NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Reinstein Woods Environmental Education Center
93 Honorine Drive, Depew, NY 14043
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www.dec.ny.gov

Dear Educator:

Thank you for your interest in Reinstein Woods' environmental education programs. You have scheduled the program "Skull Science" as an in-school program. In this packet, you will find an overview of the "Skull Science" program and post- visit activities to supplement your program. Please try to go over appropriate vocabulary terms (found in the overview) with your students before the program.

We feel that our program will be of more value to students if related classroom activities are done after the lesson. The enclosed activities are designed to reinforce concepts learned during the program.

The New York State Department of Environmental Conservation is currently sponsoring educational workshops for teachers. These workshops include Project WILD—a program that emphasizes awareness, appreciation, and understanding of wildlife—and Project WET, an education program that teaches about water resources. We also offer Project Learning Tree trainings for educators in grades PreK-12. To learn how you can attend a workshop to obtain these materials for use in your classroom, please contact Reinstein Woods or visit http://www.dec.ny.gov/education/1913.html.

We hope that this information is helpful to you and your students, and feedback is encouraged. Please take some time to complete and return the program evaluation following the lesson. We look forward to seeing you soon!

Sincerely,

Reinstein Woods Environmental Education Center Staff

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SKULL SCIENCE

Grades: 4th – 8th
Length: 45 min.
Maximum Students: 25

Standards

State learning standards addressed through our program are listed below.

2017 P-12 Science Learning Standards

3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.

Science and Engineering Practices

- Engaging in an Argument from Evidence
- Planning and Carrying Out Investigations
- Scientific Knowledge is Based on Empirical Evidence

Disciplinary Core Ideas

- LA1.A: Structure and Function
- LS3.B: Variation of Traits
- LS4.A: Evidence of Common Ancestry and Diversity
- LS4.C: Adaptation

Cross Cutting Concepts:

- Structure and Function

Excellence in Environmental Education: Guidelines for Learning (K-12)

Strand 1— Questioning, Analysis and Interpretation Skills: Guideline A, B, C

Strand 2.2—The Living Environment: Guideline A

Objectives:

1. Students will understand how the structure of the skull relates to the behavior of an animal.
2. Students will understand and identify skulls of carnivores, herbivores and omnivores.
3. Students will understand and identify adaptations of predator and prey based on skull observation.
4. Students will understand how skull similarities and differences between organisms living today and organisms in the fossil record allow us to enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2)

Background

NYSDEC Skull Science Brochure

Bones, especially mammal skulls and jaws, can tell you a lot about the animal they came from. Whether it's just a partial jaw or a full skull, the bone's size, shape and structure provides you with clues to the mammal's identity and habits.

Teeth are great visual clues to an animal's identity. They indicate what and how an animal eats. In many mammals, the teeth are quite distinctive. By examining the dentition (number and form of the teeth), you can tell whether the animal is a meat-eater (carnivore), plant eater (herbivore) or both (omnivore). Sharp, pointed teeth such as canines and carnassials (last upper premolar and first lower molar that meet with a scissors like action) are used for tearing and shearing meat, indicating a carnivore.

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Background continued

Broad, somewhat flat teeth are used for crushing and grinding vegetation, indicating an herbivore. Since omnivores, such as raccoons and humans, eat both plants and meat, they have sharp teeth in the front to rip and cut, and flattened teeth in the back to mash their food.

In addition to teeth, other skull structures can tell you whether an animal is a meat or plant eater. For example, there are numerous sites on the skull for muscle attachment, which vary from species to species. In carnivores and omnivores, there is a ridge on top of the skull called a sagittal crest. The site of muscle attachment for the strong muscle that controls the crushing lower jaw, the sagittal crest is quite pronounced on opossum and fisher, and less pronounced on coyote, raccoon and otter. Since herbivores typically have smaller jaw muscles, many lack an obvious crest.

