Make Observations & Inferences

OVERVIEW

Students will use a variety of problem-solving skills to help them understand how scientists gather observations and make inferences about extinct species.

BACKGROUND FOR EDUCATOR

In order to understand the biology of extinct organisms such as sauropods, scientists must make many types of observations, including studying fossils and living animals. Living birds are the only type of dinosaur alive today, and studying them gives scientists insight into the behavior and biology of extinct dinosaurs. Paleontologists (scientists who study ancient life) also turn to experts in other fields, such as engineers, to help them understand their observations. Together, these scientists are able to answer many types of questions, including what these dinosaurs ate, how fast they grew, and how long they lived. All kinds of scientists use tools, and paleontologists are no exception. In order to ensure that their observations are accurate, paleontologists focus on details, take accurate measurements, and carefully document their findings.

BEFORE YOUR VISIT

These activities will introduce students to the work paleontologists do: search for, uncover, and study fossil remains, the evidence of prehistoric life. Explain to students that, like paleontologists, they will be making observations that lead to inferences about the biology of extinct animals. *(Example: A snake skeleton observed in a fossilized nest may lead a paleontologist to infer that the snake was preying on the eggs.)*

Activity: Mystery Backpack

Prepare a backpack with books and other items that can help students make inferences about the owner. For example, a paleontologist's pack might contain magnifying glass, paint brush, ruler, sketch book, pencils, atlas/maps, fossil or dinosaur ID book, toothbrush, pick, goggles, sifter, sunhat, etc.

As the class examines the backpack and its contents, guide students through the following steps to help them make observations and inferences:

1. Ask students: What do you observe?
2. Prompt students to describe the backpack and its contents (e.g. size, color, style, descriptions of objects as they are shown).
3. Based on these observations what behaviors can they infer about the owner and how the contents might be used?

Write "observation" and "inference" on the board in the form of a T-Chart, and discuss these terms with students. *(An observation is data that can be measured, observed, examined, and analyzed to support a conclusion. Inference is an explanation reached on the basis of evidence and reasoning.)*

Ask students to share what they've observed about the backpack and its contents. *(Answers will include descriptions of the bag and its contents.)*

Ask students to share information acquired during the backpack activity that is based on inference (ideas that are grounded in but extrapolate from direct observation). *(Possible answers: Descriptions of the type of person who may own the bag and how he or she uses the objects found inside.)*

NYS Science Core Curriculum

S2.1d: Use appropriate tools and conventional techniques to solve problems about the natural world, including: measuring, observing, describing, classifying, and sequencing.

Plan how your students will explore *The World's Largest Dinosaurs* **using the student worksheets.**

Distribute copies of the worksheets to students before coming to the Museum. You may want to review the worksheets with them to make sure they understand what they are to do.

Activity: Animal Puzzle

In this activity, students continue using their observation skills to make inferences.

Bring to class at least 10 photos of various animals (e.g. from magazines). Be sure to include habitat when available. Cut each photo into puzzle pieces, and place them in a manila envelope. You can make the activity more difficult by cutting each image into more, smaller pieces.

Divide students into groups of two or three. Give each group an envelope and tell them to pull out one puzzle piece at a time. Have them guess which animal their envelope contains after they pull out each piece, and record each guess. In the process, they should also attempt to figure out some facts about the animal (where it lives, what it eats, etc.). Once students have identified their animal, have them write its name and pull out the rest of their pieces to check their answer.

For added difficulty, mix two puzzles together. This simulates finding the fossilized remains of many different animals in one location.

DURING YOUR VISIT

The World's Largest Dinosaurs Exhibition
4th floor (45 minutes)

Begin the exploration by having students observe the full-scale model of *Mamenchisaurus*. Ask: If this giant dinosaur went extinct long before humans appeared on Earth, how can we know what it looked like or how its body functioned? Then explain to students that they will use different scientific techniques to help fill in the picture of sauropod biology. Have them record their observations on worksheets, and draw on them to make inferences.

Koch Hall of Saurischian Dinosaurs & Wallach Orientation Center
4th floor (30 minutes)

Students will examine teeth, trackways, and a model sauropod, and gather evidence about diet, movement, and body form.

