BITE-SIZED BIOLOGY: BIOLOGICAL EVOLUTION | GRADE 3

Overview

In this onsite field trip, students encounter key concepts and vocabulary for Grade 3 science including fossils, natural selection, and adaptation. Students begin by creating their own fossil to take home. Students then handle replicas of real fossils and view animal skulls and teeth from the museum's collection, record observational data about them, and work together with peers and museum staff to make inferences about various animals' environments and adaptability.

Standards

NGSS 3-LS4 (1-4): Biological Evolution: Unity and Diversity

- **3-LS4-1:** Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
- **3-LS4-2:** Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.
- **3-LS4-3:** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
- **3-LS4-4:** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

CCSS.ELA-LITERACY: Speaking and Listening

- **CCSS.ELA.LITERACY.SL.3.1:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.
- **CCSS.ELA-LITERACY.SL.3.2:** Determine the main ideas and supporting details of a text read aloud or information presented in diverse media formats, including visually, quantitatively, and orally.
- **CCSS.ELA-LITERACY.SL.3.3:** Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.

Program Format

In this program, groups of up to 20 students rotate through three stations of 20 minutes each for a total program length of 60 minutes. Guides should use their last 1-2 minutes at each station to clean up and prepare to travel to the next station (at Station 1, 3-4 minutes of clean up time is advised). At the conclusion of the third station, all groups should meet in the Atrium. The maximum capacity for this program is 60 students.

Pre-Program Setup

- **Atrium/Station 1:** Assemble fossil kits (Model Magic and adhesive magnet) for every student. Place kits and markers on student tables. Place animal teeth and large gift box on guide table.
- **Changing Faces/Station 2:** Place pencil buckets, Megalodon/Iguanodon/T-Rex tooth fossils, and Fossil Observation sheets at the three stations. Test Dr. Carrano video and adjust volume.
- **Origins of Teeth/Station 3:** Place photograph of "Bonnie" Bonnethead in station for guide to use.

Program Introduction *(Leading museum staff member)*

INTRODUCTION: Introduce museum, docents, and program

- **Museum**
  - We are the National Museum of Dentistry
  - We are located in Baltimore City at the University of Maryland, Baltimore because the University of Maryland School of Dentistry is the oldest dental school in the world
  - Our mission is to celebrate the history and future of oral health
- **Docent:** Name(s) and basic backgrounds/museum roles
- **Program:** In the Bite-Sized Biology program, third graders learn about **BIOLOGICAL EVOLUTION**, or the theory that organisms living on the Earth today developed from other organisms that lived long ago.

Divide into groups of 20 or less and start program clock.

Station 1 (Museum Atrium): Introduction to Fossils

Define & Discuss
In addition to studying living animals, scientists who want to understand biological evolution must also study animals that no longer exist anywhere on earth. How scientists do that? (Fossils)

A **FOSSIL** is a piece of physical evidence that an extinct plant or animal once lived on Earth.

- What does it mean to say that a plant or animal is **EXTINCT**? (It is no longer found anywhere on Earth.)
- Fossils can take many forms. Examples include:
  - Preserved remains, such as dinosaur bones. These types of fossils can tell us about what an organism looked like.
  - Traces left behind, such as preserved footprints, burrows, or nests. These types of fossils can tell us about how an organism behaved.
  - Impressions of an organism or its parts, such as the stamp of a leaf left behind in rock or mud.

PRESERVED TEETH CAN BE FOSSILS. Teeth are some of the most common types of fossils in the **FOSSIL RECORD** (all of the fossils known to scientists, as well as all of the history scientists have interpreted from them).

- This is because most animal teeth, including human teeth, have a strong outer coating called **ENAMEL**. Enamel is extremely tough. When animals are alive, their enamel protects their teeth from cracks and cavities. When animals are no longer alive, their enamel helps preserve their teeth.
- **DENTAL CONNECTION:** You have enamel on your teeth, too! Your enamel is what makes your teeth shiny and strong. How do you keep your enamel healthy? (Brush twice per day, floss once per day, and make healthy choices about what foods you eat!)