Another interesting feature on a skull is the position and size of the eye sockets. Predators, such as coyote and otter, generally have forward-facing eyes. This provides them with 3-D vision, enabling them to more accurately locate and follow prey. In contrast, prey species, such as rabbits, have relatively large eyes located on the sides of their head. This gives them great peripheral vision, aiding them in locating predators and warning them about sneak attacks.

While all mammal species have specific traits and adaptations, keep in mind that animals can also be highly variable within a species, adjusting to available conditions. For example, coyotes are generally meat eaters, but will also eat fruit. Raccoons and opossums are considered omnivores, but they may be entirely carnivorous or vegetarian depending on food availability. And while deer are herbivores, they have been observed to eat fish on occasion.

An organism's features, like those described above, reflect its evolutionary history. The fossil record contains organisms with transitional features, allowing scientists to reconstruct evolutionary history. Scientists can then compare skulls to existing organisms. Similarities among existing organisms provide evidence for evolution.

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Spelling/ Vocabulary List

Carnivore - animal that eats only other animals

Herbivore - animal that eats only plants

Omnivore - animal that eats plants and animals

Incisors - front teeth used for clipping food

Canines - corner teeth used for gripping and ripping

Molars - back teeth for crushing and grinding

Marsupials - group of mammals that the young develop in a pouch

Predators - carnivores that catch and eat their prey

Scavengers - carnivores or omnivores that eat dead animals

Parts of a Skull Vocabulary

Maxilla – upper jaw

Mandible- lower jaw

Zygomatic arch- broad ridge of cheekbone

Sagital crest- ridge on top of skull

Molar- flat grinding tooth in back of jaw

Canine- sharp piercing tooth in corner of mouth

Incisor- tooth in front of jaw

WHALE EVOLUTION
RESOURCE: PBS

Grades: 7th – 12th
Length: 45 minutes
Subjects: Science, ELA

Lesson Location:

http://ny.pbslearningmedia.org/resource/tdc02.sci.life.evo.lp_fossilevid/the-fossil-evidence-for-evolution/

Background

An organism's features reflect its evolutionary history. The fossil record contains organisms with transitional features, allowing scientists to reconstruct evolutionary history. Scientists can then compare skulls to existing organisms. Similarities among existing organisms provide evidence for evolution.

Warm-up

Show the Evolving Ideas: How Do We Know Evolution Happens? video. Ask students what types of evidence are used to learn about evolution (fossil, molecular, chemical, anatomical), and write the list on the board. Discuss what each term means. Then discuss the following questions with your class:

- What can we learn from fossil evidence?
- How do the transitional fossils of whales support the theory of evolution by natural selection?
- What specific fossil evidence points to whales' evolution from land to water?

Activity

1. Prepare a vertical classroom timeline of the Cenozoic era on paper. Make the timeline sixty-five inches tall, and label the top *the present* and the bottom *65 million years ago (Mya)*. Label every million years, with one inch equal to one million years (My). Highlight the Eocene epoch (55-34 Mya). Display the timeline.
2. Pass out copies of the Whales in the Making handout and the Whale Evolution Data Table Worksheet (PDF) worksheet. Have students work in teams of two. Ask them to cut out the six fossil boxes from the handout and gather the data about each fossil from resources in the Evolution Library, the school library, and the Web.
3. Ask each team of two to prepare an Eocene epoch timeline on paper, using the same scale as the classroom model (one inch equals one million years). Their timelines should be twenty-one inches long, with each million years labeled.
4. Have teams mount fossil boxes 1 and 2 from the handout at the proper locations on their timelines. Point out the large gap between these two fossils. Then have students add the remaining fossils in order by date of discovery.
5. Discuss the following:
    - What typical whale like traits were apparently the earliest to appear? What apparently evolved much later?
    - As each "missing link" was found, how many new gaps were formed? What is the relationship between gaps and fossils?
    - To find fossil evidence to fill the largest remaining gap in whale evolution, what age sediments would you search?
    - What distinguishing traits would you expect to find in whale fossils of that age?
    - Explain why the absence of transitional fossils does not mean that evolution didn't take place.