Koch Hall of Saurischian Dinosaurs: *Apatosaurus* skeleton

1. What do the teeth tell us?

Have students sketch the *Apatosaurus* skull and describe its teeth. Ask them what these observations suggest about what this dinosaur might have eaten, and how. If students are having difficulty, ask them to feel their own teeth with their tongue and explain how they're different from those of the sauropod. For further exploration, have students examine the wall panel "Teeth & Diet" (adjacent to the *T. rex* skeleton across from "What Do the Trackways Tell Us"). There they can touch different types of teeth and gather more information about the sauropod diet.

2. What do the trackways tell us?

Have students observe and sketch the trackways of the *Apatosaurus* mount. What types of information do they think the trackways contain? What types of information is still lacking? After this discussion, have students read the panel "What Do the Trackways Tell Us?" (adjacent to the *Apatosaurus* mount) and discuss.

Wallach Orientation Center: *Barosaurus* model

3. What do we really know about what sauropods looked like?

Ask students what they think sauropods looked like. What color skin did they have? Was it all one color or patterned? Was their skin scaly or smooth? Do they think that the model depicts *Barosaurus* accurately, or is it just an educated guess? Have them supply the reasoning behind their answers. Do they think that there's evidence to support their statements, or are they based on inference? Have students watch the video "What do we really know about long extinct animals like *Barosaurus*?" and revisit their answers.

BACK IN THE CLASSROOM

Activity: Exhibition Wrap-Up

Divide students into small groups to share their experiences at the Museum. Then have the whole class review the observations on their worksheets. Ask what new things they learned, and what surprised them the most. Find out whether any of the questions they came up with before their visit were answered at the Museum. Use new questions to guide further investigation. Then have students draw on what they learned in the Museum to create a picture of sauropods in their habitats.

Activity: Create a Museum Exhibition

Students can demonstrate what they've learned about sauropods by creating their own Museum exhibition. Have students work in small groups to research a topic of interest to them, such as fossil collecting, scientific illustration, or dinosaur features. Groups may want to make posters, models, dioramas, or charts. Have each group present its completed exhibition to the rest of the class.

Activity: Observe a Dinosaur

Students will observe living birds (a kind of dinosaur) and other reptiles (related to dinosaurs) to see how scientists use this information to learn about dinosaur biology and behavior.

To find out how ancient dinosaurs moved and behaved, paleontologists look for clues in fossils, such as fossilized footprints, eggs, and even dung. They also observe and analyze the movement and behavior of living dinosaurs and other animals. These data help paleontologists interpret the fossil evidence. Tell students that they too can observe living dinosaurs, by watching birds in their natural habitat. (Or, direct students to watch bird videos, such as the Cornell Lab of Ornithology's video gallery www.birds.cornell.edu/AllAboutBirds/BirdGuide/VideoGallery.html).

First, have students record information about the environment:

• Date and time
• Location and habitat
• Weather and temperature

Next, have students observe a bird and record:

• How does the bird move?
• What does the bird eat?
• Is the bird alone or in a group?
• How does the bird behave with members of its species?
• How does the bird behave with members of other species?

Tips: Have students observe birds in different weather conditions and at different times of day. To collect good data, they should try to observe similar groups of birds on two or three different occasions.

Finally, have students analyze their data:

• What can you conclude about bird behavior?
• What clues to this behavior might be preserved in the rock record (e.g. footprints)?

As a wrap-up activity, have students compare the notes from this activity to notes taken during their Museum field trip. Encourage them to discuss problem-solving strategies used for both.

ONLINE RESOURCES

Living Large: The Secrets of Sauropods: amnh.org/ology/livinglarge
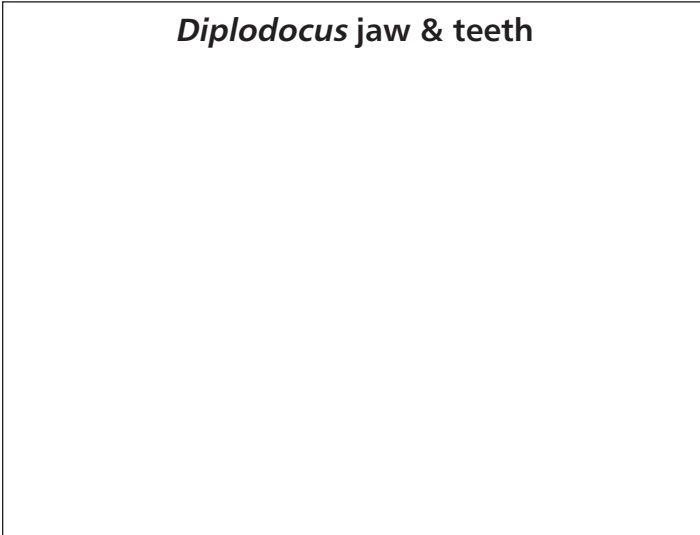
Buried Bones: amnh.org/ology/buried_bones

Going Gobi: amnh.org/ology/gobi

1. How do scientists know what sauropods ate, and how they fed?

Go to the "A Tale of Two Skulls" section. Look for the *Diplodocus* and horse skulls. Compare the jaws and teeth of the two skulls. Sketch each below.

