ABOUT THIS GUIDE

This guide presents classroom and museum field trip activities that focus on the new Columbian mammoth in the Rees-Jones Dynamic Earth Hall, located on level 3 of the Perot Museum of Nature and Science. The activities are organized by elementary, middle, and high school biology grade levels and can be completed as individual lessons or all together as a mini-unit.

Visit our website for more information about registering for Perot Museum field trips: perotmuseum.org/events-and-programs/school-programs/field-trips/index.html

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EXHIBITION OVERVIEW

The exhibit showcases a nearly complete and well preserved skeleton of a Columbian mammoth, nicknamed Ellie May. The specimen was donated to the museum and the bones are displayed as they were found, rather than posed in a life-like stance, to facilitate inquiry and discussion about how scientists infer physical characteristics and the environment from evidence at the fossil site.

WHAT IS ELLIE MAY?

Ellie May is a skeleton of a female Columbian mammoth, which was buried 35,000 to 40,000 years ago. The nickname “Ellie May” comes from the location, Ellis County, and date, May 2014, of the discovery. The mammoth stood about 2.5 meters (8 feet) tall to the top of the shoulders. The small size of the skeleton, pattern of tooth replacement, and open growth sutures in many bones indicate Ellie May was an adolescent or young adult upon death.

HOW AND WHERE WAS ELLIE MAY FOUND?

In May 2014, a farmer in Ellis County, his son, and grandson uncovered a 7 foot tusk while excavating for gravel on their land. They invited a local professor to explore the site and more bones were discovered. Fieldwork, largely done by volunteers, resulted in the recovery of a near complete skeleton. The following resources provide more information about the excavation of the specimen.

Video Clip - Perot Museum of Nature and Science Bring Your Mammoth Home! 

Article - Dallas Morning News Perot Museum getting rare, intact mammoth skeleton found in Ellis County gravel pit

Audio and Article - KERA All Things Considered Mammoth On The Move: Rare, Nearly-Intact Skeleton Heads To Dallas

WHAT ARE COLUMBIAN MAMMOTHS?

*Mammuthus columbi*, the Columbian mammoth, along with other mammoths are an extinct group of elephants. Columbian mammoths could reach up to 4 meters (13 feet) tall and weigh up to 9,000 kg (10 tons or 20,000 lbs). Columbian mammoths arrived in North America 1.5 million years ago from Asia. Remains of the species are found from the northern contiguous United States to Central America. Columbian mammoths were herbivores that grazed in open grasslands. After humans arrived in North America from Asia about 14,800 years ago, humans and Columbian mammoths coexisted until 11,700 years ago, when mammoths went extinct. At that time, many other species of large mammals went extinct in North and South America and Asia. Changing climate, over-hunting by humans, and disease may have contributed to the extinction of these large animals, however, most scientists believe rapid changes in climate and resulting environmental and ecosystem instability was the most likely reason.

WHAT IS THE DIFFERENCE BETWEEN COLUMBIAN MAMMOTHS AND WOOLLY MAMMOTHS?

Columbian mammoths were notably larger and likely had substantially less hair than woolly mammoths, *Mammuthus primigenius*. Columbian mammoths lived much longer in North America than woolly mammoths, which arrived between 150,00-100,000 years ago. While remains of Columbian mammoths are found across a broad geographic range in North America, woolly mammoths were restricted to the northern portions of North America and Asia south of permanent ice sheets that covered the polar regions. The range of these two species did overlap and there is genetic evidence of interbreeding.
HOW ARE MAMMOTHS RELATED TO ELEPHANTS?
Mammoths and living elephants share a common ancestor. In fact, genetic studies suggest Asian elephants are more closely related to mammoths than they are to African elephants. That means that mammoths are also elephants (family Elephantidae).

WHEN DID ELLIE MAY LIVE?
Ellie May lived during the Late Pleistocene Epoch and is estimated to have been buried by flood sediments between 35,000 and 40,000 years ago. The Pleistocene Epoch spanned 2.6 million to 11,700 years ago. The beginning of the Pleistocene Epoch marks the beginning of our most recent ice age, a time where ice covers the poles year-round. We are currently alive during one of the few ice ages on Earth, because ice sheets are present year-round at the North and South Poles. This current ice age has been less extreme than far older ‘Snowball Earth’ episodes, where evidence of ice is found from the poles to the tropics. During the current ice age, there have been significant shifts in the Earth’s climate, fluctuating back and forth between cooler and warmer intervals.

WHAT SIGNIFICANT EVENTS HAPPENED DURING THE PLEISTOCENE EPOCH?
During the Pleistocene, the genus Homo, and later our own species of modern humans, originated in Africa. Temperatures also dropped, ice grew at the North and South Poles, causing sea levels to fall. This opened up land bridges that allowed humans to disperse globally. Numerous other species migrated to new continents during this time. Elephants, particularly the mammoth, arrived in North America from Asia.

WHAT DO WE KNOW ABOUT THE PLEISTOCENE EPOCH IN TEXAS?
Our window into the Pleistocene of Texas is small - much smaller than the size of the state, restricted primarily to sediments near modern rivers, streams, the Gulf Coast, and the high plains (see Figure 1 on pg 8). Although the Pleistocene is well known for its cold temperature and extensive ice across many continents, including North America, these sheets did not extend south to Texas. The Pleistocene of Texas has produced many fossils belonging to the ancient megafauna - animals larger than 45 kg (100 lbs) - including extinct species such as the short-faced bear, giant beaver, giant bison, saber-toothed cats, mastodons, and mammoths. Today these species are extinct, and scientists have studied and presented hypotheses to explain the extinction of the Pleistocene megafauna, but many details remain a mystery.

