TITANS OF THE ICE AGE

EDUCATORS' GUIDE

An Educational Product of

GIANT SCREEN FILMS, THE MAMMOTH SITE OF HOT SPRINGS, SOUTH DAKOTA & THE FIELD MUSEUM

www.titansoftheiceage.com

EDUCATORS' GUIDE OVERVIEW

Titans of the Ice Age provides an opportunity to explore concepts and content in several key thematic areas:

INTRODUCTION

Titans of the Ice Age is a giant screen adventure that transports your students to a frozen Earth, ten thousand years before modern civilization. Bringing mammoths, saber-tooth cats and dire wolves to life on the giant screen, the film also explores how scientists today use ancient remains and other fossil clues to learn about life during the Pleistocene epoch.

This guide is designed as a tool to help explore the Earth's history and connect the Titans of the Ice Age film experience to your science curriculum, before and after your field trip. It includes background information as well as suggested activities that may be adapted to various grade levels and used to satisfy curricular requirements in science, biology, ecology, geography, math, English and history. Other suggested resources are also provided.

EARTH'S CHANGES

Our planet has a vast history. A variety of factors and forces have shaped its surface, ecology and environment over 4.5 billion years. A geologic timescale encompasses the different events and populations that characterize its four different eras. Earth has experienced cyclical variation in its climate, with "ice ages" (periods of glaciation) punctuated by periods of warming. Modern humans have only been on Earth for about 150,000 years. Titans of the Ice Age takes place in the Pleistocene Epoch, 20,000 years ago, during the most recent Ice Age.

CLUES FROM THE PAST

Researchers use many different clues to determine what the Earth and its inhabitants were like throughout its vast history. From fossil bones to dung to erratic boulders and ice cores, scientists analyze ancient evidence to learn about extinct species (what they looked like, how they behaved, what they ate) and the planet's climate and environments (where did glaciers reach?)

LIFE IN THE ICE AGES: ADAPTATION, SURVIVAL AND EXTINCTION

Titans of the Ice Age takes viewers back to a time when humans co-existed with mammoths and many other fascinating animals that are now extinct. Life in the Pleistocene was diverse, with flora and fauna suited to a harsh climate. Adaptations helped animals meet the challenges of their environment. Why did so many large species, like the mammoth, become extinct at the end of the Pleistocene? A variety of theories exist to explain why some animals are gone, yet other species common in the Pleistocene remain today.

THE BIG PICTURE

Science is an ongoing process of discovery. Many people around the world contribute to exploration, research, and the communication of ideas. New discoveries shape our constantly evolving understanding of what Earth's geology, climate, and inhabitants were like. What we know about the fate of the mammoths may help protect threatened species today.

BRING A MAMMOTH IN A TRUNK TO YOUR CLASSROOM!

The Mammoth site of South Dakota offers a fun, hands-on learning kit, complete with tooth and jaw replicas, molds you can make in your classroom, teachers' guides, DVDs and posters. Activities are designed for grades K-12. These trunks are available for loan. The site also offers activity booklets for grades K-5.

To Learn More, Visit:

https://www.mammothsite.com/mammoth_in_trunk.html

Phone: 605.745.6017

Email: mammothed@mammothsite.com

EARTH'S CHANGES

Background Information

Titans of the Ice Age takes us thousands of years back in time to the end of the Pleistocene Ice Age. Information and activities in this section will help students explore Earth's geologic history and understand its Ice Age past in this context.

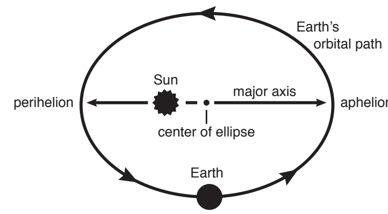
What are Ice Ages? What Caused Them?

We refer to an Ice Age as a period of cold climatic cycles in which snow accumulates more rapidly than it melts. This accumulation can produce ice sheets that cover the Earth and its oceans, affecting its surface and inhabitants.

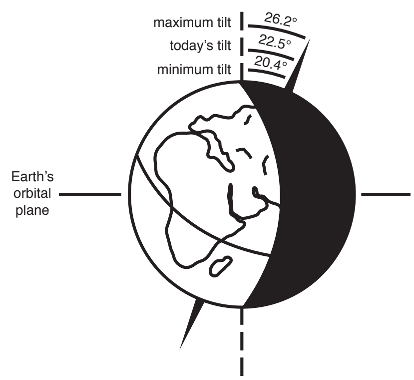
The fundamental cause of ice sheets and glaciers can be stated, simply, as an excess of snowfall in the winter months that does not melt in the summer months. The physical causes of glaciation are variable, however, and it may be a combination of several variables that allows an Ice Age to begin. Some of these variables that create significant influence include: fluctuations in solar radiation; the Earth's orbit around the sun; land mass elevation; atmospheric composition; and volcanic eruptions.

A classic model for cyclic ice ages has been produced using the Earth's orbit as a "forcing function." This model is most commonly called the Milankovitch Theory, after the Croatian mathematician who derived it. He proposed that variations in the Earth's orbit, related to the tilt of its axis, the eccentricity (or shape of its orbit around the sun) and its precession (wobble of the Earth's axis caused by the gravitational pull of the sun and moon) all influence the amount of solar energy that reaches the planet. He recognized a cyclic pattern to not only the Pleistocene ice advances (thousands of years) but also on a much larger scale, of approximately 300 million years: a Precambrian Ice Age about 900 million years ago; a Cambrian Ice at about 600 mya; a Permian Ice Age at about 300 mya; and the Pleistocene Ice Age at about 2 mya. Within these megacycles, there appears to be a 40,000 year cycle of ice advance and retreat.

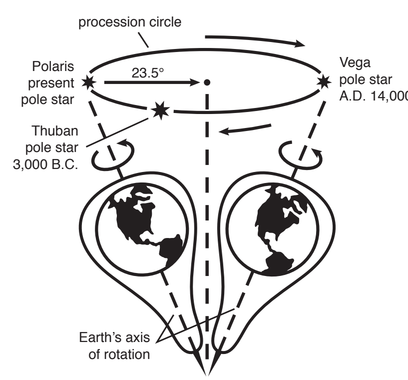
The Eccentricity (a): Tilt (b): and Precession (c) of the earth that provides cycles in the heat budget of the earth. (modified from Lange, 2002)



A. The shape of the Earth's orbital path around the Sun today is an ellipse. However, it varies in approximately 100,000 year cycles from almost a circle to an ellipse of greater eccentricity that occurs today.



B. The axis of rotation of Earth is presently tilted at approximately 23.5 degrees in relation to the plane in which Earth revolves around the Sun.



C. Because the axis of Earth's rotation wobbles like that of a spinning top as the top slows, the axis points to different places in the heavens over a cycle of about 26,000 years. For the ancient Egyptians, Thuban was the north star, Polaris, will eventually be replaced, and Vega will turn at indicating the north celestial pole.

EARTH'S CHANGES

Pleistocene Pie

Activity #1

ACTIVITY DESCRIPTION AND OBJECTIVES:

Students will gain an understanding of Earth's history by studying pie charts detailing Earth's eras and epochs, by comparing their lengths of time. They will understand the relative place of the Pleistocene epoch in Earth's history. They will learn that the Pleistocene is also known as "The Ice Ages." They will be introduced to the fauna of the Cenozoic Era and its epochs, with emphasis on the fauna of the Pleistocene and the emergence of humans during this time.

BACKGROUND INFO:

The Ice Age takes place at the very end of the Pleistocene—at the dawn of the Holocene, and a very brief moment in the context of Earth's long history. A geologic time scale for the Earth has been constructed based on the fossil content of its rocks, from oldest to youngest. The last 2 million years of geologic time are The Ice Age represented in two epochs known as the Pleistocene (2 million years ago until ca. 10,000 years ago), and the Holocene, or Recent (the last 10,000) years. The Pleistocene is often referred to as the "Ice Ages," as multiple advances and retreats of continental ice sheets have been recognized.

