MUSEUM ALIVE

GRADES K-8 EDUCATOR GUIDE

COLOSSUS PRODUCTIONS

SERENGETI ENTERTAINMENT

ABOUT

COLOSSUS PRODUCTIONS

Colossus Productions is the 3D-specialist production company formed by Atlantic Productions (see more below) with Sky in 2011. The joint venture was created to develop and produce high-end 3D films for UK and international audiences. Emerging from Atlantic Production's record in producing award winning content, Colossus has already released in IMAX and Giant Screen such diverse educational and entertaining films as *Flying Monsters 3D*, *Penguins 3D* and *Galapagos 3D: Nature's Wonderland* into cinemas worldwide. Colossus' most recent IMAX/Giant Screen films are *Museum Alive* and *Amazing Mighty Micro Monsters* which were released in late 2016 and the newest Colossus production, *Conquest of the Skies* will be released in IMAX and Giant Screen later in 2016.

ATLANTIC PRODUCTIONS

Atlantic Productions is one of the world's leading factual production companies whose multi BAFTA and Emmy award-winning films and content are regularly seen in over 100 countries around the world. Founded in 1992, Atlantic has built a reputation for world-class story-telling, enhanced by the latest techniques and technologies including the building of pioneering cross-platform and digital experiences. Atlantic Productions leads a group of companies which make television programmes, theatrical and IMAX films, apps (Atlantic Digital), visual effects (Zoo VFX) and now, immersive virtual reality experiences (Alchemy VR).

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This guide was developed as a companion to the Colossus Productions film, *Museum Alive.*

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WELCOME LETTER

Dear Educator,

Bring the most fascinating exhibits from London's Natural History Museum, including some that are typically behind the scenes, to life for your students. Excite students about their local natural history museum by introducing them to the wonders that this museum holds.

London's Natural History Museum is a preeminent scientific organization. Students will be captivated as they are transported back in time to this magical world. They will enjoy a thrilling adventure as strange and exotic extinct animals come "back to life" through the latest computer-generated imagery (CGI) technology. David Attenborough, a world-famous naturalist, introduces students to the astonishing variety of life on the planet—both today and in the distant past—and explains how scientists reveal the truth behind myths by using clues as evidence for how animals may have appeared and behaved. All of this happens thanks to a unique collaboration between scientists, Natural History Museum curators, and the world's leading animation studios. The result is spectacular, fun, enlightening, and educational.

This insider look at extinct animals is an ideal foundation for exploring natural history, paleontology, science, and technology topics with your students, and it also provides numerous opportunities for cross-curricular connections from geography to literacy. This guide includes standards-based activities designed for use with upper elementary students, with adaptations for both younger and older students. Worksheets and handouts are provided for all activities that require them, and educators will find additional activity ideas as well as a list of standards addressed by the guide.

These activities will capture your students' interest and offer excellent opportunities for learning. Enjoy interacting with the amazing historic natural history of our planet.

Sincerely,

Colossus Productions
& the Museum Alive team

Education Standards and Skills Addressed

The activities in this guide are designed to target the following national standards and key skills:

National Standards

- National Science Education Standards
- Next Generation Science Standards
- Common Core State Standards for English Language Arts
- National Geography Standards

Key Skills

- 21st Century Student Outcomes
- 21st Century Themes
- Critical Thinking Skills
- Science and Engineering Practices
- Geographic Skills

A NOTE ABOUT HOW TO USE THIS GUIDE

This guide is intended for use by both museum and classroom educators.

Formal classroom educators will find activities to deepen learning around the film by introducing students to the content before they view the film and expanding on what they learned afterward. Museum educators can make these activities available to classroom educators via their organization's website.

Museum educators will also find suggestions on how to share information about the *Museum Alive* film with educators in their area as well as additional activity ideas to engage students on-site, before and after viewing the film. Although the material is copyrighted, educators may reproduce instructional assets within this guide for non-commercial purposes in order to share with fellow educators. within this guide for non-commercial purposes in order to share with fellow educators.

SPREAD THE WORD ABOUT THE FILM

NEWSLETTER TEXT

Include the following text in your organization's newsletter to raise awareness about *Museum Alive:*

Join world-famous naturalist David Attenborough for a private tour of London's Natural History Museum. Leave dazzled by what you see with *Museum Alive*! 23 WORDS

Museum Alive is a thrilling exploration of life—both past and present—on the planet. This film invites students to explore natural history, paleontology, science, and technology topics through examples of fascinating organisms, as introduced by world-famous naturalist David Attenborough. 40 WORDS

Bring the past roaring back to life! *Museum Alive* takes students on a tour of the wonders of London's Natural History Museum. This captivating film features some of the planet's unique specimens. World-famous naturalist David Attenborough is your guide as he explains how we know what we know about these organisms, through the lenses of history, natural history, technology, and science. It is sure to be an unforgettable field trip experience! 71 WORDS

BACKGROUND INFORMATION

FILM SYNOPSIS

BRINGING THE PAST ROARING BACK TO LIFE!

Audiences will be captivated as they are transported into a magical, Hogwarts-like museum to enjoy a thrilling adventure as strange and exotic beasts emerge from their display cases and come back to life. But this is not just a Hollywood fantasy; *Museum Alive* is the result of an extraordinary collaboration between leading museum experts and prize-winning special effects animators, who together created the most scientifically accurate and photo-realistic film about extinct creatures, based on the latest interpretations of the fossil evidence.

Providing the link between specimens is naturalist David Attenborough, who has been given the privilege of visiting the museum after hours, and who chooses some of the most scientifically significant and visually exhilarating animals to showcase. By resurrecting them in incredible "living" detail, the film allows Attenborough to interact with the animals as if they had never gone extinct, while demonstrating how they would have behaved when alive.

Museum Alive unites stunning visuals, exciting storytelling, and the latest science to create an experience that is spectacular, enlightening, and fun for young and old.

THE FILM FEATURES THE FOLLOWING ORGANISMS:

Diplodocus (sauropod dinosaur)
Gigantopithecus (huge ape, yeti)
Smilodon (saber-toothed cat)
Archaeopteryx (early bird)
Moa (giant flightless bird)
Harpagornis (giant eagle)
Glossotherium (giant ground sloth)
Ichthyosaurus (marine lizard)
Gigantophis (gigantic snake)
Dodo (flightless bird)

DID YOU KNOW?

FUN FACTS ABOUT NATURAL HISTORY

London's Natural History Museum is sometimes known as the "Cathedral to Nature." It opened in 1881 and houses more than 80 million specimens.

Scientists estimate that 99.99% of all species to ever live on Earth, throughout Earth's multi-billion year history, are now extinct.

Some scientists want to bring back species that are extinct, using the controversial procedure of genetic engineering. By using DNA from extinct species, it might be possible to create an organism through cloning.

The Haast Eagle (*Harpagornis moorei*) is the largest eagle that ever existed. Its wingspan measured up to 3 meters (almost 10 feet). That's at least half a meter (2 feet) longer than the wingspan of today's bald eagle.

A mass extinction is when a large number of species become extinct in a short period of time. Scientists know of five mass extinctions in Earth's history: at the end of the Cretaceous, in the late Triassic, at the end of the Permian, during the late Devonian, and during the late Ordovician periods.

The term "dinosaur" was coined by the London Natural History Museum's first director, Richard Owen. Dinosaur comes from the ancient Greek words *deinos*, meaning "fearfully great," and *sauros*, meaning "lizard."

London's Natural History Museum's collection includes specimens from Charles Darwin's voyage on HMS *Beagle* and from Captain Cook's journey aboard HMS *Endeavour*.

A naturalist is an expert in or student of natural history. Natural history is the research and study of organisms, including animals, fungi, bacteria, and plants, in their environment. Naturalists also study the physical environment these organisms live in.

ACTIVITIES TO BUILD CONTENT KNOWLEDGE

BEFORE VIEWING THE FILM

Activity 1: Clues to the Past

ACTIVITY DESCRIPTION

Students explore the various ways paleontologists use clues—from fossils to extinct animals' living, modern relatives—to make inferences about what animals from the distant past looked like and how they behaved. Students take on the role of paleontologists in order to practice this type of scientific thinking.

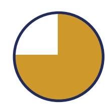
CONNECTION TO FILM

In the film, students hear about how expert scientists use fossils, skeletons or bones, and bits of skin and feathers to make conjectures about what organisms from the distant past looked like and how they behaved. Before viewing the film, all students will benefit from a deeper understanding or review of fossils and how paleontologists use scientific thinking to interpret evidence and to make inferences about fossils.

LEARNING GOALS

- ✓ describe the work of paleontologists
- ✓ define fossil and the types of clues fossils can provide
- ✓ distinguish between evidence and inference

TIME NEEDED



45 minutes

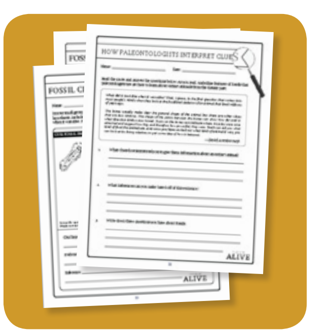
PREPARATION

Before conducting the activity, print at least one worksheet for each small group.

VOCABULARY

- ✓ cast
- ✓ evidence
- ✓ extinct
- ✓ fossil
- ✓ hypothesis
- ✓ inference
- ✓ mold
- ✓ organism
- ✓ paleontologist

MATERIALS LIST



- ✓ How Paleontologists Interpret Clues worksheet
- ✓ Fossil Clues worksheet (1 per small group)

Note: all worksheets are available in the Worksheets and Handouts section of this guide.