WE CAN LEARN FROM FOSSILIZED TEETH. We can observe and compare fossilized teeth to make inferences about the animals to which they belonged, and specifically, their sizes and diets. Fossilized teeth can also provide clues about an extinct animal's modern living relatives.

Activity
LETS MAKE A FOSSIL! (Supplies: Crayola Model Magic, markers, animal teeth, gift box)

- **SETUP:** Each table should be set up with fossil making kits (Model Magic ball approximately 1" in diameter) and markers. Guide distribute one or more animal teeth to each table.
- **INSTRUCT:**
  - Optional: If time permits, students may start by dyeing their Model Magic with markers.
  - Students prepare their Model Magic by forming it into thick discs.
  - Students make impressions into one side of their discs with animal teeth of their choosing
  - Optional: students may choose to stick an adhesive magnet to their fossil
  - Students use permanent markers to write their names on one side of their discs
- **CLEAN-UP (3-4 MINUTES):** Students place fossils in gift box for groups to transport back to school. Guides collect all animal teeth.

Proceed to Changing Faces/Station 2 by going up the Atrium staircase.

Station 2 (Changing Faces): Junior Paleontology Activity

Define & Discuss
A **PALEONTOLOGIST** is a scientist who studies fossils.

Paleontologists use two scientific skills to determine what information a fossil can tell them:
- **OBSERVATION:** Looking carefully at the details of an object to learn something about it
- **COMPARISON:** Examining the similarities and differences between two objects

By making observations about a fossil, and comparing its traits with those of other fossils, paleontologists can determine information about the living creature it belonged to.

Activity
NATIONAL MUSEUM OF NATURAL HISTORY PALEONTOLOGY VIDEO
- **INTRODUCE:** In this video, a real paleontologist named Dr. Matthew Carrano will show us how he uses observations and comparisons to gather information from the fossils he studies.
- **PLAY VIDEO (Adjust volume as needed!)**
- **FOLLOW-UP**
  - What fossil traits did Dr. Carrano use to determine the difference between the dinosaur tooth and the dinosaur claw? (Texture/Shine)
  - What fossil traits did Dr. Carrano use to conclude which dinosaurs ate meat and which dinosaurs ate plants? (Sharpness/Shape)
  - What fossil traits did Dr. Carrano use to conclude which dinosaur species were larger and which species were smaller? (Size)

Activity
FOSSIL OBSERVATION (Supplies: Megalodon, Iguanodon, T-Rex tooth replicas, Fossil Observation worksheets, pencils)
- **INTRODUCE:** These are life-sized copies of teeth from three animals that lived long ago but are no longer found anywhere on earth. In small groups, we will use the Fossil Observation worksheet to help us make observations and comparisons regarding the physical traits of these fossils.
  - Megalodon: prehistoric shark (not a dinosaur)
  - Iguanodon: dinosaur
  - Tyrannosaurus Rex: dinosaur
- **SETUP:** Divide students into three groups of 6-7 students each. If there are three adults in the group, assign one adult to each group. If there are not, identify student group leaders. Show each group to their space within the Changing Faces area. Facilitate 3-minute rotations until each group has observed each fossil.
- **REVIEW & REFLECT:**
  - After each group has observed all fossils, review together using discussion key.
  - Follow-up questions:
    - Which of these animals ate meat? Which ate plants? How do you know?
    - Which of these animals was probably the largest? Which was probably the smallest? How do you know? (Show comparative graphic)

DENTAL CONNECTION: Humans are **OMNIVORES**. This means that our teeth are able to chew plants and meat. Based on all we have discussed and observed, can you tell which teeth in your mouth are good for eating plants? Which ones are good for eating meat?

Proceed to Origins of Teeth/Station 3 by going down the gallery staircase.

Station 3 (Origins of Teeth): Teeth and Diet

(Exhibit made possible through the generous support of the American Academy of the History of Dentistry)

Define & Discuss

Organisms have traits that make them well suited to their environments. These are called **ADAPTATIONS**. Individuals who are well-adapted to their environment pass these traits to their offspring.