MORE INFORMATION
Watch this interview with Perot Museum paleontologist Dr. Ron Tykoski for more information about mammoths, their environments and their evolutionary relationship to elephants.
https://vimeo.com/perotmuseum/review/145917596/4f89cdcf0e
PEROT MUSEUM GETTING RARE, INTACT MAMMOTH SKELETON FOUND IN ELLIS COUNTY GRAVEL PIT

Ron Tykoski, a staff paleontologist with the Perot Museum of Nature and Science, is working to get mammoth bones discovered on an Ellis County farm out of the elements and to the safety of the museum’s research lab.

Michael Ainsworth/Staff Photographer

By DAVID FLICK dflick@dallasnews.com

Staff Writer

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Updated: 25 August 2014 02:17 PM

Wayne McEwen’s 138-acre farm in southern Ellis County produces hay, cattle and – from the gravel pit on his property – the occasional arrowhead or shark tooth.

His son and grandson were gathering road bedding material from the pit in May when McEwen’s excavator hit something even more rare: a 6-foot mammoth tusk. It was the first clue to what would become an unusual paleontological find.

Mammoth remains are not unknown in this area, but they are almost never as well-preserved as the specimen on McEwen’s farm – a nearly complete mammoth skeleton, intact and unmolested by scavengers, lying on a bed of sand where the creature died 20,000 to 40,000 years ago.

“Usually the bones are scattered and you get the remains of maybe 30 or 40 percent of the animal. But anyone can look at this and know it’s a mammoth. It looks exactly like what it is,” said Tom Vance, the Navarro College professor who oversaw the scientific excavation.

The specimen appears to be that of a female Columbian mammoth, which lived in the region in the Late Pleistocene Epoch. The Columbians were slightly larger but less hairy than the more famous woolly mammoth, which lived near the northern glaciers. The Ellis County mammoth was about 8 or 9 feet at the shoulder and was smaller than average, about the size of a modern-day female Asian elephant.

HANDLING WITH CARE

In July, volunteers alerted officials of the Perot Museum of Nature and Science in Dallas. The Perot Museum sent a representative to McEwen’s gravel pit to take a look. Museum officials were impressed by what they learned. McEwen, in turn, donated the mammoth to the museum.

Colleen Walker, the museum’s CEO, praised the McEwen family, noting that in less caring hands the mammoth “very well could have ended up as part of our Texas highway system.”
McEwen said his family was intrigued from the first.

“We realized there was something interesting there,” he said. “We knew this was something nice, not something to just haul away.”

A McEwen neighbor who had been a student of Vance contacted the professor, who organized a group of students, staff and amateur paleontology enthusiasts to dig out the remains. Over the next two months, they carefully brushed away sand and silt that had encased the mammoth – growing increasingly excited about what they found.

“We’d find one bone and there would be another one next to it and another and another, and we realized they weren’t just scattered,” Vance said.

‘HUGE CONTRIBUTION TO SCIENCE’

McEwen looked on Friday with satisfaction.

“It was fun just watching the volunteers,” he said. “They’d come out of the pit and they were grinning from ear to ear. They were just so excited.”

Equally excited is Ron Tykoski, a staff paleontologist, who called the McEwens’ donation “a huge contribution to science.”

Tykoski is working against time to get the bones to the safety of the museum’s research lab. After thousands of years protected by sand, the excavated bones are now exposed to the elements. Last week’s rains washed silt back into sections that had been painstakingly excavated. Mice made a nest out of the paper tags Tykoski used to label the remains.

While water poses a menace to the mammoth bones now, it was water that guaranteed their preservation for thousands of years.

In the Late Pleistocene age, what is now Ellis County was prairie, much as it is now, but much wetter. The area was crisscrossed by rivers, with sandbars that formed at the bows.

Tykoski speculates that the mammoth got bogged down in the wet sand and died. Soon after – so soon that there is no sign that the carcass was ever disturbed by scavengers – floodwaters covered the body with silt.

MUCH RESEARCH TO BE DONE

Within a few weeks, Tykoski will wrap the bones in a protective jacket of plaster and burlap for delivery to an unmarked museum warehouse near the Dallas Design District. He will spend at least a year researching the remains for clues to age, diet and perhaps cause of death.

It is not known yet if the bones will ever be publicly displayed.

Even if the remains had not ended up as road fill, the mammoth bones might have been sold to a private collector. The McEwens’ gift to the Perot Museum means that the specimen can be researched and cataloged by an accredited institution – a necessary condition for any findings to have scientific validity, Tykoski said.

“Without their gift, this magnificent creature might have gone onto the auction block, never to be seen again,” he said.
Columbian mammoths are an extinct species that lived in North America during the Pleistocene epoch (2.6 million to 11,700 years ago). Columbian mammoth remains have been found from the northern United States to Central America.

In addition to the new specimen, Ellie May, now displayed on level 3, a Columbian mammoth is also displayed on level 4 at the Perot Museum. This Columbian mammoth was excavated in 1965 from a site in Dallas County. The bones were in storage for about 18 years before a team of museum volunteers assembled the mammoth specimen for exhibit in a standing pose.