DIRECTIONS

1. **Activate prior knowledge about extinct animals from the distant past.**
Ask students to list **extinct** animals that lived a long time ago (e.g., dinosaurs, woolly mammoth, saber-toothed cat). Write their responses on the board. Ask: *How do we know what animals that lived long ago looked like or how they behaved?*

2. **Explain the difference between evidence and inference.** Explain to students that scientists are still asking and answering questions about these types of animals, but they primarily use two types of reasoning and clues: they analyze **evidence** from fossils; and they make **inferences** based on the appearance and behavior of the living, modern relatives of these ancient animals. Evidence can be thought of as clues; an inference is a reasoned argument based on evidence. Write the definitions on the board so students can refer to them throughout the activity.

3. **Review the definition and formation process of a fossil.**
A **fossil** is a preserved remnant, impression, or trace of an organism from a past geologic age. Add the definition of a fossil to the board. Discuss how fossils are formed:

    1. An **organism** dies.
    2. Animals and bacteria remove the flesh of the organism.
    3. Material, such as sediment, buries the remains
    4. Whatever material covers the remains turns into rock through geologic processes. A **cast** and **mold** form when the remains of the organism dissolve and minerals take its place, forming a fossil.
    5. A fossil is revealed or found through natural geologic processes, human activity, or other means.

4. **Ask students to identify how fossil clues provide paleontologists with evidence.**
Explain to students that **paleontologists** are people who search for, discover, and study fossils. Distribute a copy of the worksheet, How Paleontologists Interpret Clues, to each student. As students read, have them underline features that act as clues. Then have them answer the questions.

    Draw a simple T-chart on the board with column heads: Clues, Evidence. Fill in the T-chart as students share their answers to the worksheet questions. Ask: *What clues do scientists rely on to give them information about an extinct animal?* (teeth, scars, bones, shape of joints). Tell students that scientists sometimes also find bits of fossilized skin and feathers. Ask: *What do these clues tell us about the organism?* (an animal's size, what its skeleton looked like, what its exterior looked like, when it lived, where it lived, what it ate, its predators). Invite volunteers to share their questions about fossils.

5. **Have students hypothesize about animals using illustrations of their fossils.**
Divide students into small groups and distribute a copy of the Fossil Clues worksheet to each group. Assign an organism to each group. Explain that students are going to act

as paleontologists and look at images of fossils. As a group, they will come up with a **hypothesis**, including a sketch, about what their assigned animal looked like and how it behaved when it was alive, and they will share both their evidence and inference with the class. Encourage groups to include ideas about the appearance and behavior of the animal's modern relative(s) when developing their hypotheses.

6. **Have a class discussion on the importance of evidence.**
   Have each small group present their hypothesis and sketch and share their reasoning. After each group has presented, have students research what scientists believe their assigned species looked like. Discuss how the scientific representations compare to students' hypotheses. Ask: *How do our hypotheses and sketches compare to scientific ones? How challenging was it to construct a hypothesis with partial information?* Discuss the importance of evidence and how its presence can better inform inferences. What was difficult or easy for the groups that only had fossilized teeth, skin, and feces? What was difficult or easy for the groups that had full skeletons? What additional information would have helped students? (e.g., information about size, location fossils were found in, age of fossils)

ADAPTING THE ACTIVITY FOR YOUNGER STUDENTS

Additional materials:

- ✔ modeling clay
- ✔ white glue
- ✔ hard items to make impressions (e.g., small animal figurines)
- ✔ trays or cookie sheets

Have students model how a fossil forms as you review the process from Directions Step 3. Explain the difference between a mold (an imprint in soft earth) and a cast (a copy of the original when the mold is filled).

Have students work independently or in small groups. Give each student a small piece of modeling clay and a tray or cookie sheet. Working on the tray or cookie sheet, have them roll the clay into a ball and then push it flat so that it is still a relatively thick piece of clay. Next, have students press their item into the modeling clay. Students should be careful not to push their item all the way through the clay. Direct them to carefully peel out the item. The impression left in the modeling clay is the mold. Have students squeeze glue into their molds. Note, these will need to dry overnight (at minimum). Before students add glue, ensure that they have not pushed their item into the modeling clay so hard so that it has broken through the modeling clay on to the tray or cookie sheet. Once the glue has dried, carefully peel it out of the modeling clay. The dried glue is a cast.

Give a quick overview of the different types of fossils that can form. Body fossils are the remains of an organism. They can form in different ways. Trace fossils are evidence of an animal's activity, like a set of footprints. Add the definitions for body fossils and trace fossils to the board. Next, designate one side of the room the "body fossil side" and the other half of the room the "trace fossil side." Ask: *Who made trace fossils? Who made body fossils?* These two types can form as molds and casts. Have students move to the correct side of the room based on whether they created a body fossil or trace fossil. Then, have each student present their fossil to the rest of the class, so students see multiple examples of each type.

ADAPTING THE ACTIVITY FOR OLDER STUDENTS

Expand the discussion about fossil evidence from organisms to environments. Ask: *What other kinds of evidence can fossils provide?* In addition to fossils providing clues about the organism, they can also provide clues about the environment.

Explain that evidence and inference can be applied to the environment as well. For example, the discovery of marine fossils in a desert gives us evidence that the location might have been a very different environment in the past.

Have students return to their hypotheses and sketches in their small groups. Based on their animal's characteristics, what kind of environment did it live in? Prompt students to make inferences about the environment based on evidence from the fossil (what the animal ate) and connections to its modern relative (what temperatures it might prefer, what kind of ecosystem might it live in). Ask students to list additional evidence they would need about their fossil (what the fossil is made of, how the fossil formed) to make more in-depth inferences. Have each group create a bulleted list to describe the environment and the additional information required to make more in-depth inferences. Invite groups to share their environment descriptions with the whole class.

CROSS-CURRICULAR CONNECTION

Science (Geology) Review the three main rock types: igneous, metamorphic, and sedimentary. Ask students to explain how these rock types form. (Igneous rocks form when magma cools. Metamorphic rocks form through intense heat and pressure. Sedimentary rocks form as layers of sediment are pressed together.) Ask students which rock types are most likely to have fossils. (sedimentary) Have them share their reasoning.

KEY SKILLS

21st Century Student Outcomes

Learning and Innovation Skills

- ✓ Critical Thinking and Problem Solving
- ✓ Communication and Collaboration

Information, Media, and Technology Skills

- ✓ Information Literacy

21st Century Themes
- ✓ Environmental Literacy

Critical Thinking Skills
- ✓ Applying
- ✓ Analyzing

Science and Engineering Practices
- ✓ Analyzing and Interpreting Data
- ✓ Engaging in Argument from Evidence

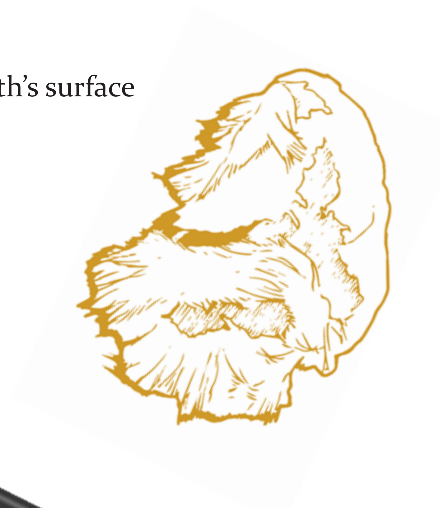
CONNECTIONS TO STANDARDS

National Science Education Standards
(K-4) C-1: The Characteristics of Organisms
(K-4) D-1: Properties of earth materials
(K-4) G-1: Science as a human endeavor
(5-8) A-2: Understandings about Scientific Inquiry
(5-8) C-5: Diversity and Adaptation of Organisms
(5-8) D-2: Earth's history

Next Generation Science 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.

4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support explanation for changes in a landscape over time.

National Geography Standards
7. The physical processes that shape the patterns of Earth's surface
17. How to apply geography to interpret the past



Activity 2: Extinction

ACTIVITY DESCRIPTION

Students review extinction factors, including human and Earth processes, and then use ecosystem simulations to explore why some animals are no longer on Earth.

CONNECTION TO FILM

All of the creatures featured in the film are extinct, but students only learn how the dodo went extinct. Students will benefit from an overview of extinction factors. This activity is an opportunity to discuss various case studies of extinction, as well as practice hypothesizing and applying knowledge to organisms featured in the film.