Diplodocus jaw & teeth	horse jaw & teeth

Based on your drawings, what information can the jaws and teeth tell us about sauropods?

What kind of inferences can you make? Why?

What information can't they tell us?

Go to the "Fuel" section. Check out the box of food to see how much sauropods had to eat every day, and what types of food they ate.

amnh.org/wld

2. How do scientists know what sauropods looked like?

Observe the skin of the *Mamenchisaurus* model in the middle of the room. Then go to the "Camouflage and Attraction" section and look through the viewers.

What evidence is there about sauropod skin?

What information can it tell us?

What kind of inferences can you make? Why?

What information can't it tell us?

3. How do scientists know the size of sauropods?

Go to the "Measure the Femur" Section. Use the sliding ruler to measure the juvenile sauropod femur.

Record the length: _____   Record the weight calculation: _____

What information can it tell us?

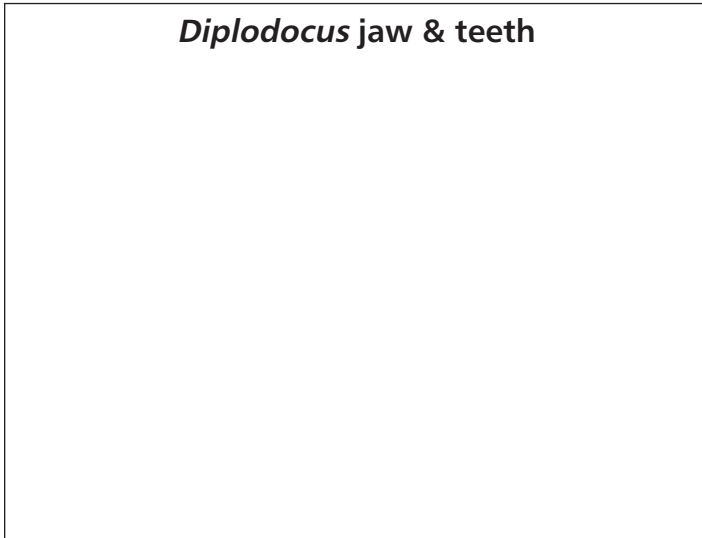What kind of inferences can you make? Why?
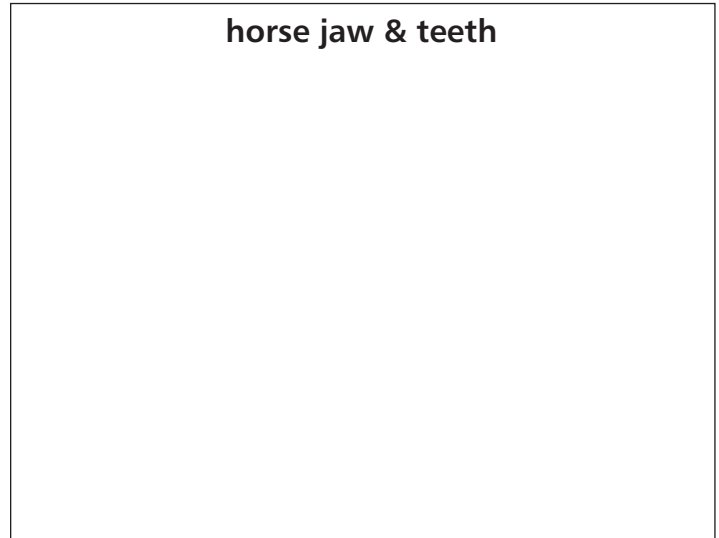
What information can't it tell us?

ANSWER KEY

1. How do scientists know what sauropods ate, and how they fed?

Go to the "A Tale of Two Skulls" section. Look for the *Diplodocus* and horse skulls. Compare the jaws and teeth of the two skulls. Sketch each below.