Ellie May, the skeleton of a Columbian mammoth, is displayed horizontally at the Perot Museum of Nature and Science to show the position her bones were found in when she was discovered in Ellis county, May 2014. The specimen itself is flipped to display the more pristine bone surfaces that originally were facing down.
Figure 1. Map of Texas with rocks and sediments 2.6 million years ago to present shown in brown. This is our main window into the current ice age of Texas. The green shows areas of rock older than 2.6 million years.
GLOSSARY

**BERINGIA:** the region around the Bering Strait and the most northwestern portion of North America (Alaska) and northeastern part of Asia (Russia), including the Bering Land Bridge during periods of low sea level

**BIOGEOGRAPHY:** is the study of the distribution of species and ecosystems in geographic space and through geological time

**COMMON ANCESTRY:** two or more organisms or groups of organisms that descended from a single population

**CLADE:** a group of organisms that share a common ancestor

**CLADOGRAM:** a diagram that depicts evolutionary relationships between organisms

**CLIMATE:** patterns of weather over a long time interval; for the Pleistocene, climate is weather averaged over 100 years; today climate is averaged over 30 year intervals

**COLUMBIAN MAMMOTH:*** *Mammuthus columbi,* an extinct species of elephant, that lived in North America from 1.5 million years ago to 11,700 years ago

**DERIVED:** a change or modification of a more primitive characteristic; e.g. the wings of a bird are derived from or relative to the primitive featherless arms

**DESCENDANT:** an organism that is a direct offspring or in a direct line of generations from an earlier organism

**EXTINCTION:** the end of an organism or group of organisms’ existence

**FOSSIL:** any evidence of past life older than 10,000 years

**GLACIAL PERIOD:** time intervals in an ice age of declining temperatures when ice sheets expanded their coverage on the Earth’s surface

**HOLOCENE EPOCH:** subdivision of the Quaternary Period from 11,700 years to present; since the last glacial period

**HOMOLOGY:** similarity resulting from common ancestry

**ICE AGE:** time intervals when ice sheets are present at the poles

**INTERGLACIAL PERIOD:** time intervals in an ice age of increasing temperatures and receding ice sheets

**LAND BRIDGE:** connection between two or more landmasses

**MAMMAL:** a warm-blooded vertebrate organism that has hair or fur, nurses its young, and (typically) births live young

**MAMMOTH:** any one of several species of extinct elephant of the genus *Mammuthus*

**MEGAFAUNA:** large animals, usually those with a mass of 45 kg (100 lbs) or more

**PALEONTOLOGY:** the study of the history of life on Earth

**PALEONTOLOGIST:** a scientist who studies paleontology

**PLEISTOCENE EPOCH:** a subdivision of the Quaternary Period from 2.6 million years to 11,700 years ago; it spans the start of the current Ice Age through the end of the last glacial period

**PRIMITIVE:** a character in a lineage that has undergone little to no change

**QUATERNARY PERIOD:** the current period of Earth’s geologic time from 2.6 million years ago to present; coincides with the current ice age

**WOOLLY MAMMOTH:** *Mammuthus primigenius,* a mammoth species that arose in Asia about 750,000 years ago, was adapted to cold conditions, and entered North America about 150,000 to 100,000 years ago

**YOUNGER DRYAS:** a sharp decline in temperature in the Northern Hemisphere at the end of the Pleistocene, occurring between 12,900 and 11,700 years ago
ELEMENTARY SCHOOL ACTIVITIES

LETTERS TO A PALEONTOLOGIST

GRADE LEVELS Kindergarten - 5th

TEKS SCIENCE CONTENT
4.3C Represent the natural world using models such as rivers, stream tables or fossils and identify their limitations, including accuracy and size.
5.7D Identify fossils as evidence of past living organisms and the nature of the environments at the time using models.

SCIENCE INVESTIGATION AND REASONING SKILLS
K-2.2A Ask questions about organisms, objects and events observed in the natural world.
3-5.3D Connect grade-level appropriate science concepts with the history of science, science careers and contributions of scientists.

ENGLISH LANGUAGE ARTS Writing/Literary Text
K.13 Students use elements of the writing process (planning, drafting, revising, editing and publishing) to compose text (with adult assistance).
1-2.19.B Write short letters that put ideas in a chronological or logical sequence and use appropriate conventions (e.g., date, salutation, closing).
3.20.B Write letters whose language is tailored to the audience and purpose (e.g., a thank you note to a friend) and that use appropriate conventions (e.g., date, salutation, closing).
4.18.B Write letters whose language is tailored to the audience and purpose (e.g., a thank you note to a friend) and that use appropriate conventions (e.g., date, salutation, closing).
5.18.B Write formal and informal letters that convey ideas, include important information, demonstrate a sense of closure, and use appropriate conventions (e.g., date, salutation, closing).

LEARNING OBJECTIVES STUDENTS WILL BE ABLE TO:
• Retell the events of the Colombian mammoth fossil discovery in Ellis County in May 2014;
• Describe physical features of mammoths;
• Describe the work of a paleontologist; and
• Write a letter, using the grade-appropriate formatting.

ESSENTIAL QUESTION What can we learn about Columbian mammoths, fossils and paleontology from the Columbian mammoth fossil that was found in Ellis County, Texas in May 2014?

VOCABULARY fossil
mammoth
paleontology
paleontologist
mammal
woolly mammoth
Columbian mammoth
CLASsROOM ACTIVITIES

MATERIALS PER CLASS
- KWL Chart
- Computer with internet access, projector, and speakers

MATERIALS PER GROUP OF STUDENTS
- Picture of the mammoth skeleton currently on display at the Perot Museum of Nature and Science (pg 7)
- Scientific illustration of a Columbian mammoth (pg 7)

MATERIALS PER STUDENT
- Finding Ellie May Storyboard (pg 13-16)
- Blank paper, pencil, and coloring utensils
- Dallas Morning News Story (pg 5-6)
- 1 blank Fossil Trading Card (pg 18)
- Dr. Ron Tykoski Scientist Trading Card (pg 22)

**WHO IS ELLIE MAY? (20 MIN)**
1. Tell students that farmers in Ellis County recently discovered the bones of a prehistoric animal, a Columbian mammoth. Read students the *Dallas Morning News* article or use the Finding Ellie May Storyboard to tell the story of the discovery.
2. Tell students that they will explore fossils, paleontologists, and mammoths to learn more about this discovery. At the end of this mini-unit, they will write a letter to a Perot Museum paleontologist to ask him any questions they have! Create a KWL chart and record ideas students already know about fossils, paleontologists, mammoths, and the Columbian mammoth that was discovered in Ellis County. What do they want to know? Refer back to this chart throughout this exploration and add new ideas to the Learn column.
3. Optional: Ask students to create a book that tells the story of Ellie May’s discovery. Use Google Maps to locate Ellis County. How long would it take to drive there from your school?