Over time, entire populations of living organisms adapt and change. This is called **NATURAL SELECTION.**

Activity

ANIMAL OBSERVATION (No supplies needed)

Evidence of adaptation, or the development of traits that can help species of organisms survive in a particular environment, can be found among the animals in this exhibit. Observe as a group:

- **AFRICAN WARTHOGS** have large, sharp tusks. In what ways do you think these unique teeth help the warthog survive, grow, and reproduce in the African savanna?
  - Warthogs use their tusks to defend themselves from predators as well as to dig in the hardened savanna to build burrows and find underground food like roots.

- **SHARKS** have many rows of teeth that can regenerate if teeth are lost or broken. How does this adaptation help sharks survive, grow, and reproduce in the ocean?
  - Sharks are meat-eaters and hunt prey with hard bones and exoskeletons (such as shellfish). In the process of hunting and eating, they break or lose a lot of teeth! Regeneration helps sharks maintain the sharp teeth they need to hunt and eat.

- **RABBITS** have long incisors at the front of their mouths that never stop growing. How does this adaptation help rabbits survive, grow, and reproduce?
  - Rabbits eat high-fiber diets that wear away their teeth over time. Because the rabbit's incisors never stop growing, it is able to maintain the blunt, sharp teeth it needs to cut through fibrous foods.

- **HORSES** are native to North America where grasslands are plentiful. They have long, narrow skulls with flat incisors at the fronts of their mouths. How has this adaptation helped horses survive in North American grasslands?
  - Horses can access hard-to-reach patches of grass. Their flat, sharp teeth are perfect for cutting grasses, as well as eating apples, carrots, and other crunchy foods.

DENTAL CONNECTION:

- **BEARS,** like humans, are omnivores. This means that their teeth are able to chew plants and meat. This helps bears survive in a wide variety of environments: why?
  - Thanks in part to their diverse teeth, bears can consume and digest a wide variety of food sources. So can people!

Activity
SOLUTIONS TO ENVIRONMENTAL CHANGE (No supplies needed)
As a group, let's consider how two of these animals might need to adapt if their environment changed.

- **SHARKS**: Imagine that the deep ocean suddenly became too warm for some sharks to survive there, forcing them to move north to cooler waters and away from the large animals they were used to hunting. How might the sharks adapt to survive?
  - Adapt to become better hunters by swimming faster and growing sharper teeth in order to hunt more food
  - Adapt to eating a different kind of food
  - **REAL-WORLD ADAPTATION:** One species of hammerhead shark--the Bonnethead--has adapted to be able to digest plant material as well as meat. If faced with hunting challenges, could other shark species adapt similarly to their cousin, the Bonnethead, and develop the ability to digest plant material?
    - Optional: show photograph of "Bonnie" the Bonnethead shark, whose sharp teeth are rotated to allow her to cut through plant material using their flat sides--much like horses and rabbits!

- **HORSES:** Imagine that desert begins to spread across North America and grasslands begin to disappear, eliminating much of the food source for horses. How might horses adapt to survive?
  - Move to South America in search of large, open plains
  - Adapt to eating a different kind of food
  - **REAL-WORLD ADAPTATION:** Another hooved animal with some similarities to the horse--the giraffe--does not typically eat grass. Instead, giraffes prefer the leaves of tall trees. Giraffes can eat from tall trees because they have adapted by developing long necks. Could horses adapt similarly to their cousin, the giraffe, and develop longer necks to reach tall tree leaves?

Proceed to Atrium/Station 1.

Program Conclusion *(Leading museum staff member)*

WHY DO THIRD GRADERS STUDY BIOLOGICAL EVOLUTION? We live in a world that is constantly changing--and always has been. By studying evolution and related concepts, including natural selection and adaptation, we can better understand the Earth and the plants and animals who live on it--as well as ourselves!

QUESTIONS?

TOUR THE MUSEUM: Following any programming, students, teachers, and chaperones may tour the museum at their own pace and/or eat lunch in the atrium.

RETURN STUDENT FOSSILS TO TEACHER(S) TO TAKE HOME.

