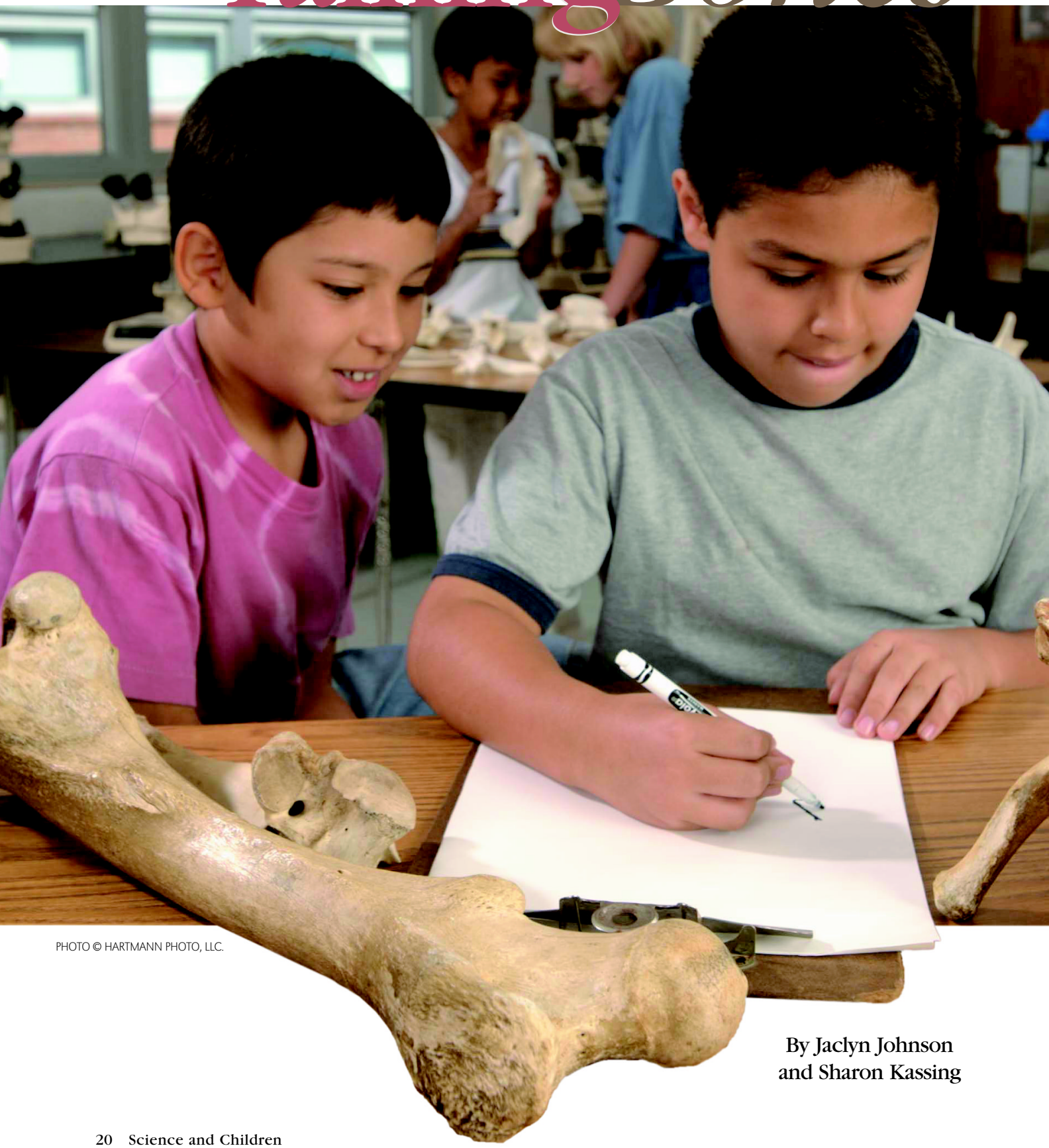
# Talking Bones



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By Jaclyn Johnson
and Sharon Kassing

Bones reveal many facts about the animals from which they come, making them a great hands-on educational tool. For the past six years, the Saint Louis Zoo has offered a summer course on bones, where children in grades three to five learn how animals move, what they eat, and how big they grow by examining and making inferences about bones. Our goal is to help children understand what bones can tell us about animals—and to do it effectively in two hours.