LEARNING GOALS

- ✓ Use simulations to explore the causes and effects of extinction on ecosystems
- ✓ Examine multiple causes and effects on specific organisms that have gone extinct
- ✓ Identify major extinction factors

TIME NEEDED

45 minutes

VOCABULARY

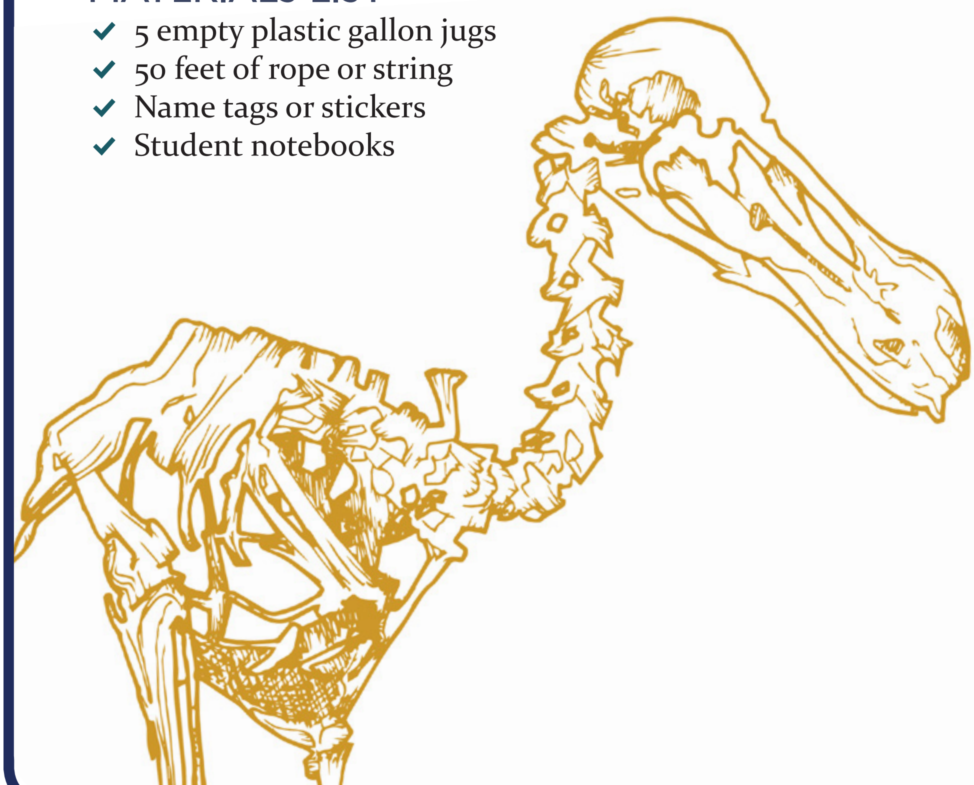
- ✓ affect
- ✓ adaptation
- ✓ cause
- ✓ characteristics
- ✓ ecosystem
- ✓ effect
- ✓ extinct
- ✓ habitat loss
- ✓ human impacts
- ✓ introduced species
- ✓ overconsumption
- ✓ pollution
- ✓ population growth
- ✓ species
- ✓ survival

PREPARATION

No special preparation is needed for this activity.

MATERIALS LIST

- ✓ 5 empty plastic gallon jugs
- ✓ 50 feet of rope or string
- ✓ Name tags or stickers
- ✓ Student notebooks



DIRECTIONS

1. **Review key concepts with students.**
   Ask students to recall what they know about **species** and how species relate to their **environments**. Record student responses on the board. Elicit from students that many species have specific **adaptations** that help them survive their environment. Tell students that adaptations do not always guarantee **survival**.

2. **Introduce the term *extinct*.**
   Remind students that some animals that once lived on Earth went extinct. When a species is **extinct**, none of its kind is alive today. Scientists estimate that 99.99% of all species to ever live on Earth, throughout Earth's multi-billion year history, are now extinct. Ask students to brainstorm some extinct animals they know of (e.g., dinosaurs, woolly mammoth, dodo). Ask: *How do we know about these species if they are no longer alive?* Elicit from students that fossils provide scientists with evidence about organisms that lived long ago.

3. **Review major extinction factors with students.**
   Explain that the extinction of a species occurs when the environment changes and the adaptive **characteristics** of a species are not enough to support its survival. Explain that these changes are so drastic that organisms aren't able to change their behavior or physical characteristics to survive. Six main **causes** of this type of change are **habitat loss**, **introduced species**, **population growth**, **pollution**, **overconsumption**, and **human impacts**. Write these factors and their definitions on the board for students to copy into their notebooks. These changes can happen incrementally (such as a changing climate) or all at once (due to a catastrophe, such as an asteroid impact). Explain that when these changes occur in an ecosystem, they **affect** the organisms that are a part of that ecosystem.

4. **Simulate extinction events using a systems web.**
   Explain to students that extinction isn't always due to just one cause, or reason. Often, it's caused by a combination of multiple factors. Tell students that they are going to simulate several examples of extinction events. They will need to hypothesize how various organisms became extinct, citing one or more of the six main causes they recorded in their notebooks.

   Divide students into small groups as directed for each simulation. Have each group take a turn while other students observe and take notes on what happens. Students will need these notes to make connections between the events at the end of the activity. Use the case studies and scripting below. When it is a group's turn, students will hold empty plastic gallon jugs connected by rope to represent an ecosystem. Each jug represents an organism. Connect the jugs using the rope as you introduce each case study.

SIMULATION 1: HUMAN IMPACTS

1. Setup: six students representing a human, a moa, a Haast eagle, adzebills (a type of bird), waterfowl, plants (shrubs and trees). Each of the six students should wear a name tag stating the name of the organism they represent. Connect the moa, adzebill, and waterfowl to the plant jug; the Haast eagle to the moa, adzebill, and waterfowl; and the humans to the waterfowl and moa.
2. Have students identify the predators and prey in the model ecosystem. Add "predator" or "prey" to each student's name tag.
3. Ask: *What caused the moa to go extinct?* Have students hypothesize what happened, citing one or more of the six main extinction factors.
4. Explain that these organisms all lived in New Zealand. Early settlers (ancestors of the Maori) arrived. These settlers had a strong hunting tradition and moa was a main source of food. Within 200 years of humans' arrival in New Zealand, the moa and many species of waterfowl and adzebills were hunted to extinction. Have students drop the moa, adzebill, and waterfowl jugs. Ask: *What do you think happened to the Haast eagle after these other animals went away?* (The Haast eagle went extinct because its food source disappeared.)

SIMULATION 2: INTRODUCED SPECIES

1. Setup: five students representing a human, a dodo, dodo eggs, fruit trees, and snails. Each of the five students should wear a name tag stating the name of the organism they represent. Connect the dodo to the fruit trees and snail; the dodo eggs to the dodo; and the human to the dodo.
2. Have students identify the predators and prey in the model ecosystem. Add "predator" or "prey" to each student's name tag.
3. Ask: *What caused the dodo to go extinct?* Have students hypothesize what happened, citing one or more of the six main extinction factors. Explain that the dodo evolved in isolation on an island in the Indian Ocean. As a result, it had very few natural predators. Tell students that humans arrived on the island, and soon after, the dodo went extinct.
4. Students will likely say that humans hunted dodos. Explain that the Dutch word for dodo means "disgusting bird," so it is very unlikely that they went extinct due to hunting. But humans brought many non-native species, like pigs and rats, with them. These animals ate the dodos and their main food source. Have students drop the fruit tree and snail jugs, along with dodo eggs. Ask: *What happened to the dodos when the fruit trees and snails went away?* The dodo went extinct in part because its food source disappeared

SIMULATION 3: HABITAT LOSS

1. Setup: four students representing shrubs, trees, a human, and a mastodon. Each of the four students should wear a name tag stating the name of the organism they represent. Connect the mastodon to the shrubs and trees, and the human to the mastodon.
2. Have students identify the predators and prey in the model ecosystem. Add "predator" or "prey" to each student's name tag.
3. Ask: *What caused the mastodon to go extinct?* Have students hypothesize what happened, citing one or more of the six main extinction factors. Mastodons were herbivores and had to eat a huge amount of plants to sustain themselves. They had thick, shaggy coats for the cold weather.
4. Scientists debate how mastodons went extinct. Some think they were hunted by early humans, and others think shifting global climates played a role. Many agree that it was a combination of these factors that caused them to go extinct.

SIMULATION 4: CATASTROPHIC EVENT

1. Setup: seven students representing dinosaurs, pterosaurs, mosasaurs, plesiosaurs, mollusks, marine plankton, and plants. Each of the seven students should wear a name tag stating the name of the organism they represent. Connect all the jugs to each other.
2. Have students identify the predators and prey in the model ecosystem. Add "predator" or "prey" to each student's name tag.
3. Ask: *What caused the dinosaurs to go extinct?* Students will most likely say an asteroid, but ask them to connect how an asteroid impacting the earth caused one or more of the other six main extinction factors.
4. Tell students to drop all of the jugs.

5. Discuss cause and effect factors in extinction.
Ask: *What do these extinction events all have in common? How did these animals go extinct?* Have students work independently and record their answers to these questions in their notebooks. Then, have each student turn to a neighbor and ask pairs to share their answers with each other. Students' reasoning should make connections between ecosystems being impacted by external factors, like humans and climate. Have students recall each simulation and identify which of the six main causes were involved, and what effect they had on the species in the simulation. Invite pairs to share their ideas with the whole class.

ADAPTING THE ACTIVITY FOR YOUNGER STUDENTS

Additional Materials:

- ✓ Blank paper

Expand the discussion in Directions Step 1 and Step 3. In Step 1, if students are unfamiliar with the term *adaptation*, review how different organisms from different environments have different characteristics and how these characteristics help them survive in their environments. In Step 3, spend extra time defining and reviewing the six main causes of extinction: habitat loss, introduced species, population growth, pollution, overconsumption, and human impacts. Give each student a blank sheet of paper and have them fold it into 6 equal sections (fold in half lengthwise, then into thirds, width-wise). Ask students to define what each of these factors means based on what each individual word means. Discuss these definitions as a class, and have students record one term per square in writing or drawing. For example, break down "habitat loss" into "habitat" and "loss." Ask students what each word means independently, and combine those meanings into the definition of the full term.

ADAPTING THE ACTIVITY FOR OLDER STUDENTS

Have students develop their own species extinction simulations working with different organisms. Have students select an extinct animal and design their own web of extinction factors on a blank sheet of paper, using illustrations, labels, and descriptions. Ask them to indicate connections between the factors within each web, and provide a written explanation of how their chosen species became extinct.

CROSS-CURRICULAR CONNECTION

Geography Divide students into small groups and assign each group a biome (e.g., desert, freshwater aquatic, tropical forest, tundra). Ask groups: *How do threats to this particular biome create challenges for the animals that live there?* Have each group prepare a poster showing their biome, including any indigenous endangered animals, and write an essay describing environmental threats to their particular biome and how that impacts animals that live there. Have each group present their poster to the class.