EARTH'S FOUR ERAS ARE:

- **Precambrian:** 4055 million years
  Formation of oceans and continents, atmosphere and oxygen accumulation, some single and multi-celled organisms
- **Paleozoic:** 300 million years
  Sea life proliferation, swampy forests, amphibians, reptiles, and fishes
- **Mesozoic:** 179 million years
  Age of Reptiles, crocodiles, dinosaurs, small mammals and early birds
- **Cenozoic:** 66 million years
  Age of Mammals, insects, birds, mammal diversification and emergence of humans

THE SEVEN EPOCHS OF THE CENOZOIC ERA ARE:

- **Paleocene:** 10 million years
  The Paleocene begins with the extinction of the dinosaurs. Very little fossil evidence exists for the Paleocene. *Crocodiles* and *alligators* appear as well as many *small* and *medium sized mammals,* also some *hoofed animals.*
- **Eocene:** 17 million years
  The Eocene sees the emergence of many new mammals including *horses, whales* and *monkeys.* More *hoofed animals, early elephant-type animals, rodents, marsupials, pythons* and *turtles* appear.
- **Oligocene:** 13 million years
  In the Oligocene, *elephants* and *apes* arise, as well as *rhinoceroses, camels* and *early dogs*. Also, *Paracertherium,* the largest mammal to ever inhabit Earth appears in central Asia. It weighed 12-18 tons!
- **Miocene:** 20 million years
  During the Miocene, Earth begins to cool and *early humans* appear along with a diversity of *mammals* and *birds,* also *whales* and *seals.*
- **Pliocene:** 3 million years
  As more of the Earth's water freezes and the oceans become shallower, many land bridges appear between landmasses, and there is extensive migration of species. *Camels, bears, apes, giant ground sloths* and *early humans* are abundant. During the late Pliocene, *woolly mammoths, saber-toothed cats, giant armadillos, predatory birds,* and *giant turtles appear.*

- **Pleistocene:** 1.99 million years
  This Ice Age epoch is known for *mammoths, mastodons, saber-toothed cats, dire wolves, white-tailed deer,* and *modern day humans.*
- **Holocene:** 01 million years
  The Holocene is characterized by the emergence of *modern day* species.

MATERIALS:

- Pie Chart of Earth's Eras
- Pie Chart of Epochs of Cenozoic Era
- Colored pencils, crayons or markers
- Calculators

PROCEDURE:

1. Earth's Four Eras

a. Hand out Earth's Eras pie chart worksheets. Ask students to describe what they notice about the divisions. They should observe that the Precambrian "slice" is very large and that the Cenozoic "slice" is very small. Point out that the Precambrian era is labeled with 4055my, which really means 4,055,000,000 years. Ask students to add the 6 zeros to the other numbers. You can do this on the board. Discuss how it is very difficult for us to comprehend such big numbers, and such long time spans.

b. Ask students to find the age of the Earth. Add together 4055 + 300 + 179 + 66 = 4,600my or 4,600,000,000 years!!

c. Have students color each section of the pie chart a different color. Then have them create a legend which includes duration and characteristics (see background information above):

- **Precambrian**
- **Paleozoic**
- **Mesozoic**
- **Cenozoic**

2. Earth's Seven Epochs of the Cenozoic Era

a. Hand out the Cenozoic Seven Epoch's pie chart. Explain that we are taking the most recent era of the earth, the last 65-66 million years, and are breaking it down into its divisions. This way we can find out where the Pleistocene Epoch fits. (*Titans of the Ice Age* deals with the Pleistocene Epoch.)

b. Have students locate the Pleistocene "slice." How long was the Pleistocene Epoch? 1.99my = 1,990,000 years, almost 2 million years.

c. Have students color each section of the pie chart a different color.

d. Do some quick in class research and find out what animals emerged during each of the epochs. Then have students create a legend that includes the name of the epoch and the animals that lived during that time. Details are provided in the background for this activity. A Web image search for animals of each era is also very helpful!

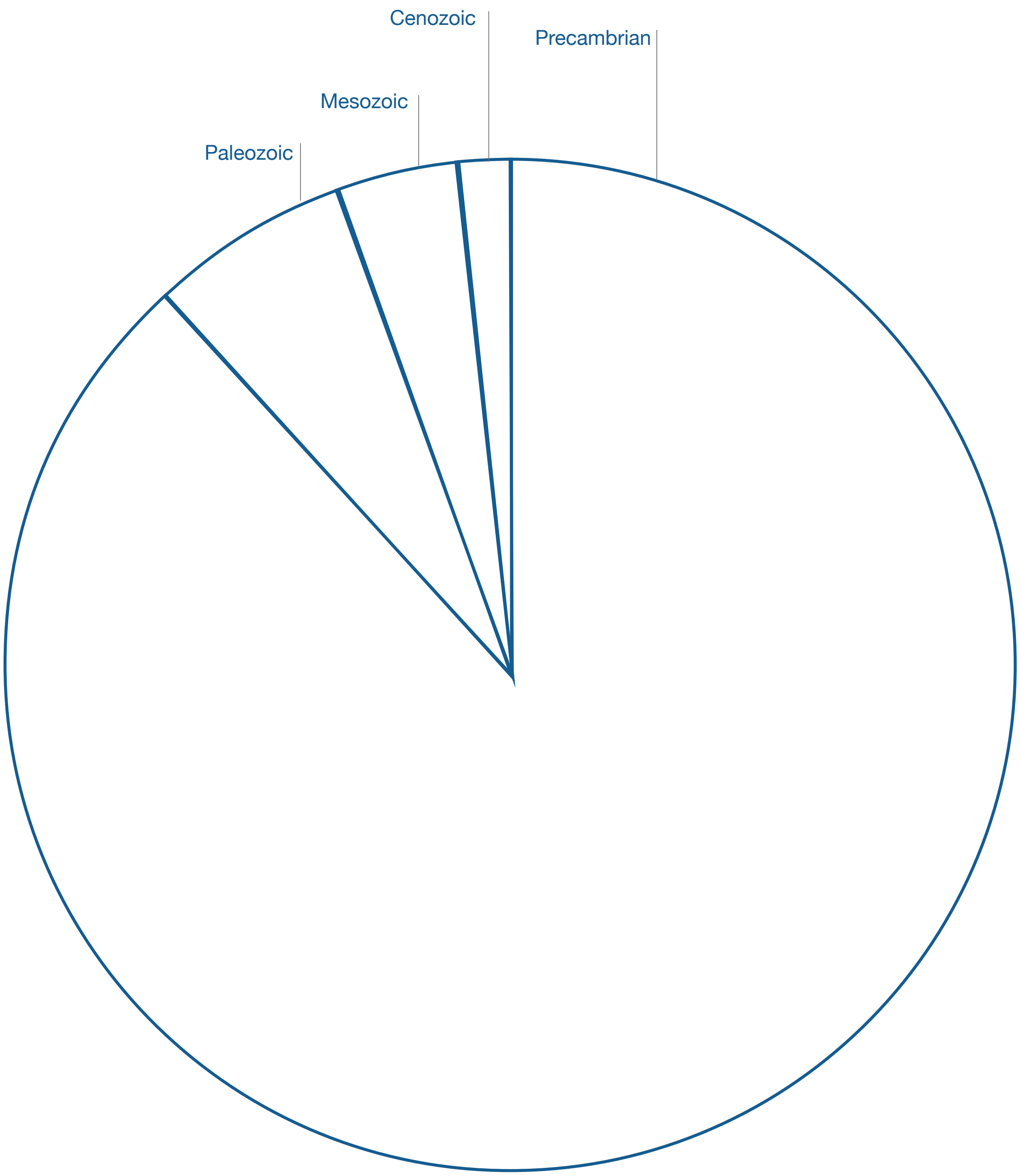
3. Summarize activity.

   a. Review in particular the megafauna of the Pleistocene: woolly mammoth, dire wolf, saber-toothed cat, giant sloth, etc

   b. Discuss again the place of the Pleistocene in the history of the Earth, approximately 2 million years out of just under 4.6 billion years.

4. Introduce idea of the increase in and spread of human populations during this time period, and the fact that they hunted for survival.