**WHAT IS A MAMMOTH? (30-60 MIN)**
1. **OBSERVE:**
   a. Show students the scientific illustration of a Columbian mammoth. Have students make observations and ask questions about what they notice in the picture.
   b. Visit Smithsonian X 3D and have your students digitally maneuver a 3D image of a woolly mammoth skeleton. As your students maneuver the skeleton encourage them to make observations and ask questions about what they notice. [http://3d.si.edu/explorer?modelid=55](http://3d.si.edu/explorer?modelid=55)
   c. See page 3 of this guide for a description of the differences between woolly mammoths and Columbian mammoths.
2. **WATCH:** The woolly mammoth video on the YouTube Channel, “I Am a Dinosaur” provides some background information on the physical and behavioral adaptations of woolly mammoths. Note: Do not be confused by the name of the YouTube Channel: woolly mammoths are NOT dinosaurs! Woolly mammoths are mammals that lived on Earth 5 million-5,000 years ago. In this video, the woolly mammoth is depicted as a talking cartoon character. Have a discussion with your students to differentiate between the facts the video provides and the fictional way the mammoth is depicted. [https://www.youtube.com/watch?v=J1Eldx-VLSE](https://www.youtube.com/watch?v=J1Eldx-VLSE)
3. **READ:** Visit the National Geographic Kids website to read about woolly mammoths at the link below. You can read the Woolly mammoth profile without an account and/or have your students create a free account on the site to create personalized profiles: [http://kids.nationalgeographic.com/animals/woolly-mammoth/#woolly-mammoth-standing.jpg](http://kids.nationalgeographic.com/animals/woolly-mammoth/#woolly-mammoth-standing.jpg)
4. **CREATE:** Using the four sources above have students create a mammoth trading card. Use the Fossil Trading Card template (pgs 18, 20).

**WHAT IS A PALEONTOLOGIST? (20 MIN)**
1. Write the word paleontologist on the board. Ask students what they think a paleontologist is.
2. Watch the music video, “I am a Paleontologist” by They Might Be Giants. YouTube: [https://www.youtube.com/watch?v=B7zo2zy1Zqg](https://www.youtube.com/watch?v=B7zo2zy1Zqg)
3. Distribute Dr. Ron Tykoski’s scientist trading card to each student. As a class read and discuss the trading card text.
4. Quick assessment: Ask students to answer the question “What is a paleontologist?” by drawing a paleontologist working or writing a few sentences to describe the work of a paleontologist.
5. Remind students that they will write a letter to Dr. Tykoski after they visit Ellie May at the Perot Museum.
FIELD TRIP ACTIVITIES

MATERIALS PER GROUP OF STUDENTS

Chaperone Letter (pg 24)

MATERIALS PER STUDENT

6 Blank Fossil Trading Cards (pgs 18, 20)

VISIT ELLIE MAY AT THE PEROT MUSEUM! (1 DAY + PREP TIME)

1. Before the trip, distribute 6 blank Fossil Trading Cards to each student. Explain that at the museum students will look for fossilized animals and create at least four trading cards about four different animals. Tell students that one of those four animals must be Ellie May. Emphasize that students are to find fossils of animals. Many fossilized animals are on display on level 4 of the museum. Ellie May is located on level 3. Tell students that after the trip, students will write letters to Dr. Ron Tykoski so if they come across anything they have questions about at the museum, they can ask Dr. Tykoski their question in their letter.

2. Distribute the chaperone letter to chaperones before the field trip so they are prepared to support the students during the field trip and can ask clarifying questions ahead of time.

3. On the day of the field trip, ask students to work in small chaperone groups to find fossilized animals and create trading cards.

CLASSROOM POST-FIELD TRIP ACTIVITIES

MATERIALS PER CLASS

Letters to a Paleontologist (pg 26)

MATERIALS PER STUDENT

Completed fossil trading cards
Dr. Ron Tykoski Scientist Trading Card (pg 22)

WRITE A LETTER TO A PALEONTOLOGIST! (30-60 MIN)

1. Ask students to review the trading cards they made at the Perot Museum and recall what they observed on the trip.

2. Review the class’s KWL chart. Add new learnings to the L column. Identify any questions the class has not yet answered.

3. Redistribute and review Dr. Tykoski’s trading card.

4. Using the letter-writing format appropriate for your grade level, have students write a letter to Dr. Tykoski.

5. Complete the Letters to a Paleontologist Cover Sheet.

6. Put all your students’ completed letters in one envelope and mail them to:

   Perot Museum of Nature and Science
   Attn: Anne Marie Fayen, Letters to Dr. Tykoski
   2201 N. Field St
   Dallas, TX 75201
FINDING ELLIE MAY: THE STORY OF A MAMMOTH DISCOVERY

In May 2014, Marty McEwen and Ethan Beasley, were gathering gravel in Italy, Texas when their excavator hit something large and hard. When they looked closer, they saw they had hit a 7 foot tusk.

Marty and Ethan shared their discovery with Marty’s father (and Ethan’s grandfather) Wayne McEwen.

The three men decided to tell a local college professor about the find. The professor gathered a group of volunteers to carefully uncover the rest of the bones found near the tusk. For two months the team of volunteers carefully brushed away the sand and silt that encased the bones.
As the team of volunteers carefully worked to remove the silt and sand, they uncovered a nearly complete Columbian mammoth skeleton!