KEY SKILLS

21st Century Themes

- ✓ Environmental Literacy

Critical Thinking Skills

- ✓ Understanding
- ✓ Applying
- ✓ Analyzing

Science and Engineering Practices
- ✓ Developing and using models

Geographic Skills
- ✓ Answering Geographic Questions

CONNECTIONS TO STANDARDS

National Science Education Standards

(K-4) C-3: Organisms and Environments
(K-4) F-4: Changes in environments
(5-8) C-5: Diversity and adaptations of organisms
(5-8) D-2: Earth's History
(5-8) F-2: Populations, resources, and environments

Next Generation Science Standards

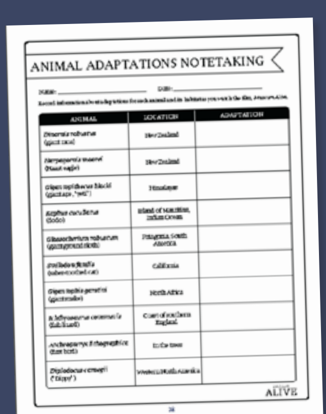
3-LS4-3. Construct and argument with evidence that in a particular habitat some organisms survive well, some survive less well, and some cannot survive at all.

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.

National Geography Standards

14. How human actions modify the physical environment

DURING THE FILM


ANIMAL ADAPTATIONS NOTETAKING

Educators planning to conduct Activity 1: Animal Adaptations after viewing the film will need to provide students with copies of the Animal Adaptations Notetaking worksheet and directions for taking notes as they watch.

AFTER VIEWING THE FILM

Activity 3: Animal Adaptations

ACTIVITY DESCRIPTION

Students examine how an animal's habitat, or environment, can affect its physical and behavioral characteristics, using convergent evolution as an example.

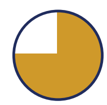
CONNECTION TO FILM

In the film, students are introduced to the *Ichthyosaur communis* (fish lizard) and how it is similar to, and yet different from, a modern spinner dolphin. This example of two groups of unrelated animals that have evolved similar bodies to suit the same environment will pique students' interest and is an opportunity to explore both animal adaptations and other examples of convergent evolution with students.

LEARNING GOALS

- ✓ examine the connection between environment and animal adaptation
- ✓ explain how adaptations help organisms survive
- ✓ discuss different types of adaptations
- ✓ describe convergent evolution

TIME NEEDED



45 minutes

VOCABULARY

- ✓ adaptation
- ✓ characteristic
- ✓ convergent evolution
- ✓ environment
- ✓ habitat
- ✓ organism

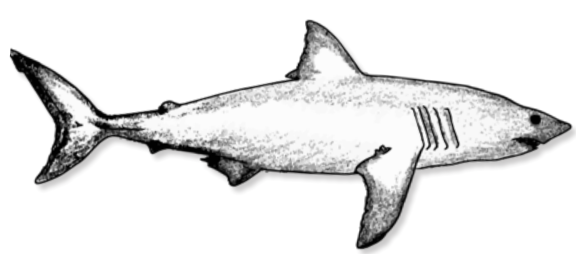
PREPARATION

Before beginning the activity, distribute a copy of the Animal Adaptations Notetaking worksheet to each student so they can take notes as they view the film, *Museum Alive*.

MATERIALS LIST

- ✓ Animal Adaptations Notetaking worksheet
- ✓ Animal Adaptations Notetaking answer key
- ✓ Comparing and Contrasting Sharks and Orcas worksheet
- ✓ Student notebooks

Note: all worksheets are available in the Worksheets and Handouts section of this guide.



DIRECTIONS

1. **Have students take notes on animal adaptations while they watch the film *Museum Alive*.**
   Tell students they are going to see the film *Museum Alive* and learn about many animals and their adaptations. Review the definition of *adaptation* with students. An **adaptation** is a modified physical or behavioral characteristic of an organism that helps the organism to survive in a place or situation. Write this definition on the board, and have students record it in their notebooks. Distribute the Animal Adaptations Notetaking worksheet. Review the directions and provided information with students, and have them take notes as they view the film.

2. **Make connections between environment and adaptation.**
   After viewing the film, remind students of the definition of habitat. A **habitat** is the environment where an organism lives or naturally occurs. Direct students' attention to the Habitat column on their Animal Adaptations Notetaking worksheet. Ask: *What do animals need from these habitats in order to survive?* Elicit responses from students such as air, water, nutrients, light, and shelter and write them on the board. Explain that even though these habitats are different they still provide the same basic needs. However, because they're different, animals have different **characteristics** to help them get what they need from the **environment**. These different physical and behavioral features are called adaptations. Revisit the definition of *adaptation* that students recorded in their notebooks.

3. **Discuss various types of adaptations.**
   Have students name adaptations that help animals survive, using notes they took during the film in the Adaptation column of the worksheet. Examples can be body shape, shape of teeth, appendages like arms or wings, size, and so on. Add this list to the board. Use the provided answer key as a discussion guide. Ask: *How did the adaptations help the animals get what they need from the environment in order to survive?* Have students revisit the class list on the board to help with their reasoning. Ask: *Were any of the adaptations and behaviors similar?*

4. **Define *convergent evolution*.**
   Have students recall the example of convergent evolution from the film with the *ichthyosaur* and the modern spinner dolphin. **Convergent evolution** is when two groups of unrelated animals evolve similar bodies to suit the same behaviors demanded by similar environments. Write the definition of convergent evolution on the board so that students can refer to it throughout the activity. Remind students that the *ichthyosaur* and modern spinner dolphin are unrelated, meaning they do not have a common ancestor. However, their needs were similar so they evolved similar adaptations independently.

5. **Ask students to analyze another example of convergent evolution.**
   Distribute the Comparing and Contrasting Sharks and Orcas worksheet. Explain that sharks (fish) and orcas (mammals) are not related. Ask students to describe the environments that both these animals live in. Have students circle common features

between these two **organisms** (fins, teeth, tails) and answer the questions. Then have students create a class Venn diagram on the board to show the distinct features of the great white shark on the left, the distinct features of the orca on the right, and features that are shared by both in the middle. Have students analyze the shared features to determine whether they may be a result of convergent evolution. Ask: *How do these shared adaptations help the orca and shark get what they need to survive from their environments?* Have students share their reasoning for how these adaptations help the organisms behave. Ask: *How is this an example of convergent evolution?*

6. Have a wrap-up discussion.
Ask students to identify other organisms that have similar adaptations but are unrelated. Examples include: fliers (bats and birds); gliders (lemurs and flying squirrels); and animals with prehensile tails, which are capable of grasping (new world monkeys, opossums). Ask: *How does the environment influence an animal's physical and behavioral characteristics?* (Species have developed adaptations to help them survive in their environment, both as individuals and in context with other organisms that live in that environment.) Have students share their ideas aloud with the class, and record their thoughts on the board for all to see.

ADAPTING THE ACTIVITY FOR YOUNGER STUDENTS

Support younger students by providing examples of physical and behavioral adaptations in Directions Steps 2 and 3. When students list habitats in Step 2, ask how we (as humans) procure those needs (by using our hands, brains). Ask: *How do animals get what they need from the environment?* (Animals get what they need using physical and behavioral features called adaptations). Review an example of adaptation with students, for example, a giraffe. Ask: *What is special about giraffes?* Elicit long legs, long neck, and any other adaptations from students. Ask students how giraffes depend on these features, or adaptations, to survive in their environment (watching for predators, reaching high food).

ADAPTING THE ACTIVITY FOR OLDER STUDENTS

At the conclusion of the activity, have students recall and write summary notes about the film, including the examples of evolution it features. Have students use their notes to write a film review, expressing their opinion on why or why not next year's class of students should see the film.

CROSS-CURRICULAR CONNECTION

Geography Have students locate Mauritius and New Zealand on a world map. Review the geography of these isolated islands. Discuss how isolated geography can lead to strange instances of evolution, as was the case with the dodo (Mauritius and the moa). Ask: *How might geography affect evolution and adaptations?* Have students research modern animal inhabitants of the islands and present their findings to the class. Assign students places such as Madagascar (lemurs) and Indonesia, Papua New Guinea, and eastern Australia (birds of paradise).

KEY SKILLS

21st Century Themes
- ✓ Environmental Literacy

Critical Thinking Skills
- ✓ Remembering
- ✓ Understanding
- ✓ Applying
- ✓ Analyzing

Geographic Skills
- ✓ Analyzing Geographic Information
- ✓ Answering Geographic Questions

CONNECTIONS TO STANDARDS

National Science Education Standards
(K-4) C-1: Characteristics of Organisms
(K-4) C-3: Organisms and Environments
(5-8) C-3: Regulation and Behavior
(5-8) C-5: Diversity and Adaptations of Organisms

Next Generation Science 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.

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-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Common Core State Standards for English Language Arts
CCSS.ELA-Literacy.W.3.8
Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

CCSS.ELA-LITERACY.SL.3.2
Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

CCSS.ELA.SL.5.2
Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

National Geography Standards
8. The characteristics and spatial distribution of ecosystems and biomes on Earth's surface
17. How to apply geography to interpret the past

Activity 4: Science and Storytelling

ACTIVITY DESCRIPTION

Students make connections between science and storytelling, and work collaboratively to plan and critique a story that incorporates facts, judgments, and speculations about an extinct animal of their choice from the film.

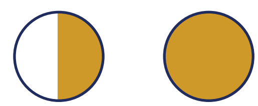
CONNECTION TO FILM

In the film, Attenborough says "Science has revealed the truth behind many a myth," and illustrates his meaning through the examples of the yeti and the moa. This premise provides an excellent launching point to introduce students to the scientific method (i.e., how myths become fact), as well as to discuss the sharing of scientific knowledge through storytelling.