PLEISTOCENE PIE
EARTH'S ERAS WORKSHEET



EARTH'S FOUR ERAS ARE:

A. Precambrian: 4055 million years, 4055, ____________________________

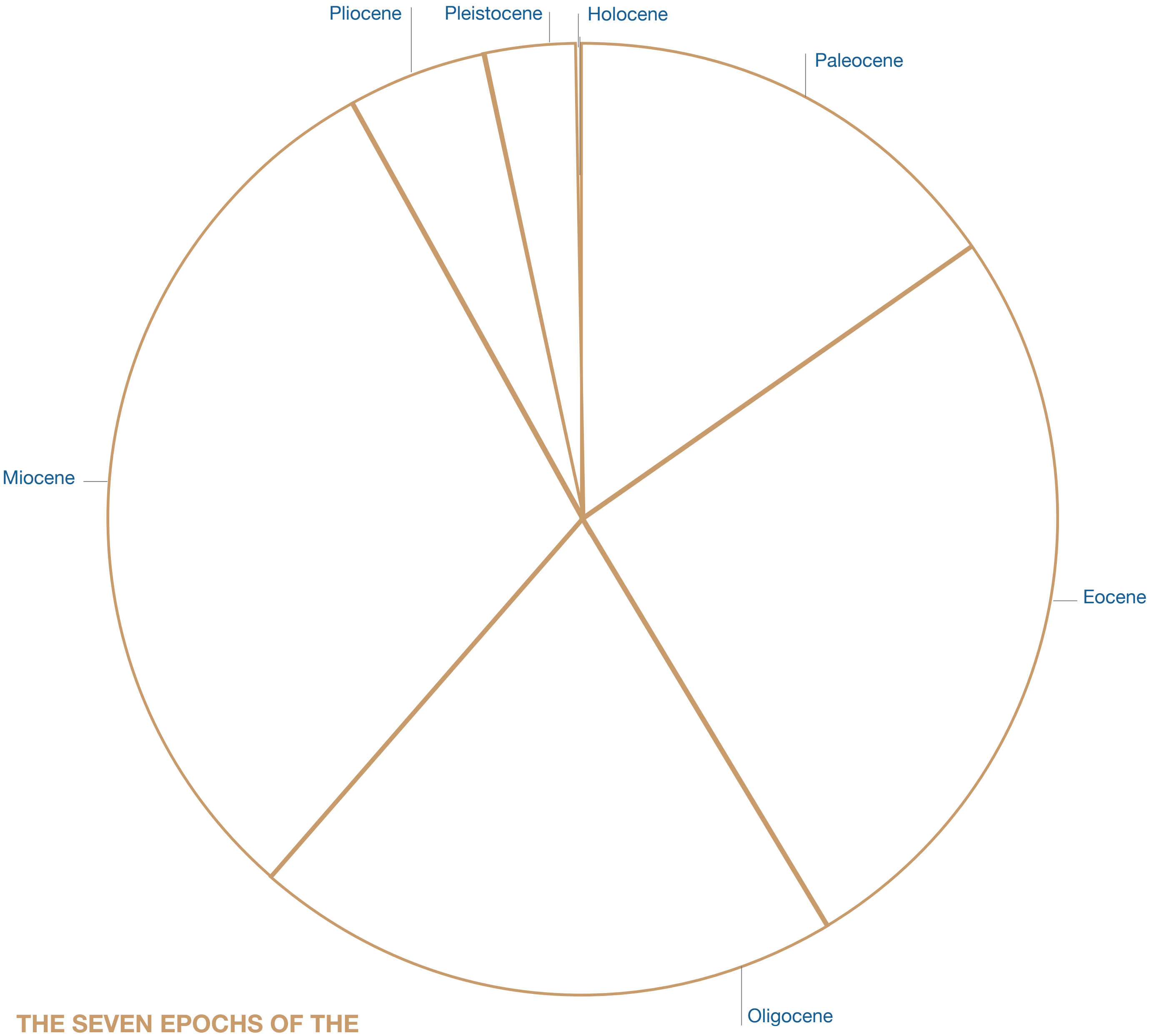
B. Paleozoic: 3005 million years, 3005, ______________________________

C. Mesozoic: 1795 million years, 1795, ______________________________

D. Cenozoic: 665 million years, 665, _________________________________

LEGEND

PLEISTOCENE PIE EARTH'S EPOCHS WORKSHEET



THE SEVEN EPOCHS OF THE CENOZOIC ERA ARE:

A. Paleocene: 10 million years, 10, ______________________________

B. Eocene: 17 million years, 17, ______________________________

C. Oligocene: 13 million years, 13, ______________________________

D. Miocene: 20 million years, 20, ______________________________

E. Pliocene: 3 million years, 3, ______________________________

F. Pleistocene: 1.99 million years, 1.99, ______________________________

G. Holocene: .01 million years, .01, ______________________________

LEGEND

CLUES FROM THE PAST

Background Information

In ***Titans of the Ice Age,*** we see scientists at work studying finds from Ice Age sites around the world, including bones and microfossils from the La Brea Tar Pits and the Mammoth Site of South Dakota, as well as the mummified body of baby mammoth Lyuba. Scientists are like detectives, using evidence left behind to understand what life was like during the Ice Ages. Activities in this section will introduce students to the work of scientists and tools and clues they use to explore Earth's history.

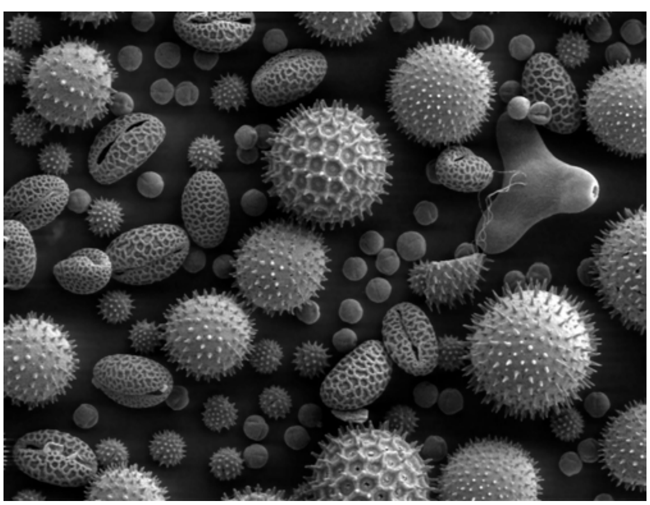
Ancient Life: How Do We Know?

Let's consider ancient life, including Ice Age animals—and our human ancestors. What did animals look like, and how did they behave? What was life like for early humans? How do we know? Scientists try to answer these questions by studying evidence such as fossil bones, tissue remains, and DNA. They also observe elephants to better understand the likely behaviors and lifecycles of mammoths. We can also study objects left behind by humans, as well as their remains.

Ice Ages: How Do We Know?

Titans of the Ice Age shows some examples of clues from the Pleistocene that help us know what Earth's climate and environment were like. Information about the ancient planet can be gained from several lines of evidence. Some of these include:

- Pollen and plant macrofossils (leaves, nuts, cones, seeds etc.) may be found in the sediments of lakes and ponds and in the stream-laid deposits called alluvium. Pollen grains can determine the species of the plant that produced it. If we know the plant, we can make a close approximation to its moisture and temperature requirements, and interpret what the environment was like at the time when the plant grew.
- Dung deposits have been preserved in dry caves and frozen deposits. Identifying the plant fragments, seeds and pollen from such materials tells us the vegetative community on which the animal fed, at the time it lived at that location. As step #1 indicates, we can reconstruct the temperature and moisture conditions (paleoclimate) from the plants.
- Packrat middens are large piles of material cemented together with urine, produced by packrats that collected pieces of plant material, plus bones, dung etc. in and around their dens. Ancient middens can be dated by radiocarbon, providing a temporal framework from which temperature and moisture conditions derived from floral evidence can be assigned. From these data, ancient climate and environments can be reconstructed.



Scanning Electron Microscopic image of pollen grains from sunflower, morning glory, prairie hollyhock, oriental lily, evening primrose, and castor bean. *NASA/Goddard Space Flight Center*

Pack rat midden

CLUES FROM THE PAST

Mammoth Molars

Activity #2

ACTIVITY DESCRIPTION AND OBJECTIVES:

Students will emulate scientists by trying to identify an unknown object: a mammoth's tooth. Once identified, they will look for clues about the mammoth, itself. How big was it? What did it eat? Students will know that scientists can hypothesize a lot about an extinct animal with just a small piece of fossil evidence. Students will be able to define "extinct."

