questions in attempts to seek greater understanding concerning objects and events they have observed and heard about	•	•	•	•	•	•	•

■ RESOURCES AND REFERENCE MATERIALS ■

Correlations with New York State Learning Standards

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New York State Learning Standard Performance Indicators (Elementary Level)					Activity						
Standard Area	Standard #	Subject	Letter	Students will	1	2	3	4	5	6	7
MST	1	Scientific Inquiry		Question the explanations they hear from others and read about, seeking clarification and comparing them with their own observations and understandings				•			
MST	1	Scientific Inquiry		Develop relationships among observations to construct descriptions of objects and events and to form their own tentative explanations of what they have observed				•			
MST	1	Scientific Inquiry		Carry out their plans for exploring phenomena through direct observation and through the use of simple instruments that permit measurements of quantities (e.g., length, mass, volume, temperature, and time)				•			
MST	1	Scientific Inquiry		Organize observations and measurements of objects and events through classification and the preparation of simple charts and tables	•			•			
MST	1	Scientific Inquiry		Share their findings with others and actively seek their interpretations and ideas	•			•			
MST	1	Mathematical Analysis		Explore and solve problems generated from school, home, and community situations, using concrete objects or manipulative materials when possible	•						
MST	3	Operations		Add, subtract, multiply, and divide whole numbers	•						
MST	3	Measurement		Understand that measurement is approximate, never exact	•						
MST	3	Measurement		Select appropriate standard and nonstandard measurement tools in measurement activities	•						
MST	3	Measurement		Collect and display data	•						
MST	3	Measurement		Use statistical methods such as graphs, tables, and charts to interpret data	•						
MST	4	The Living Environment		Describe evidence of growth, repair, and maintenance, such as nails, hair, and bone, and the healing of cuts and bruises			•				•
MST	4	The Living Environment		Describe the factors that help promote good health and growth in humans				•			•
MST	6	Models		Analyze, construct, and operate models in order to discover attributes of the real thing			•				
MST	6	Models		Discover that a model of something is different from the real thing but can be used to study the real thing			•				
MST	7	Strategies		Work effectively—Contributing to the work of a brainstorming group, laboratory partnership, cooperative learning group, or project team; planning procedures; identifying and managing responsibilities of team members; and staying on task, whether working alone or as part of a group	•				•		

■ RESOURCES AND REFERENCE MATERIALS ■

Correlations with New York State Learning Standards

The activities included in this guide meet the following New York State Learning Standard Performance Indicators for elementary students (K-5):

New York State Learning Standard Performance Indicators (Elementary Level)					Activity						
Standard Area	Standard #	Subject	Letter	Students will	1	2	3	4	5	6	7
Health & Physical Education	1	Health Education		Know how basic body systems work and inter-relate in normal patterns of growth and development	•	•	•	•	•		•
HPE	1	Health Education		Possess basic knowledge and skills which support positive health choices and behaviors				•			•
HPE	1	Health Education		Understand how behaviors such as food selection, exercise, and rest affect growth and development				•			•
HPE	1	Health Education		Participate in physical activities (games, sports, exercises) that provide conditioning for each fitness area					•		
HPE	1	Health Education		Understand the importance of nutritious food and how it contributes to good health, make simple nutritious food choices, and assist with basic food preparation				•			•

Corresponding Field Trips

The following museums and organizations have exhibits or programs related to animals and nature. Check with each for details

American Museum of Natural History has exhibits or programs related to human and animal skeletons, including the Halls of Evolution and Dinosaurs.

Central Park West at 79th Street, Manhattan
(212) 769-5200
www.amnh.org

Brooklyn Children's Museum offers programs on a variety of natural sciences topics. For a listing of programs currently available, please see our website or contact the Scheduling Assistant at extension 118.

145 Brooklyn Avenue, Brooklyn
(718) 735-4400
www.brooklynkids.org

A field trip to a medical facility would be a great way to add to your unit on the human skeleton. There are literally hundreds of hospitals and clinics in the New York metro area. Try contacting local medical centers (especially those in your neighborhood) to see if you can arrange a tour.

You might also try to arrange for an orthopedist, chiropractor, or other medical professional to visit your class as a guest speaker.



Bibliography and Web Resources

The following books and websites may help you enrich your experience with the objects in the case.

Balestrino, Philip. The Skeleton Inside You. New York: HarperCollins, 1989.

Ballard, Carol. How Do We Move? Austin, Texas: Raintree Steck-Vaugh, 1998.

Beimler, Rosalind. The Day of the Dead. San Francisco: Pomegranate, 1998.

Carmichael, Elizabeth and Chloe Sayer. The Skeleton at the Feast. Austin, Texas: University of Texas Press, 1992.

Grant, Leslie. Discover Bones: Explore the Science of Skeletons. Reading, Massachusetts: Addison-Wesley, 1991.

Llewellyn, Clair. The Big Book of Bones: An Introduction to Skeletons. New York: Scholastic, 1998.

Simon, Seymour. Bones: Our Skeletal System. New York: Morrow Junior Books, 1998.

The Big Story on Bones:

An overview of the skeletal system for kids (in English and Spanish).

www.kidshealth.org/kid/body/bones_SW.html

Human Anatomy Online:

Explore all systems of the body.

www.innerbody.com/html/body.html

The eSkeletons Project:

Compare the human skeleton with skeletons of apes.

www.eskeletons.org

Nutrition Explorations:

The National Dairy Council's just-for-kids site about nutrition.

www.nutritionexplorations.org/kids/main.asp

Powerful Bones, Powerful Girls:

The National Bone Health Campaign's girl-friendly site about exercise and nutrition for bone health.

www.cdc.gov/powerfulbones

Muertos:

This site explains the Mexican tradition of Day of Dead, and includes many images of decorative candy and paper skeletons cheerfully adorning altars (in English and Spanish).

www.muertos.palomar.edu

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Brooklyn Children's Museum
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718-735-4400 ext. 170
www.brooklynkids.org

For information about renting this or other Portable Collections Program cases,
please contact the Scheduling Assistant at 718-735-4400 ext. 118.