LEARNING GOALS

- ✓ Discuss the nature of science
- ✓ Explore how myths become fact, or are dispelled, via the scientific method
- ✓ Reason between facts, judgments based on research, and speculations
- ✓ Practice collaborative storytelling

TIME NEEDED



90 minutes
Part I: 30 minutes
Part II: 60 minutes

PREPARATION

No special preparation is needed for this activity.

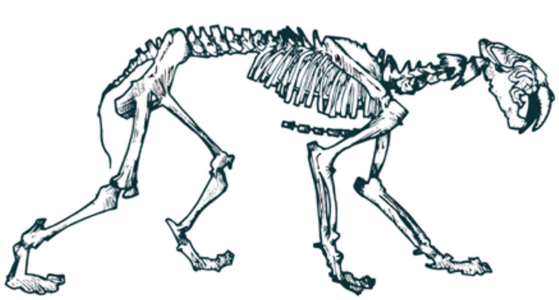
MATERIALS LIST

- ✓ Student notebooks or blank sheets of paper
- ✓ Scientific Accuracy in Storytelling worksheet
- ✓ Storyboarding worksheet

Note: all worksheets are available in the Worksheets and Handouts section of this guide.

VOCABULARY

- ✓ data
- ✓ evidence
- ✓ fact
- ✓ judgment
- ✓ myth
- ✓ scientific method
- ✓ speculation
- ✓ storyboard



DIRECTIONS

Part I (30 minutes):

1. **Ask students to recall information from the film, *Museum Alive*.**
   Ask students to recall an extinct animal from the film that "began" as a myth. Examples might be the *Dinornis robustus* (giant moa) or *Gigantopithecus* (great ape or yeti). Remind students that these organisms were once thought to be **myths**, or fictional creatures. Scientists disagreed about their existence. Ask: *What changed?* Elicit from students that fossils, or **evidence**, were found to support these organisms' existence.

2. **Introduce the concept that science is a process with many contributors.**
   Read aloud this quote from David Attenborough:

   > *"Sometimes the people who first studied the bones will have found answers which everyone agrees are still correct. Sometimes later researchers will have found evidence that show the first conclusions were wrong."*

   Explain that science is constantly changing as scientists make new observations and share new **data**. When scientists encounter new evidence, as was the case with the moa and *gigantophithecus*, they may change their explanations of phenomena. Sometimes, scientists don't agree because they interpret evidence differently. In some cases, scientists resolve their differences. In other cases, scientists continue to disagree. The outcome usually depends on what evidence is available to scientists, or if new evidence is presented.

3. **Give an overview of the scientific method.**
   Explain that many scientific theories and **facts** start as ideas and disagreements. Describe the steps of the **scientific method** with students, and have them record notes in their notebooks.
   a. Problem/Question—scientists start by asking a question
   b. Hypothesis—scientists suggest an answer to the question
   c. Procedure—scientists design a method to test the answer to the question
   d. Data—scientists obtain data through the procedure
   e. Observations—scientists observe phenomenon and record what they witness as evidence
   f. Conclusions—scientists draw conclusions from the evidence to make a judgment on the original hypothesis

4. **Introduce the steps of the scientific method through a reading.**
   Distribute the Scientific Accuracy in Storytelling worksheet to students and review the directions. Once students have finished reading, discuss the parts of the scientific process that are mentioned in the reading. For example, Attenborough hypothesized that Dippy could stand on its hind legs in the final scene of the film. Discuss similarities between making art (the film) and the scientific process, and also the importance of collaboration. Ask: *How is the process the filmmakers went through similar to the scientific process?*

5. **Define the difference between fact, judgment, and speculation.**
   Explain that the filmmakers used a series of facts, judgments based on research, and speculation to write the film. A **fact** is a statement or observation that is true; a **judgment** is a statement, based on reasoning, that conveys a value or opinion; and a **speculation** is a guess or idea about the unknown. Ask students to give examples of each of these, drawing from both their memory of the film and the reading.

Part II (60 minutes):

6. **Assign students a short storyboarding task.**
   Divide students into groups of three. Explain that they will be working collaboratively as a group to plan a story about an extinct animal of their choice from the film. Their stories will need to include at least one fact, one judgment, and one speculation. Each student will take on the role of a particular expert in the group:

   - ✔ artist—responsible for look and feel. Artists should ask questions about what things look like and how to visually represent the story.
   - ✔ scientist—responsible for facts and information. Scientists should make sure that everything is based on fact and evidence.
   - ✔ writer—responsible for story line. Writers should ask questions about audience and how best to communicate information.

7. **Groups plan their stories using the Storyboarding worksheet.**
   Distribute the Storyboarding worksheet and review the directions with students. Give each group one worksheet. Remind students that each group member is responsible for different elements of the story through their roles of artist, scientist, or writer. Review students' facts, judgments, and speculations (Part 1) before they begin the Story Scenes portion of the worksheet (Part 2).

8. **Have students switch expert roles and review another group's story.**
   Explain that groups are going to review one another's work. Review with students how to give constructive criticism. After groups have completed their worksheets, collect and redistribute the Storyboarding worksheets so that each group has another group's worksheet. Explain to students that they will take on different expert roles in order to review their peers' story. The Artist will act as a Writer, the Writer will act as the Scientist, and the Scientist will act as the Artist. In their reviews, students should ask questions about the other group's storyboard on a separate sheet of paper.

   Repeat this process. Redistribute the group's storyboarding worksheets once again, and have the students switch their expert roles so that every student has had the role of Writer, Scientist, and Artist.

9. **Have students revise their storyboards using peer feedback.**
   Return the Storyboarding worksheets to the original groups, along with the two sheets of feedback. Give students the opportunity to revise their original story plans based on the feedback they received from the two groups.

10. Have a class discussion about collaboration and the review process.
Ask students to comment on what it was like to play all the different expert roles. Ask: *How were they similar? How were they different?* Discuss the role of feedback and commenting. Ask: *What was it like to give feedback on another groups' story? What was it like to receive feedback on your group's story? How was the storytelling process similar to the scientific process?* If time allows, have volunteers share their stories with the class.

ADAPTING THE ACTIVITY FOR YOUNGER STUDENTS

For Activity Part II, divide students into small groups of three. Assign an extinct species to each group. Have one student write 1-3 sentences based on facts, and illustrate his or her work. Have another student write 1-3 sentences based on judgment, and illustrate his or her work. Have the third student write 1-3 sentences based on speculation, and illustrate his or her work.

ADAPTING THE ACTIVITY FOR OLDER STUDENTS

For Activity Part II, have students cite the sources they used for the scientific facts in their story. Direct students to incorporate a visual aid, such as a diagram, graph, or scaled drawing, into their story.

CROSS-CURRICULAR CONNECTION

Literacy Review the definition of a myth and read aloud an example to students. Have students write their own myths about fantastic animals and then discuss what evidence they would need in order to prove the animals were real or not.

KEY SKILLS

21st Century Student Outcomes

Learning and Innovation Skills
- ✓ Creativity and Innovation
- ✓ Communication and Collaboration

Information, Media, and Technology Skills
- ✓ Information Literacy
- ✓ Media Literacy

21st Century Themes
- ✓ Financial, Economic, Business, and Entrepreneurial Literacy

Critical Thinking Skills
- ✓ Remembering
- ✓ Understanding
- ✓ Applying
- ✓ Analyzing
- ✓ Evaluating
- ✓ Creating

CONNECTIONS TO STANDARDS

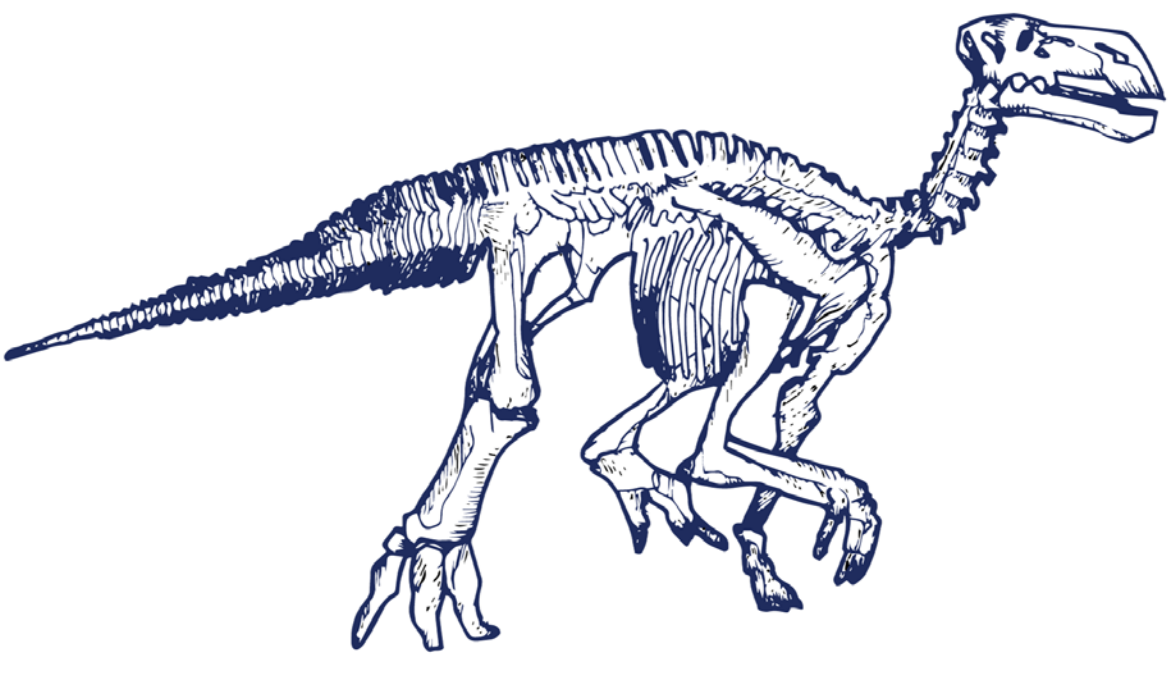
National Science Education Standards
(K-4) C-1: Characteristics of Organisms
(K-4) G-1: Science as a human endeavor
(5-8) G-1: Science as a human endeavor
(5-8) G-2: Nature of science

Common Core State Standards for English Language Arts
CCSS.ELA-Literacy.W.3.3
Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.