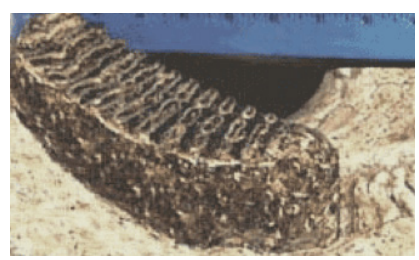
BACKGROUND INFO:

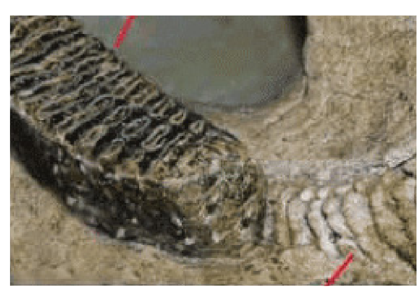
Mammoth teeth are fascinating, revealing the animal's age and specie. With four functional shoe-box sized teeth in their mouth, two upper and two lower, a mammoth chewed approximately 500 pounds of vegetation daily. Over the years, these molars began to wear and break apart. Behind the worn teeth, in both the jaw and skull, new teeth formed. Slowly advancing,the new teeth gradually pushed out the old set. Similar to a forward moving conveyor belt, the new teeth moved into position. Like the elephants of today, mammoths grew six sets of teeth over a lifetime.

By the age of six, mammoths had acquired their first three sets of teeth. The fourth set of molars arrived by the age thirteen, the fifth set by age twenty-seven and the last set of molars came in when the mammoth was approximately forty-three years old. Eventually, when the mammoth's last set of teeth worn away, the mammoth died through reduced ability to feed. Life expectancy of the average mammoth was 60 to 80 years.

Researchers determine the approximate age of the mammoth by measuring the length and width of its molars. Using molar measurement and age charts of modern day elephants, the scientists calculate the mammoth's age at death. The number of ridges that occur in the first four inches of the chewing surface of the tooth reveals the species of mammoth. These teeth have been identified as Columbian mammoth, (Mammuthus columbi). The new tooth is a series of enamel tubes, filled with dentin and bonded by cementum. The tubes, compressed into ovals as the tooth grew, formed the ridges on the tooth's occlusal (chewing) surface.

Imagine teeth as big as a shoe box...and six sets of teeth over a lifetime!





MATERIALS:

- Picture or replica of mammoth tooth (image online or replicas available from the Mammoth site, see p.2)
- Blackboard/White Board

PROCEDURE:

1. Show students either a picture or replica of a mammoth tooth. Ask them to guess what they think it might be. (THINK-PAIR-SHARE method would work nicely here.) Record ideas on board. If using a picture, be sure to provide an accurate size comparison, for example, a shoebox.
2. Share with students that the object is a mammoth tooth. Show picture of a mammoth. Tell them that a mammoth is an extinct animal that lived on Earth during the most recent Ice Age during the Pleistocene Epoch.
3. Discuss what it means for an animal to be extinct.
4. Observe the tooth in more detail. Check out the ridges on the top, etc. Discuss the background information.
5. Summarize by talking about how scientists use a piece of fossil evidence to determine things like age, size and eating habits of an extinct animal, and how it also helpful to compare the extinct animal to a modern day relative, like mammoth to mastodon.
6. If desired, go one step further, and compare a mammoth tooth with a mastodon tooth, with emphasis on eating habits.

WHO IS LYUBA

Activity #3

ACTIVITY DESCRIPTION AND OBJECTIVES:

By exploring information available online, students will learn about the Siberian baby woolly mammoth, Lyuba. They will be introduced to her biology and her adaptations for survival. Students will see how scientists use technology to study ancient remains, and how they use and interpret their discoveries.

BACKGROUND INFO:

Sometimes, nearly intact mammoths are found in the permafrost of Siberia, providing scientists with a wealth of information about their lives. During much of the Pleistocene, or last great Ice Age, millions of woolly mammoths roamed the Earth. Because many of these animals lived and died in cold, dry regions, their remains are often well preserved, giving scientists much to study.

In ***Titans of the Ice Age***, we see baby Lyuba, is the most complete and well-preserved mammoth specimen ever found, brought back to life. We also see her body—the most studied mammoth ever found. This female woolly mammoth died in Siberia about 42,000 years ago. She was about one month old at the time of her death. By studying her DNA, bones, stomach contents, internal organs, teeth and tusks, as well as the area where she was found, Lyuba provides scientists with valuable information about a population of mammoths for which few samples exist.

MATERIALS:

- Computers with Internet connection
- Paper and writing tools

PROCEDURE:

1. Ask students to explore ***National Geographic's*** Waking the Baby Mammoth online channel. They can read the article, watch the short documentary, and review the image galleries, interactives, etc. After a period of exploration, assign one or more of the specific discussion questions listed below to each student.

   http://natgeotv.com/asia/waking-the-baby-mammoth

2. Students may also be directed to read the ***ICE BABY: Secrets of a Frozen Mammoth*** article. ***http://ngm.nationalgeographic.com/2009/05/mammoths/mueller-text***

3. After investigating, ask students to share what they think life was like for Lyuba and possible causes for her death. Scientists have asked these same questions and are also currently working to identify the answers. Since mammoths are no longer living, how do students think scientists learn about Lyuba? What evidence do scientists use to reconstruct past mammoth life?

Possible Discussion Questions:

- Where was baby Lyuba found?
- What does the name Lyuba mean?
- How long ago did baby Lyuba live? How old was she when she died?
- What are three reasons why Lyuba is so well preserved?
- How do scientists know that Lyuba was a healthy baby?
- Scientists think that the cause of Lyuba's death was accidental choking. What evidence supports their reasoning?
- How do we know that Lyuba was well fed?
- Why would a baby mammoth be fed mammoth dung?
- What are two things we can learn from Lyuba's teeth?
- How do we know that Lyuba lived in a place with very few trees?

4. Following the discussion, have students review the online documentary if desired, and then write an article for a newspaper announcing Lyuba as a new scientific discovery and explaining how scientists are reconstructing her life from different lines of evidence.

5. After discussion, students may also wish to explore Lyuba's Facebook page:

https://www.facebook.com/BabyMammothLyuba. Check out her profile, albums, etc. Perhaps students will want to post drawings on her page!

MAKE A FOSSIL

Elementary School

Activity #4

ACTIVITY DESCRIPTION AND OBJECTIVES:

Students will make a salt dough model of a fossil. Students will be able to define fossil and know that one type of fossil that we find is actually an impression of the original organism. Students will understand that it can be difficult to determine what the original organism looked like by observing a single fossil.

BACKGROUND INFO:

Fossil remains are the evidence of pre-existing life. A fossil may be a complete organism, such as a frozen specimen, or it may be a mummy (desiccated). More often, it is a fragment of a specimen that has been preserved. To become a fossil, an organism needs hard parts: shell, bones, teeth, tusks or antlers for an animal, or seeds, pollen wood or bark for plants. It can even be what is called a “trace fossil”: a mold, cast, track, trail or coprolite (dung).

The scientists who study fossils are most often paleontologists or archaeologists. What is the difference?

Paleontology *The science of studying and interpreting non-human fossils*

Archaeology *The science of studying human remains and artifacts*

MATERIALS:

- Flour
- Salt
- Water
- Collected objects: acorns, shells, sticks, rocks, pine cones, etc.

PROCEDURE:

Collect natural objects from a nature walk, if possible. It is always nice to have a selection on hand as well. Hard objects with texture work best. Seashells work exceptionally well. If none of these are available, common objects like coins, keys and screws will do.

1. Prepare dough according to the recipe below. (Prepare ahead or have students help measure and mix the ingredients.)

   Enough for 24 individual fossils

   4 cups flour
   2 cups salt
   1 ½ cups water or more

   Mix dry ingredients; then add water gradually until the dough is the right consistency for modeling.

2. Demonstrate how to make fossil.
   a. Tell students that when fossils are found they are often imperfect and broken. Shape lump of dough into an irregular shape, perhaps like an interesting rock, and flatten it.
   b. Lightly dust surface of dough with flour.
   c. Take one of the objects and show how to press it gently into dough. Point out how the impression may look quite different from the actual object. Also place the object into the dough at different angles to show how a single object can leave several kinds of impressions.
3. Provide each student with a lump of dough, and give each time to prepare his/her fossil. They may have to try several times to obtain a clear imprint. SAVE THE OBJECTS FOR FOLLOW-UP ACTIVITY.
4. Have each student write his/her name on a paper towel or small paper plate. Place "fossil" on paper or plate and allow to dry for several days. Note that if humidity is high, fossils will remain soft, and it will be necessary to bake them. Bake at 200° for 10 to 30 minutes, depending on thickness.
5. When dry, write name on the bottom of each fossil. Paint if desired. (Best if done with earth tones.) A thin acrylic paint wash works well.