The class has allowed us to shift from the typical "show and tell" format to a more inquiry-based approach when presenting animal lifestyles. Children experience a browsing lab to observe assorted bones, structured discussions, and activities such as identifying skulls and determining animal weight. For each activity, children complete worksheets (downloadable from *www.nsta.org/elementaryschool*), which are compiled into a take-home resource and class souvenir. We advertise the program (limited to 16 children) in the museum's summer brochure of fee-based programs.

## In the Browsing Lab

During the first exercise children become "bone detectives." They enter a classroom full of different biofacts that are numbered and displayed on tables. (*Biofacts* are the bones, skulls, and other preserved body parts of animals.) We explain to the children, "When animals die naturally at the zoo, we save parts of their bodies to study." Our collection of biofacts includes a bird leg, a catfish spine, a turtle shell, fish teeth, an alligator eyelid bone, and a python leg bone. The identity of some of the biofacts is obvious, such as the elephant femur. Other biofacts, such as carp gill rakers, are not so obvious. Children are intrigued to see and touch the biofacts, and we encourage them to inspect and handle the bones carefully since this may be their only opportunity to handle so many bones up close.

The children (in groups of four) then fill out a worksheet as they observe the biofact displays. The worksheet lists the name of the biofact, and the children match the name with the corresponding number from the tables. The chart also includes space for the children to justify their answers. As the instructors, we only answer clarifying questions, such as, "Does this animal swim, walk, or fly?" or "Where is this bone attached to the body of the animal?" The children enjoy the element of mystery, and discussion is lively with such questions as, "What part of the animal do you think this comes from?" and "How does the animal use this body part?" We enjoy listening to the children as they use clues and science-process skills to determine the identity of the different biofacts.



After about 30 minutes, we examine their choices as a class. In those instances where children cannot identify a biofact, we provide instruction. For example, carp gill rakers are not easily identifiable. Therefore we explain their location in the fish and their function. In the majority of cases, however, the children's answers are correct, and they are quite pleased to find out they know more than they think they do.

## What Good Are Bones Anyway?

We begin the next activity and discussion with the question: What good are bones anyway? Because the age span among participating students is significant, the responses vary. Most children answer, "Bones make us strong," "Bones help us stand up," and "Bones protect us." The great thing about using biofacts in the classroom is that bone facts are straightforward and easy to understand. It doesn't take long for the children to realize the three primary functions of bones: protection, locomotion, and support. We discuss the following:

- Bones that protect surround vital organs, such as the turtle shell and gar skull;
- Bones that aid locomotion help the animal move, such as the sea lion flipper bones and elephant leg bone; and
- Bones that provide support and structure give the body shape and strength, such as the bird skeleton and bird eye ring.

Next, we introduce the terms *axial* and *appendicular* using diagrams to show the bones on the human body that are included in each category. The axial skeleton includes the skull, thorax (breastbone and ribcage), and spine. The appendicular skeleton includes the limbs, shoulder, and pelvic girdle.

To review this discussion, we hand out a worksheet showing a human skeleton and the skeleton of a horse standing up on its hind legs. With colored pencils, children color the axial and appendicular bones of the human

**Children learn about animal lifestyles through hands-on activities with bones from a local zoo.**

skeleton and then the comparable bones of the horse. (This activity takes approximately 20 minutes.) For the human, the children simply look at our earlier diagrams and copy what they observe. For the horse, children need to draw comparisons that are not so obvious. One of the trickier comparisons for children to make, for example, is between the human pelvic bone and the horse shoulder girdles because they look very different from one another.

We enjoy watching the children make the connections in their minds. Some of the younger children do not have the fine-motor skills for coloring the small bones, but approximations are fine. What's important is that they understand the difference between the two parts of the skeleton and see the similarities between the bones of the two different animals.

## Skull Identification

The children next learn about what skulls can reveal about animals, such as dentition and diet; placement of eyes and length of nasal cavity; brain size; and strength of bite. Their mission is to use these "clues" to identify 12 skulls on display. For example, by examining the skulls, the children can see that the mountain lion and owl have eyes that face forward, indicating that these hunting animals see depth and distance. When children look at the beaver's flat incisors, they can infer that it is an herbivore. The children use a worksheet as they match the skulls

**Figure 1.**

### Skull clues.

**Dentition:** The teeth and arrangement of teeth in an animal's jaw.

- Herbivores have incisors and flat molars for grinding. Canine teeth are absent or very small.
- Carnivores have sharp canines and molars with sharp points or serrated edges.
- Omnivores have incisors and canines and molars that may be flat and/or sharp.