Perot Museum paleontologist, Dr. Ron Tykoski, traveled to the site to see the mammoth. After some discussions, the McEwen family decided to donate the mammoth bones to the Perot Museum of Nature and Science.

The Perot Museum team finished uncovering the bones.

The team then carefully lifted the bones out of the ground and wrapped them in burlap and plaster to protect them.
The task of excavating Ellie May’s bones took precision and strength.

Once all the bones were wrapped, they were ready to be transported from the excavation site.

The wrapped bones were loaded onto a truck and moved to the Perot Museum.

When the bones arrived to the museum, a team of professional fossil preparators and skilled volunteers spent 5 months removing all the sediment from Ellie May’s bones.
The bones were then sent to another company where they were covered in a clear plastic to preserve them.

When the bones returned to the Perot Museum, the exhibits team carefully installed the bones in a nearly horizontal arrangement to showcase how Ellie May was discovered initially at the excavation site.

You can now visit level 3 at the Perot Museum of Nature and Science to see Ellie May in her new home!
## FOSSIL TRADING CARD TEMPLATE

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COLUMBIAN MAMMOTH TEACHER’S GUIDE

PEROT MUSEUM OF NATURE AND SCIENCE
BACK OF FOSSIL TRADING CARD TEMPLATE
# FOSSIL TRADING CARD TEMPLATE

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</tbody>
</table>
BACK OF FOSSIL TRADING CARD TEMPLATE
Dr. Ron Tykoski

VERTEBRATE PALEONTOLOGIST AND FOSSIL PREPARATOR AT THE PEROT MUSEUM OF NATURE AND SCIENCE

EDUCATION
University of Michigan, Ann Arbor and University of Texas, Austin Ph.D. in Geological Sciences

Dr. Ron Tykoski studies a variety of fossil vertebrates. This means he closely examine the remains of prehistoric animals to learn more about their physical features, how they lived, their relationships, and why they are now extinct. In his everyday work he spends time cleaning and repairing fossils, writing scientific papers, and working to preserve fossils in the museum’s collections.

Dr. Tykoski was the Perot Museum paleontologist who oversaw the excavation of Ellie May in Ellis County and the cleaning/preparation of her bones at the Perot Museum. He worked with a team of 2 preparators and a large team of well-trained, skilled volunteers to prepare the bones for display in just 5 months.
BACK OF
RON TYKOSKI
TRADING CARD
Dear Chaperone,

Thank you for supporting our field trip to the Perot Museum of Nature and Science!

During our trip students are asked to find fossils of animals, make observation of the fossils, and create a trading card for at least 4 fossils.

Each student will have 6 blank Fossil Trading Cards with them and can make more than 4 trading cards, if they have time and interest. The trading card template will guide students to draw a picture of the fossilized animal on one side of the card and complete information about the animal on the other side.

When making drawings, students should draw what the animal looks like, based on what they see at the museum (and not draw what they think the animal looks like).

Most fossilized animals are located on level 4 of the museum. Make sure all students stop by the level 3 display of the Columbian mammoth, Ellie May. All students must create a trading card for Ellie May.

Thanks again for your help,

________________________________________
TEACHER’S NAME

______________________________
DATE

Per[ø]t
Museum of Nature and Science

2201 N. FIELD ST, DALLAS, TX 75201
LETTERS TO A PALEONTOLOGIST

SCHOOL NAME

GRADE LEVEL

TEACHER’S NAME

TEACHER’S EMAIL

Compile your students’ letters with this cover page in one, large envelope.

Mail the envelope to:

Perot Museum of Nature and Science
Attn: Anne Marie Fayen, Letters to Dr. Tykoski
2201 N. Field St
Dallas, TX 75201

Every month we will choose one letter to answer and will send a response out via email.

HOW OFTEN WOULD YOU LIKE TO HEAR FROM US?

☐ Please send me an email every month with Dr. Tykoski’s response to the letter of the month.

☐ Please only email me if a letter from my class is chosen.

Perot Museum of Nature and Science
2201 N. FIELD ST, DALLAS, TX 75201
BACK OF LETTERS TO A PALEONTOLOGIST
MIDDLE SCHOOL ACTIVITIES

MAMMOTHS IN TIME

GRADE LEVELS 6th - 8th

TEKS

SCIENCE CONTENT

6.12.E Describe biotic and abiotic parts of an ecosystem in which organisms interact.
7.10.A Observe and describe how different environments, including microhabitats in schoolyards and biomes, support different varieties of organisms.
8.11.C Explore how short- and long-term environmental changes affect organisms and traits in subsequent populations.

SCIENCE INVESTIGATION AND REASONING SKILLS

6-8.3.D Relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content.

LEARNING OBJECTIVES STUDENTS WILL BE ABLE TO:

- Observe major changes in the climate, environment, and life in North America over the past 2.6 million years;
- Describe differences in environments and organisms of the past, specifically the 'Ice Age,' and those today in North America; and
- Explore how the climatic and environmental changes affected the types of organisms.

ESSENTIAL QUESTION

What were the environmental conditions in North America when was Ellie May alive? How has the environment changed since then?