FOLLOW UP:

1. Display all of the fossils as well as the objects used to make them. Ask students to try to match each fossil with the correct object.
2. Discuss how the two are alike and how they differ.
3. Have students share what they learned by doing this activity.

MAKE A FOSSIL

Middle School

Activity #5

ACTIVITY DESCRIPTION AND OBJECTIVES:

Students will create a fossil model that enables them to understand the vocabulary: sediment, fossil, mold and cast. Students will know that it is usually the hard parts, like bones and shells, which are usually preserved as fossils. If students have already learned about Lyuba, they will be able to tell why Lyuba is such an unusual fossil find, in that most of her body, soft and hard tissues have been preserved.

BACKGROUND INFO:

What is a fossil? A fossil is the remains or evidence of pre-existing life.

Types of fossils:

- Whole organisms: such as frozen, preserved in tar or amber
- Molds: the shape of an organism preserved in sediments
- Casts: the filled replica from a mold
- Tracks: foot prints, trails by worms, or invertebrates
- Coprolites: fossil excrement
- Gastroliths: stones from the gizzard of dinosaurs and other creatures that were used to grind their food

Processes of Fossilization:

- Petrification: literally, “turned to stone” by replacement of cells by minerals such as silica, pyrite etc.
- Antisepsis: whole body preservation by freezing, encasement in tar or amber
- Mummification: desiccation

Properties favoring fossilization:

- The organism has hard parts, such as a shell, teeth or bones
- Quick burial to delay or prevent decay, scavenging etc.
- Remaining undisturbed for a long time

Uses of fossils:

- Reconstruction of ancient environments
- Determination of what a fossil animal looked like
- Determination of times and causes of extinction
- Determination of Earth’s history
- Fossil fuels such as coal, petroleum etc.

MATERIALS:

- Clay, plastic based or natural
- Plaster of Paris
- Water
- Paper cups, 8–12oz for mixing Plaster of Paris
- Wide bottom paper cups, e.g. to go soup cups or lunch milk cartons, 8-12oz, cut down to 2 or 3 inches high for fossil making
- Plastic spoons
- Graduated cylinders if desired
- Hard objects for imprinting: shells work especially well, but everyday items such as coins, keys, nuts and bolts, etc. will work as well.

PROCEDURE:

1. Prior to class, premeasure Plaster of Paris into cups. The ratio of plaster to water is 2:1. The size of fossil cup will determine the amount of plaster that you use. Usually about ½ c of plaster to ¼ c water is just right. If you want students to do the measuring with lab containers, 100ml plaster to 50ml water will work.
2. Distribute fossil making cups. Put names on outsides of cups, preferably with permanent markers.
3. Demonstrate how to make the fossil.
   a. Press a lump of clay into the bottom of the cup. It should cover the bottom, but does not have to be totally level.
   b. Carefully press objects into clay and carefully remove them. Check for clear imprints. Remind students that sometimes a single fossil is found, but often there are more than one found near each other, some broken and some not. Also, show how a single object can leave different impressions, depending on the angle of imprint.
   c. Add water to Plaster of Paris. Stir thoroughly. Pour slowly over the clay. Gently tap the container on the table so that air bubbles trapped in the plaster rise to the top.
   d. Set aside and do not disturb for 24 hours or longer.
4. Allow students to prepare their fossils.
5. Demonstrate how to reveal their fossils.
   a. Carefully tear paper cup away from the fossil. Try to not separate the clay from the plaster at this time.
   b. Show students that there are two layers: the original sediment layer (clay) and the second sediment layer (plaster).
   c. Very carefully peel the clay away from the plaster.
   d. Show the two surfaces and define mold and cast. Draw and label on the board.
   e. Remind students that fossils are very fragile.

6. Allow students to reveal and share their fossils.
7. Write names on bottoms of fossils.
8. Set aside to completely dry.
9. Fossils may be painted if desired. (Best if done with earth tones.) A thin acrylic paint wash works well.

FOLLOW UP:

1. Review how fossils are formed.
2. If common objects were used, students might want to name their fossils: "***key***obite," "***bolt***oid," etc.
3. Display fossils.
4. Discuss how this type of fossil is different from remains of Lyuba.

A MICROSCOPIC MICROFOSSIL HUNT

Activity #6

ACTIVITY DESCRIPTION AND OBJECTIVES:

By participating in a microscope lab activity, students will discover microfossils and separate them from soil particles. They will draw and try to identify a variety of microfossils and will learn why the study of microfossils is important to paleontologists.

BACKGROUND INFO:

As we see in ***Titans of the Ice Age**,* Microfossils are fossils that are so small that they can only be studied with the aid of magnification tools such as microscopes and stereoscopes. Scientists at sites like the Tar Pits at La Brea and the Mammoth Site in South Dakota rely on miscrofossils to understand the Pleistocene environment. A microfossil specimen might be an entire organism or merely a fragment of one. Some are as small as single-celled organisms. Some are plants and plant material such as pollen or seeds. As seen in the film, a microfossil could be a tiny jaw bone or a miniscule vertebra from a snake or mouse, or part of an insect's body. At other sites, animal microfossils are often shells or pieces of ancient sea lilies, corals or sponges.

Microfossils are an important piece of the paleontological puzzle. One reason scientists study microfossils is because they reveal details about environmental conditions where larger fossils have been found. For example, certain plants grow in particular climates. And, a type of shellfish might be specific to fresh water. Also, scientists are able to identify some of the producers and lower tier consumers in food chains and webs.

MATERIALS:

- Microfossil sample, available from school science supply vendors or sometimes from university or college geology or paleontology departments. Very little is needed. (¼ c is more than enough.)
- Picture identification guides, provided by suppliers
- Stereoscopes
- Glass culture dishes or crystalizing dishes
- Wood splints or toothpicks
- Microfossil lab sheet with chart printed on both sides (Worksheet iii)

PROCEDURE:

1. Obtain your microfossil sample and prepare according to directions. It is often necessary to wash your sample several times in a very fine sieve to remove silt particles. It is fine if some rock and sand particles remain in the sample, as the activity is more like a fossil hunt then. Students learn to distinguish between soil particles and actual fossils.
2. Set up stereoscope stations.
   a. Set up stereoscopes.
   b. Place a picture identification guide at each station.
   c. Each station should have a glass dish containing about a teaspoon of the sample. Glass containers work better than plastic petri dishes because they are more stable and less likely to tip and spill while students are looking through scopes.
   d. Provide several wood splints.
3. Make double-sided copies of Microfossil Hunt Lab Sheet. Pass out lab sheets and explain to students that they are going on a fossil hunt. Demonstrate how to carefully use wood splints to search through fossil sample while looking through the stereoscope.
4. Instruct students to draw and identify what they find. Encourage them to use pencil rather than pen to make the drawings, and also to show detail, add shading, etc.
5. After a period of time, ask students to move to a different station and continue their work.
6. When lab work is complete, discuss what students learned from this experience. Record on the board all the different organisms that they identified. Explain and discuss why studying microfossils is an important branch of paleontology. This provides an opportunity to explore another sample or samples.

A MICROSCOPIC MICROFOSSIL HUNT LAB SHEET

FOSSIL DRAWING	ORGANISM NAME

LIFE IN THE ICE AGES

Background Information

While many species that lived during the Pleistocene are still present today, many of the fascinating animals brought back to life in ***Titans of the Ice Age*** are now extinct. Information and activities in this section will help explain how life adapts to environmental changes, and offer theories on what caused the Ice Age extinctions.

TITANS OF THE ICE AGE

Trunks and Tusks: Meet the Proboscideans

Elephants, mammoths, and mastodons belong to a group of mammals called proboscideans (pro-bo-SIH-dee-ans). The name comes from the proboscis or trunk, a feature many of these animals share. The first proboscideans appeared in Africa about 55 million years ago. Over many generations, they evolved into over 150 different species that ranged across the globe. The proboscidean family tree traces the ancestry of mammoths, mastodons, elephants and their relatives back through 55 million years of evolutionary history. The first proboscideans originated in Africa. From there, they expanded into Asia, Europe, and eventually into the Americas. In Africa, scientists find nearly complete skeletons of one of the earliest proboscideans (Moeritherium), but complete skulls are rarely found. To understand what these animals looked like, scientists create composites or combinations of skull parts from different individuals.