**Nasal Cavity:** The home of the olfactory organs and sinus membrane. Animals with long nasal cavities usually have a good sense of smell.

**Eye Sockets:** Support and protect the eye. Forward-facing eye sockets, also called binocular vision, permit an animal to see depth and distance. Eyes in sockets on the sides, called monocular vision, prevent the sense of depth and distance but provide great peripheral vision.

**Zygomatic Arches:** Also called cheek bones. This opening houses the muscles that connect the lower jaw to the cranium. The larger the zygomatic arch, the stronger the muscles are for biting and chewing.

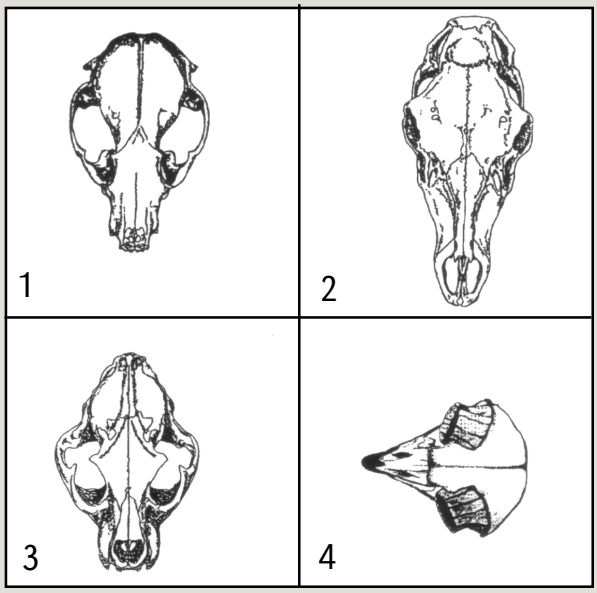
**Cranium:** The part of the skull that protects the brain.



"From what animals could these bones have come?" Children sketch and make inferences about bones.

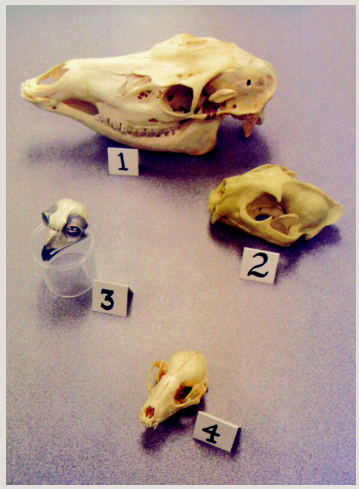
**Figure 2.**

Skull worksheet.




| | |
|---|---|
| Elk | Owl |
| Raccoon | Mountain Lion |

Full-size, downloadable worksheets are available for NSTA members at *www.nsta.org/elementaryschool.*




ILLUSTRATIONS 1–3 ADAPTED FROM *SKULLS AND BONES* (SEARFOSS 1995). ILLUSTRATION 4 ADAPTED FROM *EYEWITNESS BOOKS: EAGLE AND BIRDS OF PREY* (PARRY-JONES 1997). PHOTO COURTESY OF CHRISTY CHILDS, PUBLIC RELATIONS ASSISTANT, SAINT LOUIS ZOO.

Children first examine these skulls and then complete the worksheet in Figure 2.

The answers are the following: 1 (Raccoon), 2 (Elk), 3 (Mountain Lion), and 4 (Owl).

with the animals on their list. The worksheet is also a reference guide because it explains some of the clues. (See Figure 1 for the clues.)

The 12 skulls include those of the anteater, beaver, bird, black bear, coyote, elk, mountain lion, owl, peccary, raccoon, turtle, and viper. With the exception of the two bird skulls, these skulls are more alike than different, so the children must refer to the clues on the worksheet and recall what they already know about the animals. Gradually, they pinpoint their choices and we review answers as a class. The children make changes where needed to have accurate information to complete another worksheet in which they cut out skull drawings and paste them to the correctly labeled box (see Figure 2). This activity reinforces what the children learn about skulls and creates a "skull key" for future study. Some children finish this part more quickly than others, and we often find them roaming back to the skulls with their papers to make some additional observations.

## A Fibula Formula

Sometimes it's possible to figure out how big an animal is from just one bone! Forensic pathologists do it all the time. This final exercise presents an opportunity for the children to use mathematics to solve a real scientific problem.