Diplodocus jaw & teeth	horse jaw & teeth

Based on your drawings, what information can the jaws and teeth tell us about sauropods?

(Answers may include: The shape of the teeth tells us that they ate plants. The Diplodocus *jaw has no back teeth (molars) which means that it didn't chew. The horse jaw contains back teeth (molars) which means that it did chew.)*

What kind of inferences can you make? Why?

(Answers may include: Since Diplodocus *didn't chew its food and its teeth are pencil shaped, it probably stripped leaves off of branches quickly.)*

What information can't they tell us?

(Answers may include: What types of plants they ate. How much they had to eat.)

Go to the "Fuel" section. Check out the box of food to see how much sauropods had to eat every day, and what types of food they ate.

ANSWER KEY

2. How do scientists know what sauropods looked like?

Observe the skin of the *Mamenchisaurus* model in the middle of the room. Then go to the "Camouflage and Attraction" section and look through the viewers.

What evidence is there about sauropod skin?

(Answers may include: Skin can't fossilize, but scientists have found fossil skin impressions.)

What information can it tell us?

(Answers may include: We can tell that sauropod skin had a bumpy texture/scales. Some sauropods, like the titanosaurs, had protective shells made of bony pieces, or osteoderms, that grew from within the skin.)

What kind of inferences can you make? Why?

(Answers may include: Other animals use skin color and patterns for camouflage or attraction, so sauropods may have as well.)

What information can't it tell us?

(Answers may include: Scientists can only guess at skin color and the purpose of osteoderms.)

3. How do scientists know the size of sauropods?

Go to the "Measure the Femur" Section. Use the sliding ruler to measure the juvenile sauropod femur.

Record the length: _____   Record the weight calculation: _____

What information can it tell us?

(Answers may include: We can use the femur length to figure out what the dinosaur would have weighed.)

What kind of inferences can you make? Why?

(Answers may include: The weight can tell us if it was a juvenile or adult.)

What information can't it tell us?

(Answers may include: We still don't know the sauropod's height or how fast it grew.)

The World's Largest Dinosaurs · New York State Science Core Curriculum

Standard	Major Understandings	Introduction	The Importance of Size	Meet *Mamenchisaurus*	Eating	Brain	Neck & Biomechanics	Size of Sauropods	Reproduction	Skin	Trackways	Metabolism	Biology Theater	Circulation	Respiration	Dig Pit	Epilogue
Elementary School																	
LE 4	**3.1c:** In order to survive in their environment, plants and animals must be adapted to that environment.... animal adaptations include coloration for warning or attraction, camouflage, defense mechanisms, movement, hibernation, and migration.		X	X	X	X	X			X	X		X				
	1.2a: Living things grow, take in nutrients, breathe, reproduce, eliminate waste and die.	X	X		X		X	X	X			X	X	X			
	3.2b: Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to permit its survival. Extinction of species is common. Fossils are evidence that a great variety of species existed in the past.	X		X				X	X		X				X	X	X

Standard	Major Understandings	Introduction	The Importance of Size	Meet *Mamenchisaurus*	Eating	Brain	Neck & Biomechanics	Size of Sauropods	Reproduction	Skin	Trackways	Metabolism	Biology Theater	Circulation	Respiration	Dig Pit	Epilogue
	3.2c: Many thousands of layers of sedimentary rock provide evidence for the long history of the earth and for the long history of changing life forms whose remains are found in the rocks. Recently deposited rock layers are more likely to contain fossils resembling existing species.		X		X		X	X			X					X	
LE 4	**3.1b:** Changes in environmental conditions can affect the survival of individual organisms with a particular trait. Small differences between parents and offspring can accumulate in successive generations so that the descendants are very different from their ancestors. Individual organisms with certain traits are more likely to survive and have offspring than individuals without those traits.		X		X		X	X							X		
	1.2a: Each system is composed of organs and tissues which perform specific functions and interact with eachother, e.g., digestion, gas exchange, excretion, circulation, locomotion, control, coordination, reproduction and protection from disease.		X	X	X	X	X	x	X	X	X	X	X	X	X		
	1.1H: Living things are classified by shared characteristics in the cellular and organism level. In classifying organisms, biologists consider details of internal and external structure . Biological classification systems are arranged from general (kingdom) to specific (species).		X		X	X	X	X	X	X	X	X	X	X	X		