Life in the Herd

What was life like for young mammoths? How were they raised and nurtured? Who were their family members? Scientists try to answer these questions by studying evidence such as fossil bones, tissue remains, and DNA. They also observe elephants to better understand the likely behaviors and lifecycles of mammoths. About three million years ago, mammoths extended their range beyond Africa by moving into Eurasia. Over time, these mammoth populations became isolated from one another, eventually evolving into new species as a result of adapting to different environments.

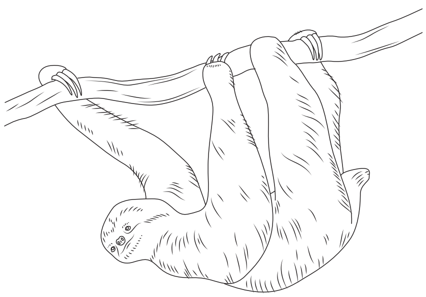
Sometimes, nearly intact mammoths are found in the permafrost of Siberia, providing scientists with a wealth of information about their lives. During much of the Pleistocene, or last great Ice Age, millions of woolly mammoths roamed the Earth. Because many of these animals lived and died in cold, dry regions, their remains are often well preserved, giving scientists much to study.

SHARED STOMPING GROUNDS:

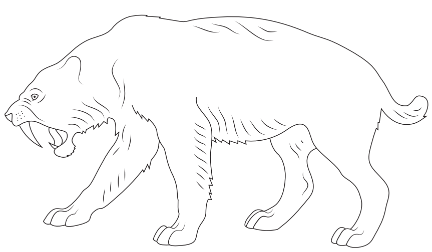
During the Pleistocene, or last great Ice Age, mammoths lived alongside many other mammals—many now extinct. They shared their North American habitat with other herbivores like rabbits, antelopes, camels, horses and giant ground sloths—the largest herbivores after mammoths and mastodons. Powerful carnivores also populated these regions: dire wolves, short-faced bears, and American scimitar-toothed cats—the most successful predators of mammoths.

This skeleton of an American mastodon shows the beast's tusks have a more pronounced curve than those of today's elephants. Photo by John Weinstein © The Field Museum

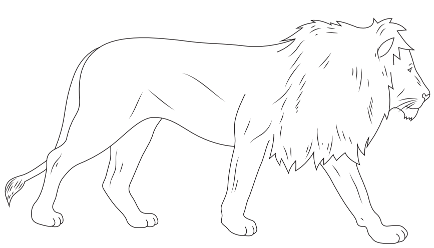
Pleistocene Sloth



Modern Day Sloth



Pleistocene Cat



Modern Day Cat

THE HERBIVORES:

Camels and Camelids originated in the Great Plains of North America, migrated to Eurasia and South America, and became extinct in North America at the end of the Pleistocene. Camelids is a term used for a variety of predominantly South American forms such as llamas, alpacas, vicunas and guanacos. Some of these animals are still present in the wild in many of the mountainous regions of the continent.

Horses were also relatively common in the Pleistocene. Like camels and camelids, they originated in North America and migrated to other continents, and because extinct in North America. They were reintroduced to North America by Spanish conquistadors.

Sloths were also widespread and abundant in the Pleistocene. Small tree sloths still live in the tropical rain forests. Four varieties of fossil sloths all originated in South America in the Oligocene. Some were as large as modern elephants and were covered with thick, coarse hair. The Harlan's sloth had protective "armor" of small, bony plates on the underside of its thick hide. The cause(s) of extinction of these animals remain undetermined.

THE CARNIVORES:

Bears are of two origins in the Pleistocene of North America. The largest bear, the giant short-faced bear *(Arctodus simus)* originated in South America, crossed the Panamanian Land Bridge and became fairly widespread across North America, all the way to Alaska. They favored open grasslands which were also habitat of many prey species. Short faced bears were large (up to 2,000 lbs or >900 kg); they had forward pointing toes (compared to the "pigeon toed" modern bears), which meant they were probably able to travel swiftly in grassland environments.

Cats is a general term for the large felids of the Pleistocene There were several varieties. The largest was the American Lion (Panthera leo atrox), which is the same genus as the African lion, but was larger. There were smaller cats such as the Saber toothed cat (Smilodon fatalis) with extended upper canine teeth and the Dirk toothed cat (Megantereon hesperus). A surprise came from a natural trap in Wyoming, in the form of a Pleistocene Cheetah *(Acinomyx trumani).* It is thought by some that the cheetah originated in North America and spread to the Old World. Modern cats include mountain lions, jaguar, lynx and bobcats.

Wolves and Coyotes are fairly common in modern environments. One extinct wolf, the Dire wolf *(Canis dirus)* was very common in the late Pleistocene Rancho la Brea, California has perhaps the largest collection of dire wolves that were trapped in the asphalt seeps, probably as they were trying to feed on other animals trapped earlier. A second type of wolf is contemporary to the dire wolves and is still in modern faunas, the Grey wolf (Canis lupus). The Coyote (Canis latrans) is a modern survivor of the genus *Canis.* This small, wolf-like canid has adapted to nearly every modern environment, including cities, and is sometimes referred to as the "urban coyote."

ANOTHER PREDATOR: HUMANS

For tens of thousands of years, humans lived alongside mammoths and mastodons. Early peoples painted images of mammoths inside the caves of southwest Europe. And in North America, people hunted both mammoths and mastodons with spears (and bravery!). Some scientists hypothesize that humans directly caused the extinction of mammoths and mastodons. Others suggest that climate change was to blame. Whatever the cause, by 12,000 years ago, nearly all mammoths and mastodons had disappeared from mainland Eurasia and North America.

Thomas Jefferson, America's third President, was a naturalist. He commissioned William Clark (of "Lewis and Clark") to go west after Clark had returned from his exploration of the Louisiana Purchase to collect mastodon bones for Jefferson's private collection. During his 1807 expedition to Big Bone Lick, Kentucky, William Clark uncovered spear points along with the bones of mastodons. Clark's find was the first to suggest that early peoples once hunted mastodons in North America.

In addition, depictions of mammoths from Paleolithic times have been found in Eurasia, but no prehistoric images of mammoths are known to exist in North America. In 2007, however, underwater archaeologists found what appears to be a rock carving of a mastodon in Lake Michigan's Grand Traverse Bay. And in 2009, an amateur fossil hunter in Vero Beach, Florida, found what appears to be an engraving of a mastodon (or mammoth) on ancient bone. Scientists are trying to authenticate both objects.

TWILIGHT OF THE TITANS

In the last 10,000 to 12,000 years many of the Ice Age animals disappeared (became extinct). In fact, 72 percent of the North American mega fauna and about 32 percent of the Eurasian large faunal animals died out.

What caused the terminal Pleistocene extinction, which consisted primarily of large terrestrial vertebrate animals? There are four major theories:

1. Climate Change (Overchill): The changing climate, going from cold, wet glacial age climate to the warmer, drier Holocene conditions has long been cited as the cause of the late Pleistocene extinction. The major objection to a climate-caused extinction event is that the late Pleistocene animals had already gone through 2 million years of worse, and better, climate fluctuations. In that same period, they had spread geographically and evolved biologically. Why should they become extinct just as the environment is changing to better conditions? There is some validity to the climatic argument in the cold, polar regions. Dry tundra grasslands become wetter, even waterlogged, as warmer conditions lead to melting of the permafrost. However, just the reverse would be true in temperate zones, where forests would retreat and grasslands would expand, creating more pasturage for herbivores, leading to more prey species for carnivores.
2. Human Hunting (Overkill): The advent of human populations of hunters to a continent of animals who had never developed evasion strategies for such predators may have caused a short-lived, expanding, extinction wave. Sites demonstrating successful human hunting of mammoths by Clovis people lend credence to this theory. In contradiction, human hunting could not have eliminated all the species that became extinct.
3. Hyperdisease (Overill): The introduction of a virulent, fatal disease by incoming humans, or their animal companions (dogs) to a continent that had no previous exposure could have decimated mega faunal populations. On the other hand, what known disease has eradicated entire species, or groups of species?
4. Bollide Impact (Overspill): A theory proposing an impact of a comet caused a hail of death-dealing debris and fire, which not only destroyed the mammoths (and some other large animals) but the Clovis people, as well. Objections focus on the survival and expansion of other large species, such as bison, etc., which occupied the same range and mammoths and mammoth hunters, which were not affected. Also, the lack of an impact site, although the Laurentide Ice Sheet has been proposed.