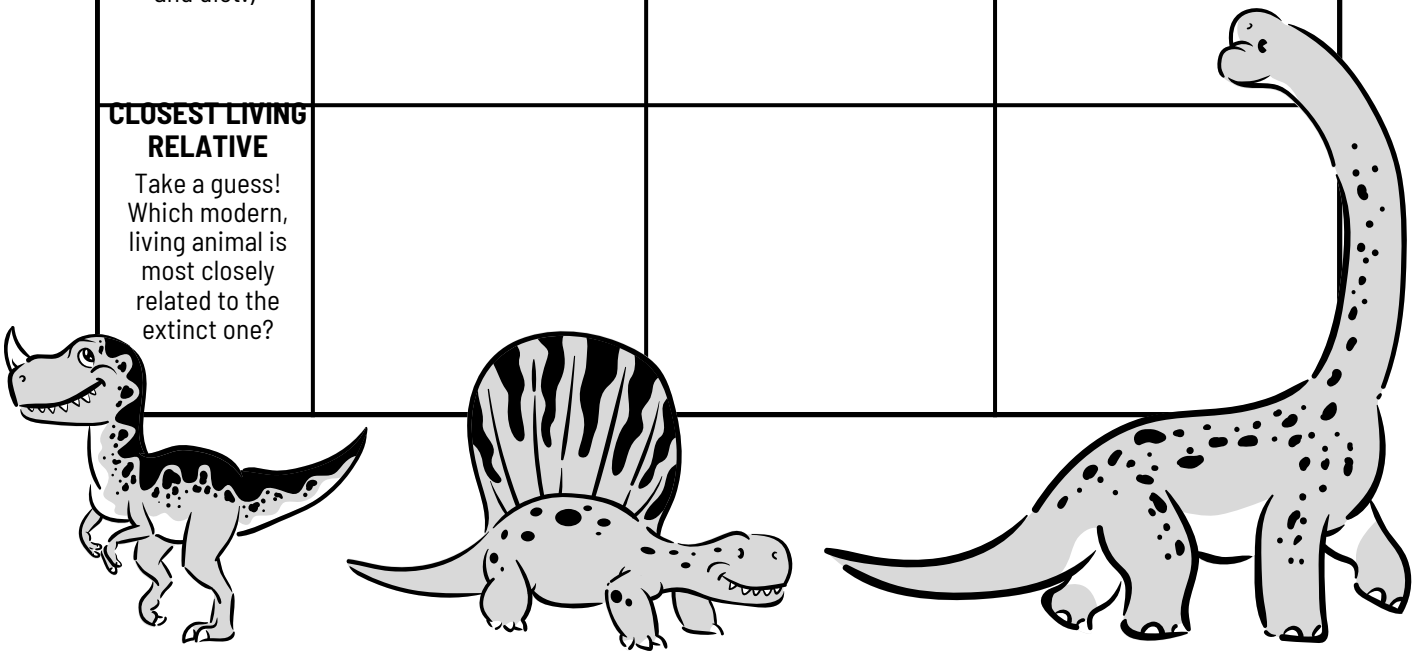
Key Vocabulary

- **ADAPTATION:** a physical or behavioral trait that makes an organism better suited to its environment
- **BIOLOGICAL EVOLUTION:** the theory that organisms living on the Earth today developed from other organisms that lived long ago
- **COMPARISON:** Examining the similarities and differences between two objects
- **ENAMEL:** a strong outer coating on the teeth that protects teeth from decay
- **EXTINCT:** having no living members; a species that is extinct is no longer found anywhere on Earth
- **FOSSIL:** a piece of physical evidence that an extinct plant or animal once lived on Earth
- **FOSSIL RECORD:** all of the fossils known to scientists, as well as all of the history scientists have interpreted from them
- **NATURAL SELECTION:** a process through which populations of living organisms adapt and change
- **OBSERVATION:** Looking carefully at the details of an object to learn something about it
- **PALEONTOLOGIST:** a scientist who studies fossils

FOSSIL OBSERVATION

What can we learn by observing fossils? In the table, record observations about each fossil's shape, size, and sharpness. Use your observations to make inferences about the animals they belonged to.