Children divide themselves into four groups. Each group receives a fibula from one of the following animals: zebra, raccoon, koala, and squirrel monkey. (The *fibula* is the smaller of the two bones between the knee and ankle in the lower limbs of vertebrates. Before they begin this activity we show the children complete skeletons of several mammals and identify the fibula on each one.) Without revealing the identities of the animal fibulas, we complete the following steps as a class:

1. To determine the circumference of the bone, the children wrap a strip of paper around the bone, mark the point of overlap, and then measure the length of paper to the mark with a metric ruler. (We explain *circumference* as the distance around the bone.) We write each of the four values (from the four groups) on the board and make each value equal to $C$ (circumference).
2. We write the formula $C / Pi = D$ on the board (where $Pi = 3.14$ and $D$ = diameter). (This formula comes from Glenn Searfoss' *Skulls and Bones* (1995). In the chapter "Limbs"

**Figure 3.**

Fibula facts.

| Animal | Circumference | Diameter | Approx. weight |
|---|---|---|---|
| Squirrel Monkey | 1.7 cm | 0.5 cm | 1.6 kg |
| Zebra | 10.0 cm | 3.2 cm | 317.0 kg |
| Koala | 3.5 cm | 1.1 cm | 17.1 kg |
| Raccoon | 3.0 cm | 0.96 cm | 15.0 kg |

the author presents an easy way to determine the weight of a mammal by using the diameter of its fibula. However, we do not tell the children how the formula was derived.)

3. Next, we plug each *C* into the equation. For example, if one group measures the circumference of their bone at 18 cm, we write *18/3.14 = D*. Before we complete the calculation, we write the equation for each group's data. By the time we get to the fourth group, the children understand the idea. It is important to do each part of the calculation for each group's bone before moving on.
4. We complete the calculations as a class, dictating the operation as the children enter the data into their calculators. We repeat the steps for the other three groups.
5. Using the number they have just calculated and the chart on the worksheet, the children can determine the approximate weight of their animal.
6. We reveal the fibula identities and have the children determine which value goes with which animal. See Figure 3 for a list of fibula diameters and corresponding animal weights.

Because the zebra and squirrel monkey represent the biggest and smallest animals, the children easily identify the biggest and smallest weights respectively. The raccoon and the koala are similar in weight, so the children have to decide as a group what each animal weighs. Many times they decide by process of elimination. The children are surprised and excited to use mathematics this way. Although we were apprehensive about this activity at first, we knew it was successful after hearing one young child tell his mother, "Mom, we did math!" It was the first thing he told her about the class. For this activity, children do not have to understand all the components of the mathematical formula. They only need to understand what number fits into each part of the equation and that scientists use mathematics to solve problems.

## Article Glossary

**Axial:**
Skull, thorax (breastbone and ribcage), and spine
**Appendicular:**
Limbs, shoulder, and pelvic girdle
**Biofact:**
The bones, skulls, and other preserved body parts of animals
**Circumference:**
The distance around an item
**Fibula:**
The smaller of the two bones between the knee and ankle in the lower limbs of vertebrates

## Bones All Around Us

Part of the Saint Louis Zoo's mission is to cultivate a respect for animals and promote conservation. Historically we have accomplished this mission by providing educational programs that allow children to directly interact with live animals. The bone class, however, showed us that children can learn just as much through a hands-on investigation of bones and skulls.

This class has proved to us that children can understand animal concepts without direct contact with living animals. We encourage teachers to use the elements of this class that they find helpful or that they can modify to their own situation and availability of resources. Biofacts may be available through such lending institutions as zoos, science centers, or state conservation departments. College and high school science departments might also lend helpful materials. Teachers could also start their own biofact collection. Bones are expensive, but collaboration among other teachers might make purchases more feasible. Even boiling a chicken and using those bones can start a biofact collection!

***Jaclyn Johnson and Sharon Kassing are naturalists and instructors at the Saint Louis Zoo in St. Louis, Missouri.***

### Resources

Johnson, J. 1994. *Skeletons: An Inside Look at Animals*. New York: Reader's Digest Association.

Mattison, C. 1995. *Encyclopedia of Snakes*. New York: Facts on File.

Parker, S. 1988. *Eyewitness Books: Skeleton*. New York: Knopf.

Parry-Jones, J. 1997. *Eyewitness Books: Eagle and Birds of Prey*. New York: Knopf.

Searfoss, G. 1995. *Skulls and Bones: A Guide to the Skeletal Structures and Behaviors of North American Mammals*. Mechanicsburg, Penn.: Stackpole.