It is probable that no one theory may explain all the extinctions at the end of the Pleistocene. It may be a combination of causes, or a cause that has not even been considered yet.

Many genera of Pleistocene animals are still present in the Holocene Epoch. Most are smaller than their Pleistocene ancestors, but they have adapted in the post-Pleistocene world.

LIFE IN THE ICE AGES

Activity #7

Ancient Relatives: Digging Up The Past

ACTIVITY DESCRIPTION AND OBJECTIVES:

Students will participate in a fossil dig simulation. They will collect and assemble puzzle pieces of Ice Age mammals. They will then match these Pleistocene creatures with their modern day relatives. They will learn that many animals of the Ice Age were much larger than their current day counterparts. Students will discuss how scientists might determine such things as fur color and behavior of ancient animals.

BACKGROUND INFO:

As seen in ***Titans of the Ice Age,*** animals living during the Ice Age were large and diverse. It is thought that many animals grew to great size due to survival adaptations in the severe conditions, which were much colder and wetter than today's climate.

Pages 23-24 of this guide include images and descriptions of several species present during the Pleistocene.

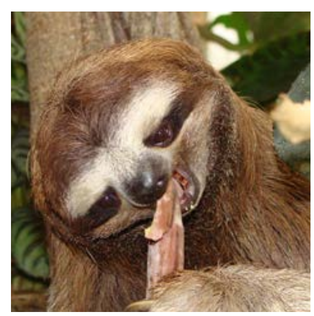
MATERIALS:

- Pictures of an African lion, African elephant, gray wolf, and tree sloth
- Pictures on card stock, perhaps laminated, of saber toothed cat, woolly mammoth, dire wolf, and shasta sloth . These pictures will be cut into puzzle pieces.
- Pictures of paired animals, showing relative size, for coloring
- Burying medium, such as sand, animal bedding, sawdust, shredded paper, or whatever you think might work
- "Tools" for digging, perhaps plastic cups, spoons and tweezers
- Empty container for collecting medium as it is removed from the site
- Clear tape

AFRICAN LION
download here

AFRICAN ELEPHANT
download here

GRAY WOLF
download here



TREE SLOTH
download here

PREPARATION:

1. Prepare puzzles: print each on a different color of card stock and cut apart into puzzle pieces. Vary the number of puzzle pieces depending on the age of the group.
2. Depending on the age and ability of group, you can make one large digging site, such as an outside sandbox, or smaller digging sites, such as cardboard boxes or trays, filled with the medium. For younger groups, you might bury one puzzle per site, and for older, more than one. To add interest you can throw in a totally unrelated "piece," or you can hold out a "piece" so the puzzle is incomplete.
3. Determine student groups, depending on how you set up your site.
4. Hang pictures of modern day animals at the front of the room.

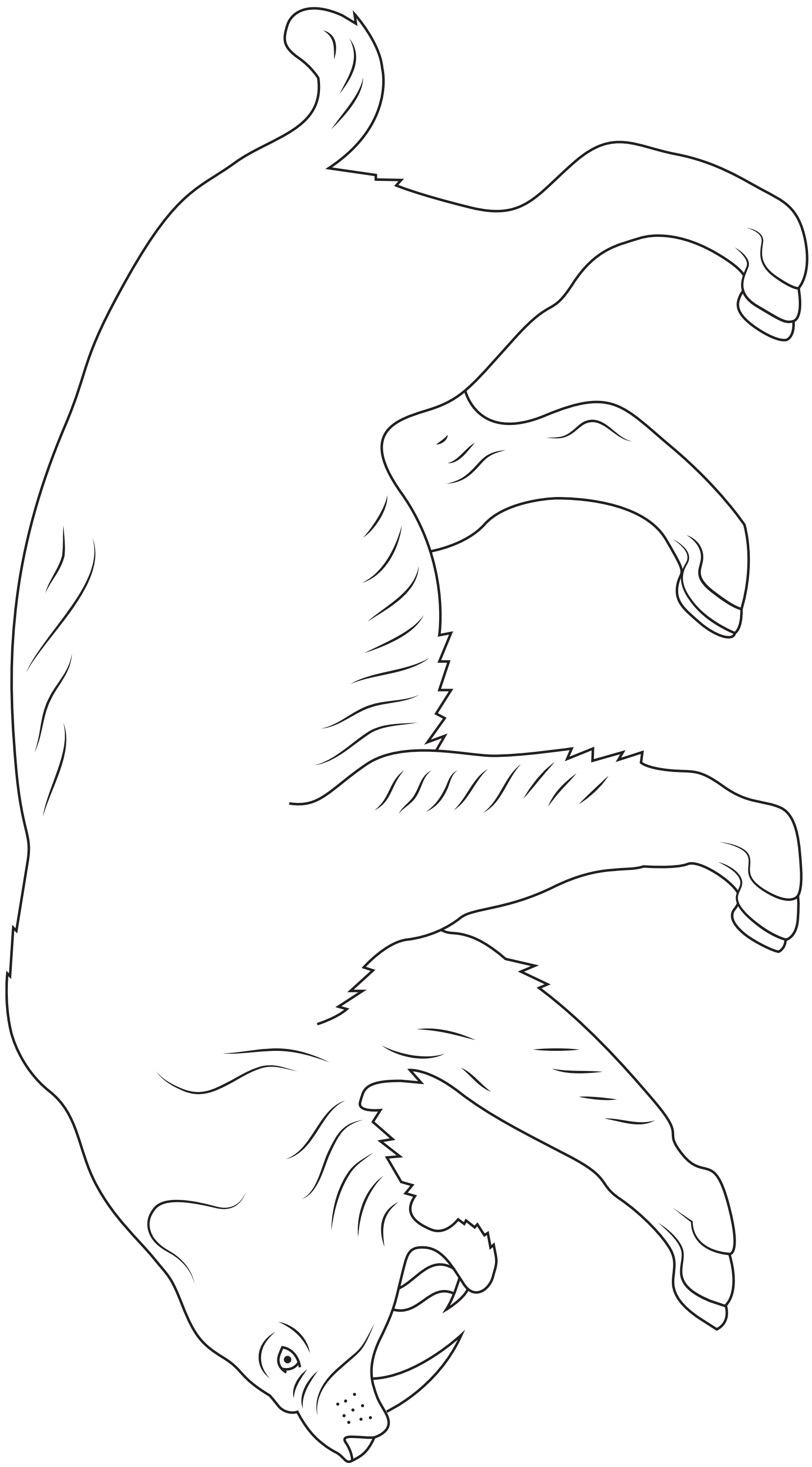
PROCEDURE:

1. Class discussion: ask students to identify and tell what they know about each of the modern day animals. Encourage them to discuss both physical and behavioral aspects of the animals. Write the name or have a student write the name of the animal below its picture.
2. Ask students what they know about Ice Age Animals. (They may share some ideas from the animated Ice Age films.)
3. Explain that they are going to hunt for clues to Ice Age animals. Be sure to emphasize and demonstrate how paleontologists are very careful when looking for and extracting fossils. Show them how to carefully remove medium from around "fossils."
4. When all of the "fossils" are collected, assemble the puzzles, tape them together, and hang them below their modern day relatives.
5. Ask students if they know the names of these ancient animals. Write the name below the picture.
6. Discuss what students already know about these animals. Compare and contrast ancient with modern.
7. Ask if we actually find whole animals like the puzzles represent. Then discuss how we might determine how they looked. How could we guess their color?
8. Discuss how we might know how these ancient creatures behaved. For example, why do we think that woolly mammoths travelled in family groups?
9. Give out one coloring sheet per student. Have them write in the name of each animal. Depending on the age, they could write in additional info, like height, weight, etc. Finding the additional info could be a homework assignment. Color.