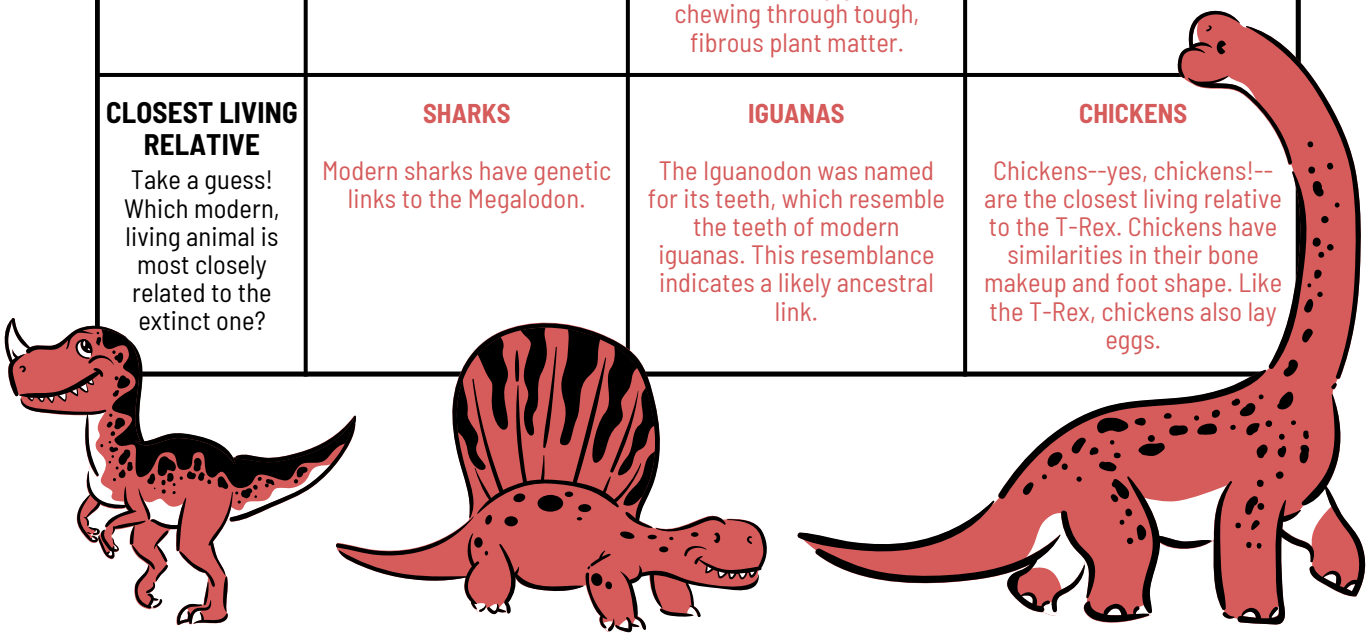
	MEGALODON	IGUANODON	TYRANNOSAURUS REX
SHAPE Is the tooth pointy or flat?			
SIZE Is the tooth small, medium, or large?			
SHARPNESS Is the tooth sharp or blunt?			
INFER Based on your observations above, what can you infer about the animal this fossil belonged to? (Think about the animal's size and diet!)			
CLOSEST LIVING RELATIVE Take a guess! Which modern, living animal is most closely related to the extinct one?			