VOCABULARY

- ice age
- land bridge
- climate
- glacial period
- interglacial period
- extinction
- Beringia (Bering Land Bridge)
- Quaternary Period
- Holocene Epoch
- Pleistocene Epoch
- megafauna
- Younger Dryas
CLASSROOM ACTIVITIES

<table>
<thead>
<tr>
<th>MATERIALS PER GROUP OF STUDENTS</th>
<th>MATERIALS PER STUDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>scissors</td>
<td>pencil</td>
</tr>
<tr>
<td>glue/tape</td>
<td>Ice Age Timeline (pg 31)</td>
</tr>
<tr>
<td></td>
<td>Ice Age Events Cards (pg 32)</td>
</tr>
</tbody>
</table>

ICE AGE TIMELINE (45 MIN)
1. While working in groups, have each student cut out the Ice Age Events Cards and arrange the events from oldest to youngest.
2. Have each student tape or glue their cards to the Ice Age Timeline and label when these events occurred.
3. Ask students to discuss the global events that have happened so far during our current ice age.

FIELD TRIP ACTIVITIES

ICE AGE MEGAFAUNA AT THE PEROT MUSEUM (30 MIN)
1. Ask students to visit the mammoth exhibit in the T. Boone Pickens Life Then and Now Hall on level 4 of the museum. Around this mammoth, there are several other animals that lived during the Pleistocene Epoch (giant beaver, dire wolf, giant bison).
2. Have the students find each one, then indicate when each lived on the Ice Age Timeline. When a precise age is not known, an estimated range is given.
3. Instruct students to also visit the Ellie May exhibit on level 3. Have students indicate on the timeline when she lived.
CLASSROOM POST-FIELD TRIP ACTIVITIES

**MATERIALS PER CLASS**
- completed posted questions (see number 2. below)

**MATERIALS PER STUDENT**
- completed Ice Age Timeline (pg 31)
- pencil
- paper

**TIMELINE WRAP UP (30 MIN)**

1. Ask students to work in groups to review their now complete timelines.
2. Instruct each group to work together to answer the following questions
   a. What events happened on Earth around the time Ellie May lived in Texas?
   b. What was the environment in Texas when Ellie May lived?
   c. List the significant climatic events that occurred near the end of the Pleistocene, between 15,000 and 11,700 years ago.
   d. List the significant events that happened to life in North America at the end of the Pleistocene, between 15,000 and 11,700 years ago.
   e. How might humans have impacted ecosystems in North America after arriving 14,800 years ago?
   f. How might changes in climate have affected ecosystems in North America when the Earth fluctuated between 12,900 and 11,700 years ago?
   g. What factors could have led to the extinction of many large mammals at the end of the Pleistocene?
3. After each group has had time to bring together ideas, encourage them to present their ideas to the class.
ICE AGE EVENTS CARDS

PRE-VISIT ICE AGE TIMELINE CARDS

Humans arrive in North America
14,800 yrs ago

Columbian mammoths arrive in North America
1,500,000 yrs ago

Bering Land Bridge closes
11,700 yrs ago

Bering Land Bridge first open
2,600,000 yrs ago

Ice in North America beginning of ice age
2,600,000 yrs ago

End of last glacial
11,700 yrs ago

Younger Dryas
12,900 yrs ago

Megafauna extinction in North America
11,700 yrs ago

FIELD TRIP ICE AGE TIMELINE CARDS

Castoroides
GIANT BEAVER

Canis dirus
DIRE WOLF

Bison latifrons
GIANT BISON

Mammuthus columbi
COLUMBIAN MAMMOTH
**ICE AGE TIMELINE**

**KEY**

- **Columbian mammoths** arrive in North America 1,500,000 yrs ago
- Ice in North America beginning of ice age 2,600,000 yrs ago
- Bering Land Bridge first open 2,600,000 yrs ago
- Megafauna extinction in North America 11,700 yrs ago
- End of last glacial 11,700 yrs ago
- Younger Dryas 12,900 yrs ago
- Humans arrive in North America 14,800 yrs ago
- Megatherium columbi
- Bering Land Bridge closes 11,700 yrs ago
- Canis dirus
- Carcharodon megalodon
- Bison latifrons
- GIANT BEAVER
- GIANT BISON
- GIANT WOLF

**TIME**
ka - thousands of years

**PRESENT**

**PLEISTOCENE**

**HOLOCENE**

**TIME**

- 0 ka
- 10 ka
- 20 ka
- 30 ka
- 40 ka
- 50 ka
- 500 ka
- 1000 ka
- 1500 ka
- 2000 ka
- 2500 ka
HIGH SCHOOL ACTIVITIES

MAMMOTHS IN TIME

GRADE LEVELS Biology - High School

TEKS

SCIENCE CONTENT

Biology 7.A Analyze and evaluate how evidence of common ancestry among groups is provided by the fossil record, biogeography, and homologies, including anatomical, molecular and developmental.

SCIENTIFIC PROCESS

Biology 2.G Organize, analyze, evaluate, build models, make inferences, and predict trends from data.

Biology 2.H Communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

LEARNING OBJECTIVES STUDENTS WILL BE ABLE TO:

- Analyze and evaluate evidence of common ancestry between mammoths, elephants and other animals based on physical characteristics;
- Analyze and evaluate evidence of common ancestry between mammoths, elephants and other animals based on DNA evidence; and
- Compare and contrast the accuracy of classification based on physical characteristics vs. DNA evidence.

ESSENTIAL QUESTION

How do scientists research the evolutionary relationships between elephants and Mammoths and other extant organisms?

VOCABULARY

biogeography
clade
cladogram
common ancestry
descendant
derived
homology
primitive
CLASSROOM ACTIVITIES

MATERIALS PER CLASS
Interview with Dr. Ron Tykoski
https://vimeo.com/perotmuseum/review/145917596/4f89cdcf0e

MATERIALS PER GROUP OF STUDENTS
Morphology Animal Cards (pg 38-39)
Morphology Cladogram (pg 40)
tape
Morphology Cladogram Answer Key (pg. 41)

MATERIALS PER STUDENT
Post-It note
Ellie May Fact Sheet (pg 37)

INTRODUCTION TO ELLIE MAY (10 MIN)
1. What is a mammoth? Provide each student with a Post-it note. Ask them to write one word that comes to mind when they hear the word mammoth. Have students share out answers and as a class describe a mammoth.