CCSS.ELA-Literacy.W.3.8
Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

CCSS.ELA-LITERACY.RST.6-8.8
Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

CCSS.ELA-LITERACY.RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.



ADDITIONAL ACTIVITY IDEAS

Use these quick, 5-10 minute additional activity ideas for a variety of purposes. Use them as warm-up activities to introduce students to topics or as learning extensions in museums, classrooms, or at home.

USING THE *NATURAL HISTORY MUSEUM (NHM) ALIVE* APP

(SEE ADDITIONAL RESOURCES)

Give students guiding questions about certain eras of pre-history or evolution before using the app. Have them explore the app to research the question, then write their findings in an essay. (research and information fluency)

Various activities in this guide require students to recall information from, or take notes during, the film on the featured animals. Have students supplement the information they gather by using the app for additional research. (research and information fluency)

Divide students into groups and give each group a measuring tape. Assign each group an animal to research using the app, and have them measure the size of the animal in the classroom or hallway using the measuring tape. Have groups write these measurements on the board or mark them on butcher paper to compare sizes. Have students create a ratio to compare the size of the animal to the size of a common, everyday object like a human or car. (measuring, comparisons)

NATURAL HISTORY

The film's narrator, David Attenborough, is a world-famous naturalist. Take students outside and have them make observations, like naturalists do. What organisms can they identify? What features do they notice about the physical environment? Have them record their observations in their notebooks. Include the number of species they see, as well as notes about any identifying characteristics. (scientific skills)

Have students research historic explorers and naturalists (e.g., Charles Darwin, Eric Shipton, Alfred Russell Wallace, Jane Goodall, Sylvia Earle, George Washington Carver) and the contributions they made to the field of science. Host an Explorers Day. Have students prepare presentation boards and dress up as these role models to share their findings. Have students interview each other as these famous scientists, answering as if they were the historical figures. (history of science)

The film uses the scientific names of animals. Discuss the difference between scientific names and common names. What can scientific names tell us? (family, related species, behavioral and physical information) Why are common names useful? (science as a human practice)

Have students create a historic timeline for an organism of their choice. Ask students to include important events in the organism's history, leading up to the present day if the organism is not extinct. Encourage students to include information such as the ancestors of the organism, the organism's environment, and any adaptations that have occurred throughout history. Students should also research the details of any important discoveries that have been made about the organism. (information fluency and research, data visualization)

PALEONTOLOGY

Fill a small container with sand and bury small objects that assemble to a larger whole, such as puzzle pieces. Provide students with tools to uncover these objects, such as paintbrushes or spoons. As students dig, have them chart and record their findings on graph paper, noting the location of each discovered object. Have students reassemble the pieces they discover into their full form. (data, field skills)

If you have a small animal bones or a skeletal model available, break it apart and have students try to reconstruct it based on the bone shape and structure. (investigation, field skills)

Show students pictures of various animal teeth. Ask students to identify which teeth might belong to carnivores, herbivores, or omnivores. What clues informed their identification? Discuss how teeth shape informs what animals eat. (animal adaptations, physical characteristics)

SCIENCE

Review the relationship between adaptations and environment. Assign students an environment or ecosystem, such as the desert or a rainforest canopy, and have them research and report on an animal that lives in it and the characteristics that show it has adapted to its environment. How do these features help them survive in their environments? (animal adaptations, habitat)

Discuss abiotic and biotic factors in an ecosystem, and how both of these influence living organisms. Show students a photograph or illustration of an ecosystem and have them identify the living (biotic) and non-living (abiotic) factors. Discuss how both types of factors can affect organisms in an environment. (ecosystems)

After the film, ask students to recall examples of predator-prey relationships, such as the *Harpagornis moorei* (Haast eagle) and the moa. Ask students to identify features in each organism, predator or prey, that helped suit that organism to its role, for example the Haast eagle's sharp claws. (animal adaptations)

TECHNOLOGY AND STORYTELLING

Discuss the process of how a green screen works. A green screen is a tool that artists use to create special effects through a process called chroma keying. Filmmakers shoot their subjects in front of a green screen and then edit the film to remove that particular color. Once it is removed, they replace it with whatever image they want! Using technology in your classroom, create a green screen film. Hang up a sheet, and then after, edit the film. (innovations in technology; digital storytelling)

Have students design, draw, and label a museum exhibit about an animal of their choice. What information do they think is important to include? Why? Encourage students to include relevant information about the animal, its environment and adaptations, and the intended audience for the exhibit. (science communication)

GEOGRAPHY

Discuss the role that geography can play in extinction using a famous case study. Tell students that the dodo bird, now extinct, was only found on the island of Mauritius. Have students locate this island on a map, and hypothesize how island geography might have affected the dodo bird. (geographic factors)

Explore Earth's history by providing students with a map of Pangaea and a current world map. Explain that the continents moved as a result of plate tectonics. Give a demonstration by filling a tub with water. Float small flat discs on top of the water and have students observe and discuss what happens. (plate tectonics, geology)

MUSEUM-SPECIFIC IDEAS

Create your own *Museum Alive*-style event. Suggest a night at the museum with an evening viewing of the film. Before viewing the film, host a custom "behind-the-scenes" tour of any exhibits or artifacts that relate the film, and follow the film with a question and answer session.

Compare the film's species list (found in the Film Synopsis section of this guide) with your own organization's exhibits. How can you make connections for students between these species? Are there examples of convergent evolution in your collection? Are any of the same species on site? If so, give brief interpretations before or after screenings to deepen learning for students.

APPENDIX

WORKSHEETS AND HANDOUTS

BEFORE VIEWING THE FILM

Activity 1: Clues to the Past

How Paleontologists Interpret Clues 32
Fossil Clues 33

AFTER VIEWING THE FILM

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Activity 4: Science and Storytelling

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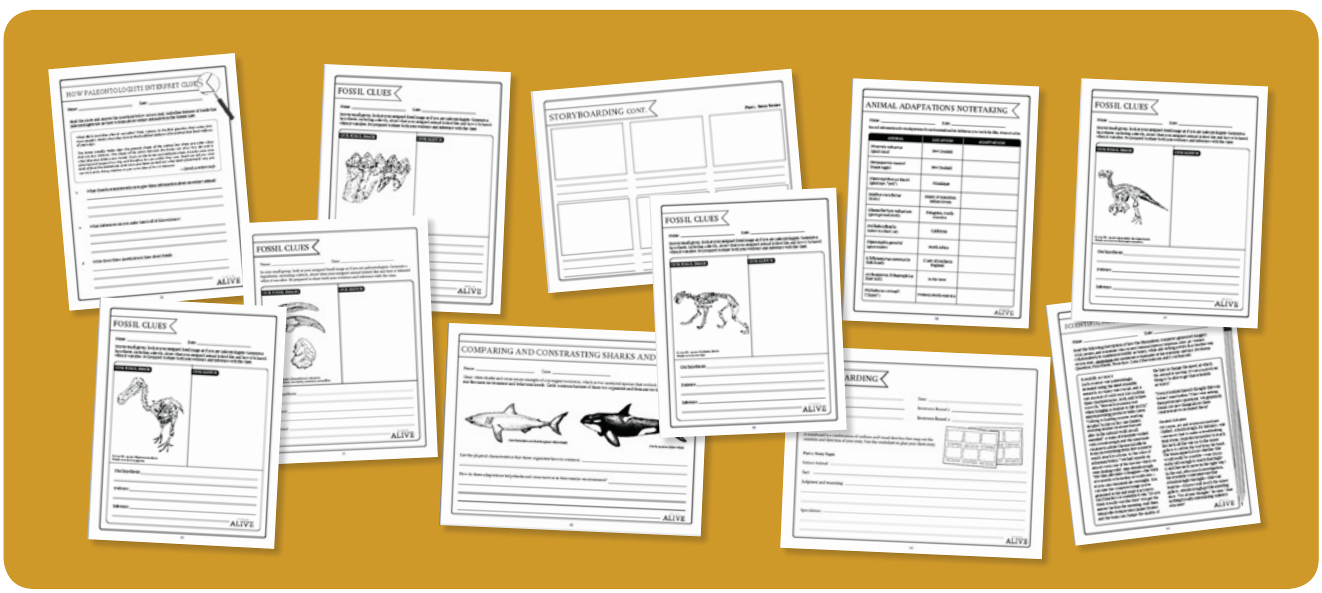
Storyboarding 42



HOW PALEONTOLOGISTS INTERPRET CLUES

Name: ______________________________ Date: ______________________________

Read the quote and answer the questions below. As you read, underline features of fossils that paleontologists use as clues to learn about extinct animals from the distant past.