FOSSIL OBSERVATION
DISCUSSION KEY

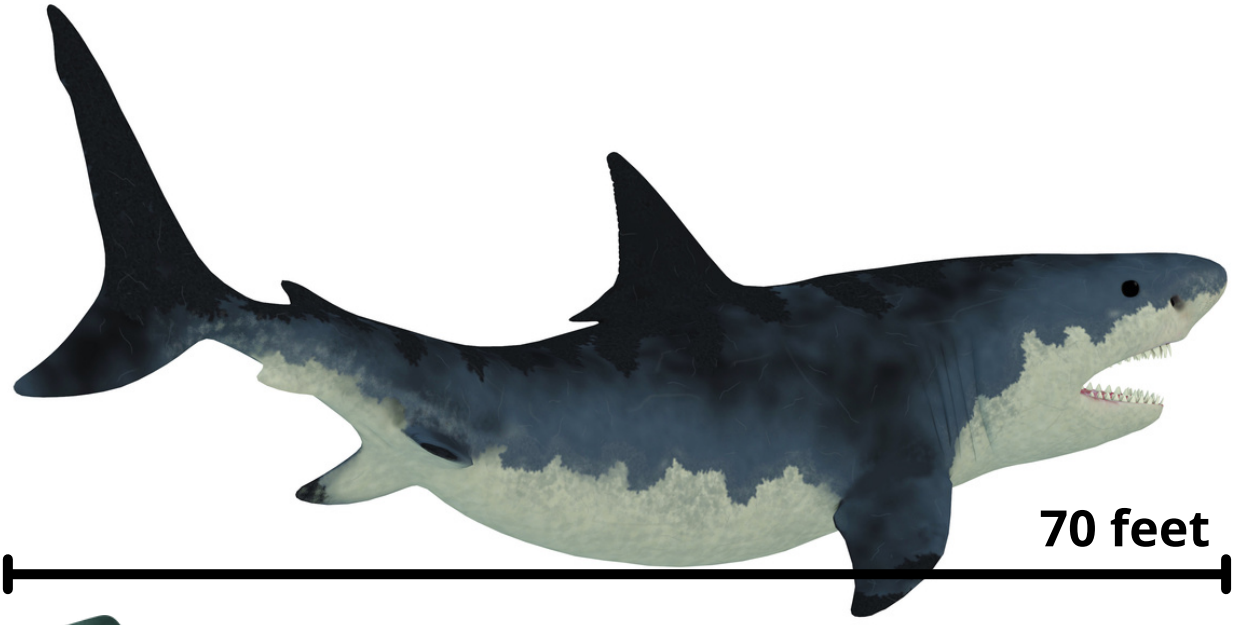
What can we learn by observing fossils? In the table, record observations about each fossil's shape, size, and sharpness. Use your observations to make inferences about the animals they belonged to.

	MEGALODON	IGUANODON	TYRANNOSAURUS REX
SHAPE Is the tooth pointy or flat?	Pointy	Flat	Pointy
SIZE Is the tooth small, medium, or large?	Large	Medium	Large
SHARPNESS Is the tooth sharp or blunt?	Sharp	Blunt	Sharp
INFER Based on your observations above, what can you infer about the animal this fossil belonged to? (Think about the animal's size and diet!)	Megalodons were the largest sharks ever to live on Earth! Scientists estimate that megalodons reached lengths of up to 70 feet. That is the length of two full-sized school buses! Megalodons were meat eaters. Their sharp, serrated teeth were very good at shredding meat.	Iguanodons were medium-sized dinosaurs (much larger than humans, but much smaller than T-Rexes or Megalodons). Accordingly, their teeth are much larger than ours--but much smaller than those of the other fossils we are observing. Iguanodons were plant eaters. Their flat, serrated teeth were very good at chewing through tough, fibrous plant matter.	The Tyrannosaurus Rex was not the largest dinosaur ever to roam the Earth, but they were pretty close! We can tell from the size of the T-Rex's teeth that they were likely quite large. T-Rexes were meat eaters. Their sharp, serrated teeth were very good at shredding meat.
CLOSEST LIVING RELATIVE Take a guess! Which modern, living animal is most closely related to the extinct one?	**SHARKS** Modern sharks have genetic links to the Megalodon.	**IGUANAS** The Iguanodon was named for its teeth, which resemble the teeth of modern iguanas. This resemblance indicates a likely ancestral link.	**CHICKENS** Chickens--yes, chickens!--are the closest living relative to the T-Rex. Chickens have similarities in their bone makeup and foot shape. Like the T-Rex, chickens also lay eggs.

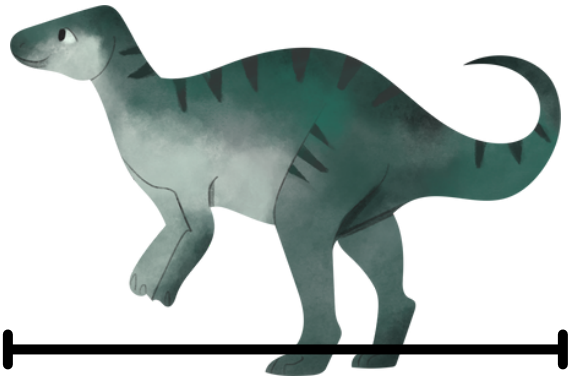


BONNETHEAD SHARK

35 feet



70 feet



33 feet

40 feet