2. Who is Ellie May? Ellie May is a Colombian mammoth that was discovered in Ellis County in May of 2014. Ellie May was donated to the Perot Museum by the people who discovered her remains. She is nearly completely intact and is displayed on level 3 of the Perot Museum. Introduce students to the story of Ellie May through Video Clips, Podcasts and or News Articles. (See pages 3-4 for these resources.)

INTERVIEW WITH PALEONTOLOGIST DR. RON TYKOSKI
MAMMOTH COMMON ANCESTORS, COUSINS AND DESCENDENTS (10 MIN)
1. Have students watch an informative interview with Perot Museum paleontologist, Dr. Ron Tykoski. Students can use the Mammoth Fact Sheet that provides visuals, definitions, maps and other relative information to reference throughout the interview. The interview questions are designed to introduce or review vocabulary terms and relative content. In the video, Dr. Ron Tykoski answers the following questions.
   a. What types of mammoths existed in the past?
   b. How did you know that Ellie May is a Colombian mammoth?
   c. Why don't mammoths exist today?
   d. What animals preyed on mammoths?
   e. Where did Colombian mammoths live?
   f. What was the environment like in North America when mammoths existed?
   g. What is the difference between ancestors and decedents?
   h. Which animals living today are closely related to the Colombian mammoth?
   i. Is there evidence in the fossil record that sheds light on the relationships between mammoths and elephants?

EVIDENCE OF COMMON ANCESTRY IN MAMMOTHS, ELEPHANTS, AND EXTANT ORGANISMS (15 MIN)
1. Distribute a set of Morphology Animal Cards to each small groups of students.
2. Have students make observations of the physical features of each animal and read the additional information on the back of the cards.
3. Distribute the Morphology Cladogram to each small group of students. Briefly discuss the definition and function of a cladogram.
4. Ask students to use the observations they made and the information they read about each animal card to complete the cladogram. First, identify features that are shared by some, but not all species. For instance, only one species, the Golden Mole, keeps the clavicles (collarbones). All other species have the shared derived character of an absence of clavicles.
5. Ask each group to share their cladograms with the class. Encourage students to explain the reasoning behind the organization of their cladograms. Are there discrepancies among the cladograms students have created?
6. Ask students to lightly tape down the animals in the order they think they should go on the cladogram. Distribute the Morphology Cladogram Answer Key and have students review their answers.
7. Tell students that they will make additional observations about Columbian mammoths at the Perot Museum and then further explore the relationship among these animals when they return to the classroom.
FIELD TRIP ACTIVITIES

MATERIALS PER STUDENT

Mammoth Observation Sheets (pg 42-43)
pencil
clipboard

MAMMOTH OBSERVATIONS (30 MIN)

1. Students can complete the Mammoth Observation Sheets by visiting the Ellie May exhibit on level 3 and the Columbian mammoth displayed on level 4.

CLASSROOM POST-FIELD TRIP ACTIVITIES

EXPLORING DNA (30 MIN)

1. Ask students to share out the mammoth observations they made at the Perot Museum.
2. Ask each group to make any changes they want to their group’s Morphology Cladogram, based on their museum observations.
3. Distribute the Molecular Animal Cards.
4. Instruct students to compare the DNA sequences provided and use this information to complete the Molecular Animal Cladogram. Remember, species that are closely related will have similar DNA sequences.
5. As a class, compare the differences between the Morphology and Molecular Cladograms. Tell students that this is the process scientists currently going through. In the past, animals were classified by physical features. As we gain more information about DNA, proteins, and molecules the classification of animals is changing. Possible lead off questions for the discussion are: what are some of the advantages of using the shapes of bones, muscles, and other physical characteristics to investigate common ancestry? What are some of the advantages of using molecules and DNA? Are there some species past or present where one method may be better, or usable at all?
6. Distribute the Molecular Cladogram Answer Key to each group. Have students compare their cladograms to the answer key. Discuss any discrepancies.
ELLIE MAY FACT SHEET

What was the environment in Texas like when Ellie May was alive?

What are two factors that could have led to the mass extinction of Columbian mammoths and other megafauna at the end of the Pleistocene?
Dugong