> *What did it look like when it was alive? That, I guess, is the first question that comes into most people's minds when they look at the fossilized skeleton of an animal that lived millions of years ago.*
>
> *The bones usually make clear the general shape of the animal but there are other clues that are less obvious. The shape of the joints between the bones can show how far and in what direction limbs once moved. Scars on the bones can indicate where muscles were once attached and suggest how big, and therefore how powerful, they were. Teeth can tell you what kind of food the animal ate. And once you have worked out what kind of animal it was, you can look at its living relatives to get some idea of how it behaved.*
>
> *—David Attenborough*

1. What clues do scientists rely on to give them information about an extinct animal?

____

____

____

2. What inferences can you make based on this evidence?

____

____

____

3. Write down three questions you have about fossils.

____

____

____

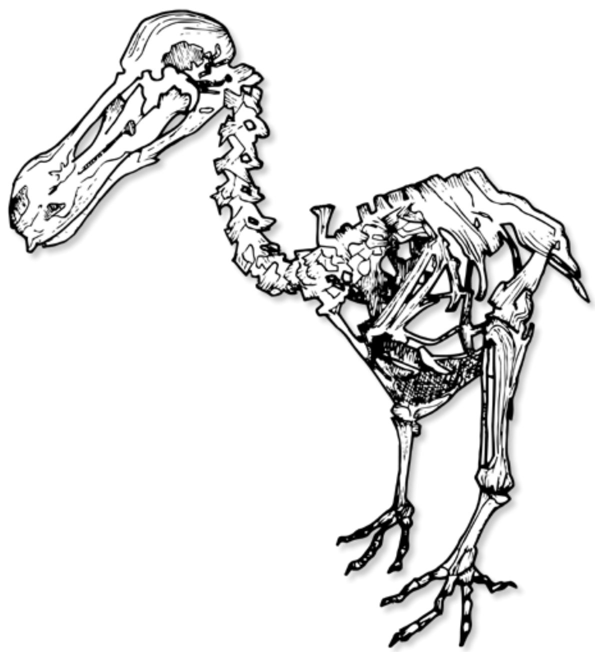
MUSEUM ALIVE

FOSSIL CLUES

Name: ______________________________ Date: ______________________________

In your small group, look at your assigned fossil image as if you are paleontologists. Generate a hypothesis, including a sketch, about what your assigned animal looked like and how it behaved when it was alive. Be prepared to share both your evidence and inference with the class.

OUR FOSSIL IMAGE



Scientific name: *Raphus cucullatus*
Modern relative: pigeon

OUR SKETCH

Our hypothesis: ____

____

Evidence: ____

____

Inference: ____

____

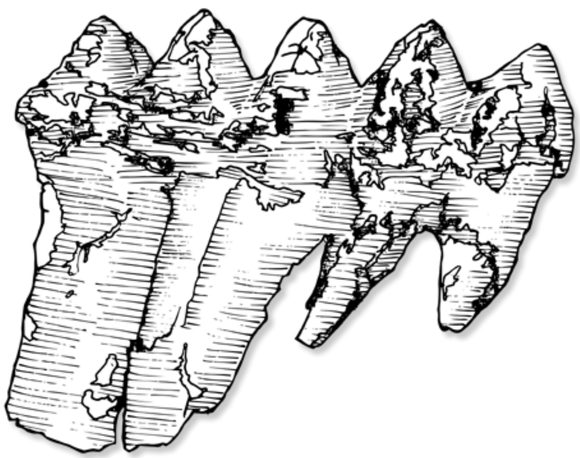
MUSEUM ALIVE

FOSSIL CLUES

Name: ______________________________ Date: ______________________________

In your small group, look at your assigned fossil image as if you are paleontologists. Generate a hypothesis, including a sketch, about what your assigned animal looked like and how it behaved when it was alive. Be prepared to share both your evidence and inference with the class.

OUR FOSSIL IMAGE



Scientific name: *Mammut americanum*
Modern relative: elephant

OUR SKETCH

Our hypothesis: ______________________________

____

Evidence: ______________________________

____

Inference: ______________________________

____

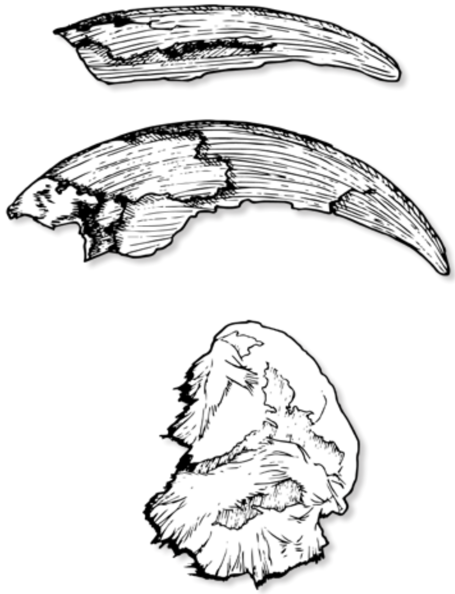
MUSEUM ALIVE

FOSSIL CLUES

Name: ______________________________ Date: ______________________________

In your small group, look at your assigned fossil image as if you are paleontologists. Generate a hypothesis, including a sketch, about what your assigned animal looked like and how it behaved when it was alive. Be prepared to share both your evidence and inference with the class.

OUR FOSSIL IMAGES



Scientific name: *Glossotherium robustum*
Modern relative: tree sloths, anteaters, armadillos

OUR SKETCH

Our hypothesis: ______________________________

____

Evidence: ______________________________

____

Inference: ______________________________

____

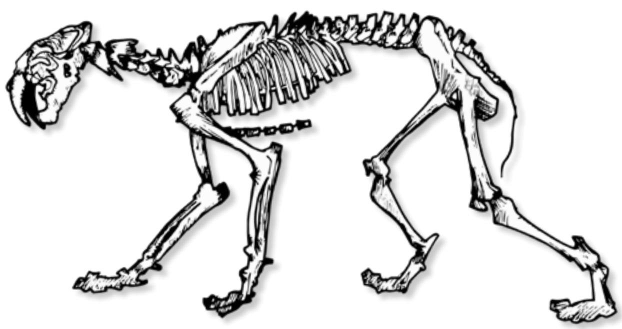
MUSEUM ALIVE

FOSSIL CLUES

Name: ______________________________ Date: ______________________________

In your small group, look at your assigned fossil image as if you are paleontologists. Generate a hypothesis, including a sketch, about what your assigned animal looked like and how it behaved when it was alive. Be prepared to share both your evidence and inference with the class.

OUR FOSSIL IMAGE



Scientific name: *Smilodon fatalis*
Modern relative: lion

OUR SKETCH

Our hypothesis: ____

____

Evidence: ____

____

Inference: ____

____

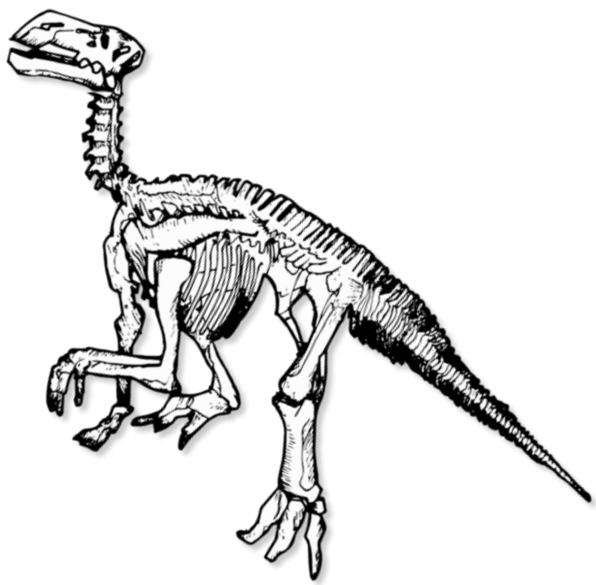
MUSEUM ALIVE

FOSSIL CLUES

Name: ______________________________ Date: ______________________________

In your small group, look at your assigned fossil image as if you are paleontologists. Generate a hypothesis, including a sketch, about what your assigned animal looked like and how it behaved when it was alive. Be prepared to share both your evidence and inference with the class.

OUR FOSSIL IMAGE



Scientific name: *Iguanodon bernissartensis*
Modern relative: birds and crocodiles

OUR SKETCH

Our hypothesis: ____

____

Evidence: ____

____

Inference: ____

____

MUSEUM ALIVE

ANIMAL ADAPTATIONS NOTETAKING

Name: ______________________________ Date: ______________________________

Record information about adaptations for each animal and its habitat as you watch the film, *Museum Alive*.

ANIMAL	LOCATION	ADAPTATION
Moa (giant flightless bird)	New Zealand	
Harpagornis (giant eagle)	New Zealand	
Gigantopithecus (huge ape, yeti)	Himalayas	
Dodo (flightless bird)	Island of Mauritius, Indian Ocean	
Glossotherium (giant ground sloth)	Patagonia, South America	
Smilodon (saber-toothed cat)	California	
Gigantophis (gigantic snake)	North Africa	
Ichthyosaurus (marine lizard)	Coast of southern England	
Archaeopteryx (early bird)	In the trees	
Diplodocus (sauropod dinosaur)	Western North America	

MUSEUM ALIVE

ANIMAL ADAPTATIONS NOTETAKING

ANSWER KEY

Record information about adaptations for each animal and its habitat as you watch the film, *Museum Alive*.