Owl Pellets:

Grades: 4th – 8th
Length: 30 minutes
Subjects: Science, Art

Materials

- ☐ Owl Pellets
  - ○ http://www.pelletsinc.com/
- ☐ Skeleton ID sheets
- ☐ Toothpicks
- ☐ Paper plates or paper

Background

Owls do not have the ability to chew their food. As a predator, they hunt and eat other animals, often swallowing their prey whole. The indigestible bones, feathers and fur are compacted into a pellet that is later coughed up. Scientists study the pellets of owls to identify the diet of the bird. Most pellets include a skull or skulls, which makes identification of the prey relatively simple. When prepared properly, or purchased, owl pellets are sterile.

Procedure:

1. Provide each students with a pellet, plate, and toothpick. It can be helpful to soak the pellets to make removing compacted hair easier.

2. Students can work to carefully pull apart the pellet and extract bones.

3. If a student finds a skull, have them sketch and label the different parts.
   - What is the length of the skull?
   - Describe the teeth. Is this a carnivore, herbivore or omnivore?
   - Where are the eye sockets located?
   - What animal is this? What evidence supports this proposal?

Resources:

Bone Chart:
http://www.carolina.com/pdf/activities-articles/Owl_Pellet_Bone_Chart_grid.pdf

Skull ID:
http://www.carolina.com/pdf/activities-articles/bonechart.pdf

Bird Skeleton Chart:
http://www.carolina.com/pdf/activities-articles/birdskeleton.pdf

Mole Skeleton Chart:
http://www.carolina.com/pdf/activities-articles/birdskeleton.pdf

Rat Skeleton Chart:
http://www.carolina.com/pdf/activities-articles/ratskeleton.pdf

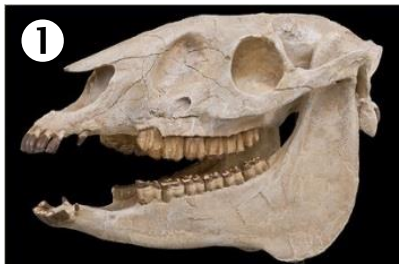
For an advanced lab version of this activity, visit:
http://www.tuskegee.edu/sites/www/Uploads/images/Research/MSP/Barn%20Owl%20Pellet%20Lab.pdf

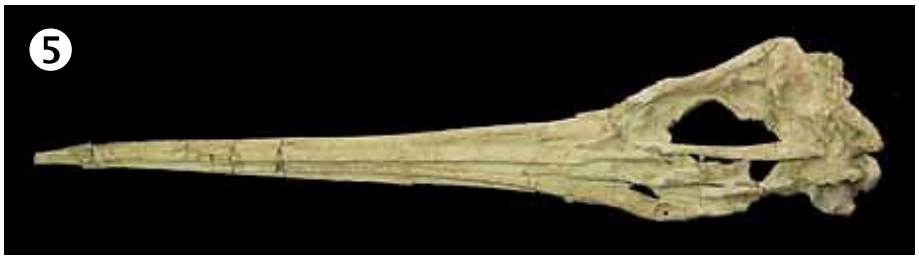
Ancient Relatives: Teacher Page

Grades: 4th – 8th

Length: 30 minutes

Subjects: Science, ELA, Art





1. Match each skull to its prehistoric relative.
   ❶ *Merychippus* and ❸ Modern Horse
   ❷ Giant Hyena and ❻ Brown Hyena
   ❹ King Penguin and ❺*Inkayacu paracasensis*

2. Choose one pair of skulls and provide three observations that support your hypothesis.
   Answers may vary. Comparisons in teeth, eye socket placement, snout length, etc.