*Common Name*

*Dugong dugong*

*Scientific Name*

Asian Elephant

*Scientific Name*

*Elephas maximus*

African Elephant

*Scientific Name*

*Loxodonta africana*

Hippopotamus

*Common Name*

*Hippopotamus amphibius*

Rock Hyrax

*Common Name*

*Procavia capensis*

Columbian Mammoth

*Common Name*

*Mammuthus columbi*

Tapir

*Common Name*

*Tapirus indicus*

Golden Mole

*Common Name*

Chrysochloridae

*Scientific Name*
<table>
<thead>
<tr>
<th>Animal</th>
<th>Placenta</th>
<th>Clavicle</th>
<th>Hooves</th>
<th>Incisors</th>
<th>Orbits</th>
<th>Incisor Enamel</th>
<th>Molar Enamel</th>
<th>Photo Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dugong</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Enlarged</td>
<td>Forward</td>
<td>Present</td>
<td>Unchanged</td>
<td><a href="http://unisci24.com/img/Dugong-2.jpg">Link</a></td>
</tr>
<tr>
<td>Asian Elephant</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Enlarged</td>
<td>Forward</td>
<td>Absent</td>
<td>Thin</td>
<td><a href="https://commons.wikimedia.org/wiki/File:Asiatischer_Elefant,_Asian_Elephant_(Elephas_maximus)_-_Zoo_Leipzig_01.jpg">Link</a></td>
</tr>
<tr>
<td>African Elephant</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Enlarged</td>
<td>Forward</td>
<td>Absent</td>
<td>Unchanged</td>
<td><a href="http://animals.nationalgeographic.com/animals/mammals/african-elephant/">Link</a></td>
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<tr>
<td>Hippo</td>
<td>Present</td>
<td>Absent</td>
<td>Present</td>
<td>Enlarged</td>
<td>At sides</td>
<td>Present</td>
<td>Unchanged</td>
<td><a href="https://en.wikipedia.org/wiki/Hippopotamus#/media/File:Hippopotamus_-_04.jpg">Link</a></td>
</tr>
<tr>
<td>Rock Hyrax</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Enlarged</td>
<td>At sides</td>
<td>Present</td>
<td>Unchanged</td>
<td><a href="https://commons.wikimedia.org/wiki/File:PikiWiki_Israel_33833_Rock_Hyrax.jpg">Link</a></td>
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<tr>
<td>Mammoth</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Enlarged</td>
<td>Forward</td>
<td>Absent</td>
<td>Thin</td>
<td><a href="https://en.wikipedia.org/wiki/Mammoth#/media/File:Mammuthus_trogontherii122DB.jpg">Link</a></td>
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<tr>
<td>Tapir</td>
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<td>Absent</td>
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<td>At sides</td>
<td>Present</td>
<td>Unchanged</td>
<td><a href="https://commons.wikimedia.org/wiki/File:Malayan_Tapir_standing.jpg">Link</a></td>
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<tr>
<td>Golden Mole</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Enlarged</td>
<td>At sides</td>
<td>Present</td>
<td>Unchanged</td>
<td><a href="http://www.afrotheria.net/golden-moles/images/remialpa_157_Edited.jpg">Link</a></td>
</tr>
</tbody>
</table>
A cladogram is a diagram that depicts evolutionary relationships among groups of organisms. Cladograms are constructed by grouping organisms together based on shared derived characteristics, which can be morphological or molecular.

**HINT:** Organisms that share more derived characteristics have a closer evolutionary relationship than other organisms represented.

Each blue dot refers to a shared derived character, a trait that indicates two or more species are closely related. First, identify the derived characters on the back of the Morphology Animal Cards. Then list the derived characters above each blue dot in the boxes provided. Two characters and one species have already been filled in for you. Finally, place the animal cards in the correct boxes on the right.
MORPHOLOGY CLADOGRAM

A cladogram is a diagram that depicts evolutionary relationships among groups of organisms. Cladograms are constructed by grouping organisms together based on shared derived characteristics, which can be morphological or molecular.

HINT:
Organisms that share more derived characteristics have a closer evolutionary relationship than other organisms represented.

Each blue dot refers to a shared derived character, a trait that indicates two or more species are closely related. First, identify the derived characters on the back of the Morphology Animal Cards. Then list the derived characters above each blue dot in the boxes provided. Two characters have already been filled in for you. Finally, place the animal cards in the correct boxes on the right.

*The mammoth and Asian elephant can be switched on this diagram and still be correct, the information conveyed is identical. The same is true if the tapir and hippopotamus are switched.
MAMMOTH OBSERVATIONS

NAME

Find the two fossils of Columbian mammoths displayed at the Perot Museum. For each specimen, record your observations below.

_Mammuthus columbi_

**SCIENTIFIC NAME**

**COMMON NAME**

**SKETCH OF SPECIMEN**

**PHYSICAL FEATURES**

**AGE**          **LOCATION FOUND**          **DATE FOUND**

**INTERESTING FACTS**
**Mammuthus columbi**

**SCIENTIFIC NAME**

**COMMON NAME**

**SKETCH OF SPECIMEN**

**PHYSICAL FEATURES**

**AGE**

**LOCATION FOUND**

**DATE FOUND**

**INTERESTING FACTS**

—

—

—
MOLECULAR CLADOGRAM

WHAT IS A CLADOGRAM?
A cladogram is a diagram that depicts evolutionary relationships among groups of organisms. Cladograms are constructed by grouping organisms together based on shared derived characteristics, which can be morphological or molecular.

First, align the DNA sequence on each Molecular Animal Card. Then calculate the similarities of each sequence. Use this information to complete the cladogram. The more similar two sequences are to each other, the more closely related the species.
MOLECULAR ANIMAL CARDS

Dugong
3'- CAGTCATCGATAACCAATGCTTCCTGATCCG -5'

Asian Elephant
3'- CACACTGCGATAGGTATGATTCACGATCCA -5'

African Elephant
3'- CAGACTTCGATAGGTTTGCTTCGTGATACA -5'

Hippopotamus
3'- GCGAAGTCATTGCGAATCGTAGCTCAATCG -5'

Rock Hyrax
3'- GACTCATCGATAGGTATGCTTCATGATTCA -5'

Columbian Mammoth
3'- CACACTTCGATAAGTATGCTTCATGATTCA -5'

Tapir
3'- GACTACTCATTGCCTATCCTAGTTCAATCG -5'

Golden Mole
3'- CACCCTTCAATAGCAATGCTTGATGAAACG -5'
BACK OF MOLECULAR ANIMAL CARDS
WHAT IS A CLADOGRAM?

A cladogram is a diagram that depicts evolutionary relationships among groups of organisms. Cladograms are constructed by grouping organisms together based on shared derived characteristics, which can be morphological or molecular.

First, align the DNA sequence on each Molecular Animal Card. Then calculate the similarities of each sequence. Use this information to complete the cladogram. The more similar two sequences are to each other, the more closely related the species.

*On this cladogram the mammoth and Asian elephant can be switched on this diagram and still be correct, the information conveyed is identical. The same is true if the dugong and hyrax, or the tapir and hippopotamus are switched.