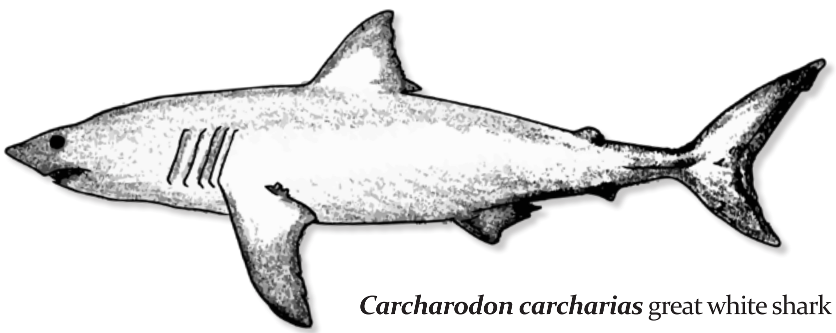
ANIMAL	LOCATION	ADAPTATION
Moa (giant flightless bird)	New Zealand	Flightless, neck joint
Harpagornis (giant eagle)	New Zealand	Big beak, sharp talons
Gigantopithecus (huge ape, yeti)	Himalayas	Molar teeth, possibly walked upright
Dodo (flightless bird)	Island of Mauritius, Indian Ocean	Flightless, powerful beak
Glossotherium (giant ground sloth)	Patagonia, South America	Giant claws for digging, teeth for eating plants
Smilodon (saber-toothed cat)	California	Teeth, muscles
Gigantophis (gigantic snake)	North Africa	Size for constricting
Ichthyosaurus (marine lizard)	Coast of southern England	Limbs like paddles, teeth, huge eyes, body shape, pointed jaws, air breathing, gives birth to live young
Archaeopteryx (early bird)	In the trees	Long leg bones, teeth, wings with feathers
Diplodocus (sauropod dinosaur)	Western North America	Coarse and tough skin, big legs, feet like an elephant, long tail

MUSEUM ALIVE

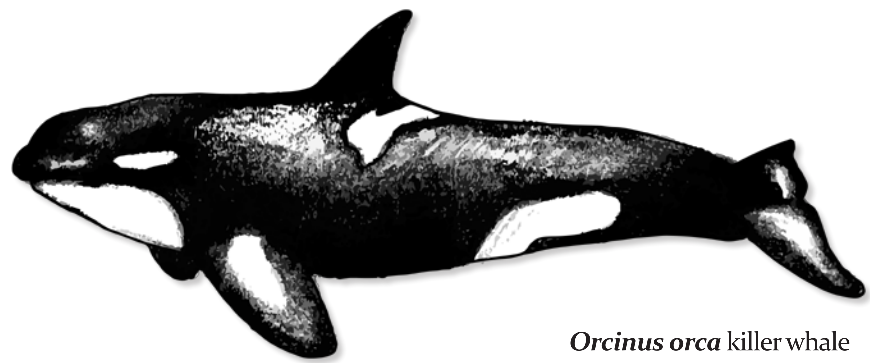
COMPARING AND CONSTRASTING SHARKS AND ORCAS

Name: ______________________________ Date: ______________________________

Great white sharks and orcas are an example of convergent evolution, which is two unrelated species that evolved similar bodies to suit the same environment and behavioral needs. Circle common features of these two organisms and then answer the questions below.



Carcharodon carcharias great white shark



Orcinus orca killer whale

List the physical characteristics that these organisms have in common: ____

____

How do these adaptations help sharks and orcas survive in their similar environments? ____

____

____

____

____

MUSEUM ALIVE

SCIENTIFIC ACCURACY IN STORYTELLING

Name: ______________________________ Date: ______________________________

Read the following description of how the filmmakers, computer-generated imagery (CGI) artists, and scientists who created *Museum Alive* worked collaboratively to maintain scientific accuracy, while also telling a story in a creative way. As you read, **underline** any mentions or examples of the scientific method (Problem/Question, Hypothesis, Procedure, Data, Observations, and Conclusions).

Scientific accuracy

Each creature was painstakingly recreated using the latest scientific research. Accuracy was crucial, and a vast amount of work went into making these creatures move, look, and behave correctly. "Research is paramount when bringing a creature to life in CGI," says supervising producer Mike Davis. "Talking to leading experts, reading detailed books on biomechanics, studying similar creatures that are alive in the natural world are all essential." A team of scientists worked with Attenborough and the museum's curators to advise the special effects team on everything from how a muscle would attach to a bone, to the color of a dinosaur's skin. "We had experts on almost every one of the species which we were dealing with," says Attenborough. "But they also have colleagues—the work of scientific scholarship is worldwide—so you can communicate overnight. You can take the computer image you've generated so far and send it across to San Francisco or Australia to say, 'Do you think it really was like this?' You get the answer back in the morning. And then visual effects supervisor James Prosser and the team can change the quality of the hair or change the speed at which the animal is moving. It was a marvelous thing to be able to get that scientific accuracy."

"Even scientists haven't thought this way before," says Geffen. "They were asking themselves new questions. We genuinely found out new things about these creatures as we recreated them."

Heated debates

Of course, art and science sometimes clashed. Attenborough, for instance, was convinced that to make a breathtaking final scene, *Diplodocus* needed to reach her neck all the way up to the upper gallery to nibble the leaf from his hand. The team argued about whether this would really be possible—was Dippy really tall enough to reach that high? Could her neck move in the right way? In the end, after much investigation, the scientific consensus was that Attenborough was right—this was feasible—Dippy could reach the upper gallery. Attenborough got his arresting shot. "I've always thought," he says, "that nothing's really entertaining unless it educates."

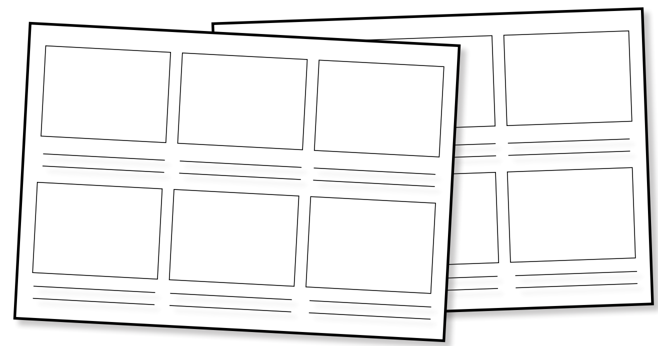
MUSEUM ALIVE

STORYBOARDING

Artist: ______________________ Date: ______________________

Writer: ______________________ Reviewers Round 1: ______________________

Scientist: ______________________ Reviewers Round 2: ______________________



A storyboard is a combination of outlines and visual sketches that map out the contents and direction of your story. Use this worksheet to plan your short story.

Part 1. Story Topic

Extinct Animal: ______________________

Fact: ______________________

Judgment and reasoning: ______________________

____

____

Speculation: ______________________

____

____

MUSEUM ALIVE

STORYBOARDING CONT.

Part 2. Story Scenes

MUSEUM ALIVE

GLOSSARY

adaptation	*noun.* A modified physical or behavioral characteristic of an organism that helps the organism to survive in a place or situation.
affect	*verb.* To alter or produce a change.
cast	*noun.* Hard shape created by a substance hardening in an impression, or mold.
cause	*noun.* Source of or reason for an event or fact.
characteristic	*noun.* Distinguishing feature of an organism or object.
convergent evolution	*noun.* Two groups of unrelated animals that have evolved similar bodies to suit the same environment.
data	*noun.* Information collected in an organized manner, usually for scientific purposes.
ecosystem	*noun.* A system formed by the interactions of living and nonliving things in a given area.
effect	*noun.* Result or impact that can be attributed to a reason, or cause.
environment	*noun.* Surrounding conditions that influence an organism or community.
evidence	*noun.* Facts and observations that support an argument or conclusion.
extinct	*adjective.* No longer existing.
fact	*noun.* A statement or observation that is true.
fossil	*noun.* Preserved remnant, impression, or trace of an organism from a past geologic age.
habitat	*noun.* Environment where an organism lives or naturally occurs.
habitat loss	*noun.* Reduction or destruction of a physical environment, which negatively affects the species that live there.
human impact	*noun.* Effect that humans have on an environment.

hypothesis *noun.* Suggested explanation of observations or phenomena that is not proven.

inference *noun.* Reasoned argument based on evidence.

introduced species *noun.* Species that does not naturally occur in an area; often introduced by an external factor.

judgment *noun.* Statement, based on reasoning, that conveys a value or opinion.

mold *noun.* Hollowed form.

myth *noun.* Legend or traditional story that is believed to be fictional.

organism *noun.* Living or once living thing, such as a type of plant, animal, or fungus.

overconsumption *noun.* Consuming a substance or resource beyond the necessary amount.

paleontologist *noun.* Person who studies life from earlier geologic periods by studying fossils.

pollution *noun.* Contamination of the environment by harmful materials.

population growth *noun.* Increase in the number of individuals in a population over a period of time in a specified area.

scientific method *noun.* empirical process of research used to draw conclusions to a problem or question by posing a hypothesis, designing a procedure, and testing a hypothesis using data and observations.

species *noun.* A rank in the classification of organisms; a group of organisms with similar qualities that can reproduce with each other.

speculation *noun.* Guess or idea about the unknown.

storyboard *noun.* Combination of outlines and visual sketches that map out the contents and direction of a story.

survival *noun.* Continued ability to live.

ADDITIONAL RESOURCES

NATURAL HISTORY MUSEUM ALIVE APP

https://itunes.apple.com/us/app/nhm-alive/id785709058?mt=8

The app allows you to wander the great building's hallowed halls, before taking control of the museum's security cameras and dropping into "night mode," exploring through a virtual torch-lit safari. If you are at the museum itself, you will find the symbol codes to unlock additional video clips using the app. This will feature painstakingly-crafted models of legendary prehistoric creatures, exclusive footage and imagery, plus guidance from David Attenborough himself.

Available: App store
Cost: $4.99 USD

DAVID ATTENBOROUGH'S *NATURAL HISTORY MUSEUM ALIVE*: THE STORIES BEHIND THE MUSEUM'S GREAT EXTINCT ANIMALS

https://www.amazon.com/Natural-History-Museum-Amabel-Adcock/dp/0957243650

This magical journey through London's famous Natural History Museum reveals the surprising stories behind David Attenborough's favorite extinct creatures. Using the very latest science and technology, they are brought back to life as never seen before.

NATURAL
HISTORY
MUSEUM