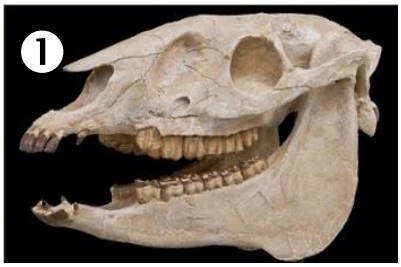
3. Choose one skull and list two conclusions you can make about the animal's behavior. What evidence do you have for your conclusions?
   Answers may vary. Some examples include:
   1. I conclude that animal 3 is a prey animal based on the side-facing eye sockets.
   2. I conclude that animal 1 is a herbivore due to its flat, broad teeth and lack of canines.

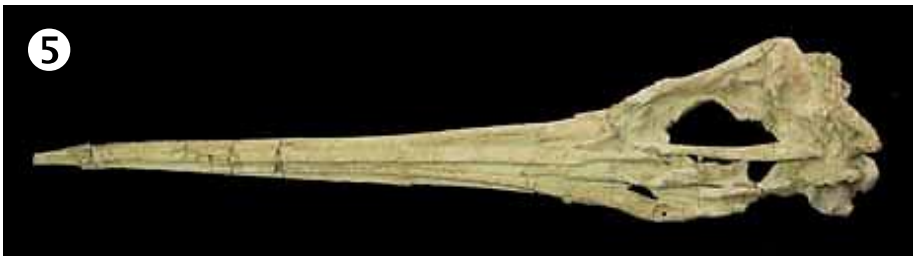
Extend the lesson:

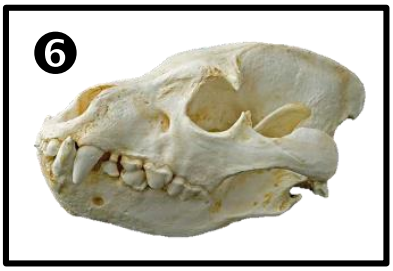
1. Have students research one of the prehistoric animals. When did it live? What was its habitat?
2. Have students compare other animal skulls to their prehistoric relatives.
3. Have students research and compare sizes of prehistoric animals and their modern relatives.

NAME:

ANCIENT RELATIVES







1. Match each skull to its prehistoric relative.

2. Choose one pair of skulls and provide three observations that support your hypothesis.

3. Choose one skull and list two conclusions you can make about the animal's behavior. What evidence do you have for your conclusions?

Art

Students can use the California Academy of Natural Sciences' 3D Skull Viewer to sketch and label skulls.

Design

Have students design a skull using clay and square and triangle beads. Students can describe the behavior of their animal based on teeth, eye socket location, etc.

Discuss and Apply

Watch MIT's Built to Peck video series.

- Discuss what scientists have learned about woodpeckers by studying bird skulls.
- What skills or tools did these scientists use?
- How could an engineer use this information to solve a problem?
- What other adaptations to woodpeckers have?

Citizen Science

Project NOAH:
Identifying animals through osteology

Virtual Lab

Older students can complete and submit an online mammal skull lab at http://www.mhhe.com/biosci/genbio/virtual_labs/BL_27/BL_27.html

Additional Resources

Non-Fiction

Animal Skulls: A Guide to North American Species
by Mark Elbroch

Animal Skulls & Bones: A Waterproof Pocket Guide to The Bones of Common North American Mammals
By J.M. Kavanaugh

Skull Alphabet Book
By Jerry Pallotta and Ralph Masiello

Internet

Skull Science Brochure
NYSDEC

Skull Science
NYS Conservationist for Kids

3D Skull Viewer
California Academy of Natural Sciences

Built to Peck video series
Massachusetts Institute of Technology

Online Mammal Skull Lab

Take it Outside!

- Look for signs of herbivores, omnivores and carnivores in your schoolyard.
- Play a game to reinforce predator/prey roles. Find an example here.
- Set up a fake paleontologist dig. IF you don't have access to skulls or bones, have different items (bottles, etc) represent different animal bones.

We've done the searching for you!

Find links to these resources and additional activities on our Skull Science Pinterest Board.

Visit.
pinterest.com/reinsteinwoods

Pinterest