LIFE IN THE ICE AGES

Pictures for Puzzle Pieces

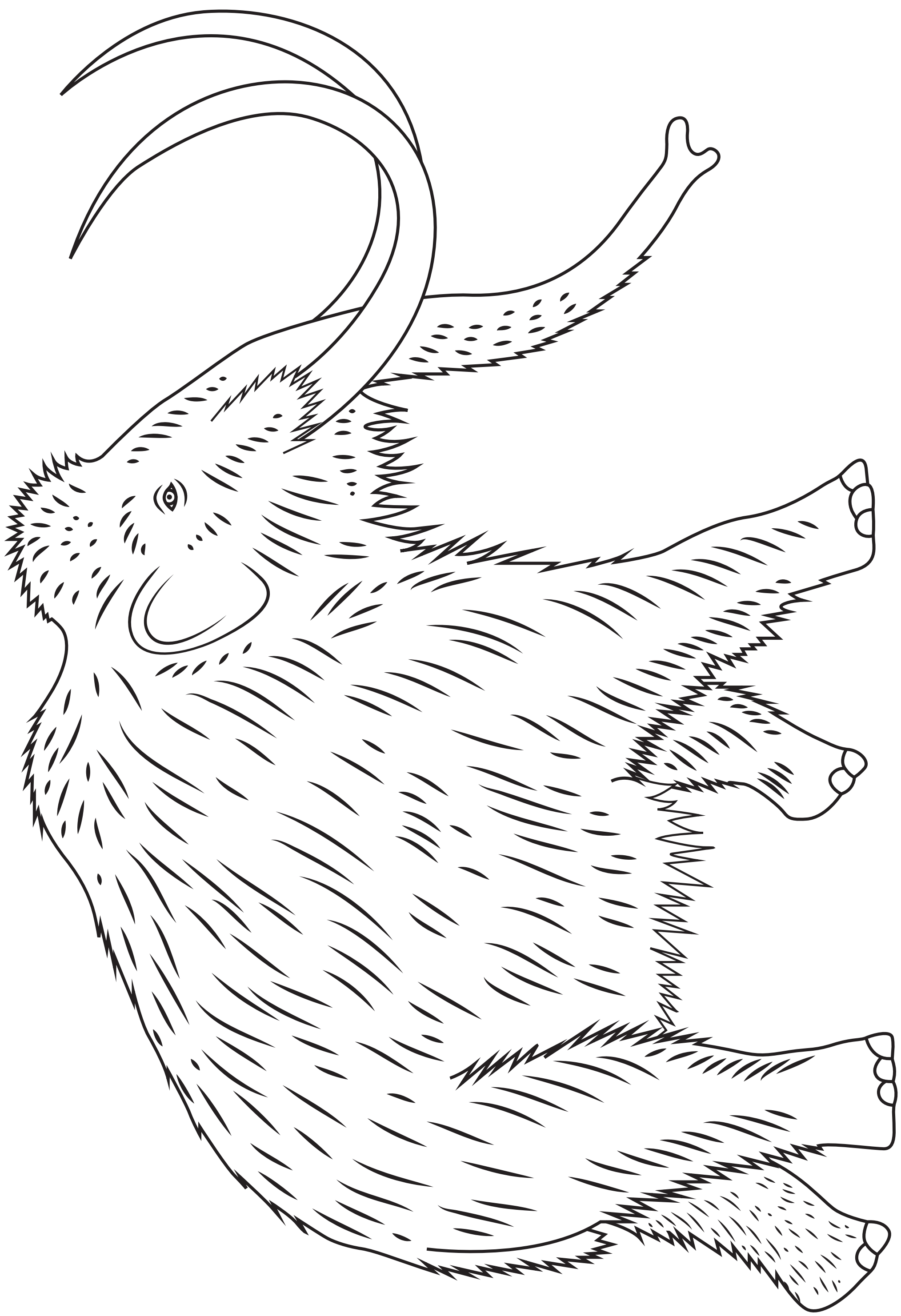
SABER TOOTHED CAT



LIFE IN THE ICE AGES

Pictures for Puzzle Pieces

WOOLLY MAMMOTH



LIFE IN THE ICE AGES

Pictures for Puzzle Pieces

DIRE WOLF

LIFE IN THE ICE AGES

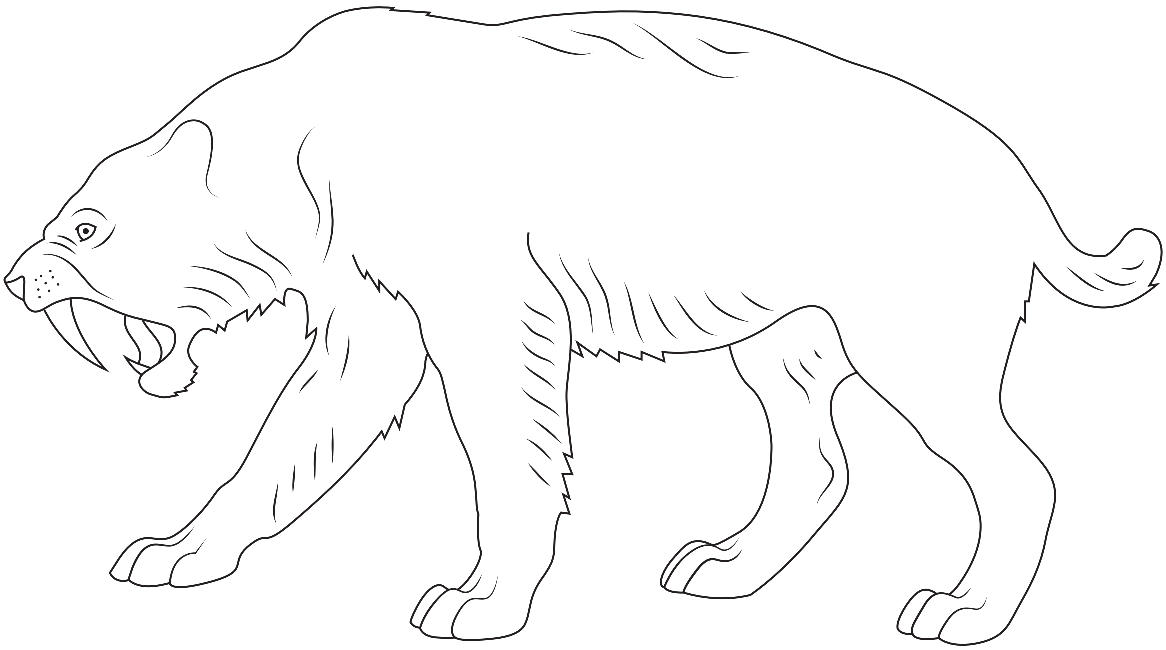
Pictures for Puzzle Pieces

SHASTA SLOTH

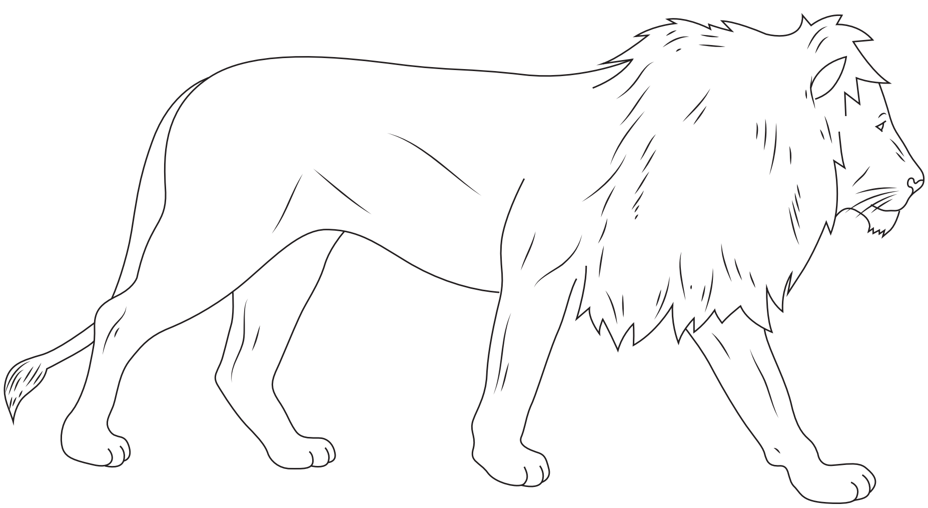
LIFE IN THE ICE AGES

Ancient Relatives Coloring Worksheet

SABER TOOTHED CAT



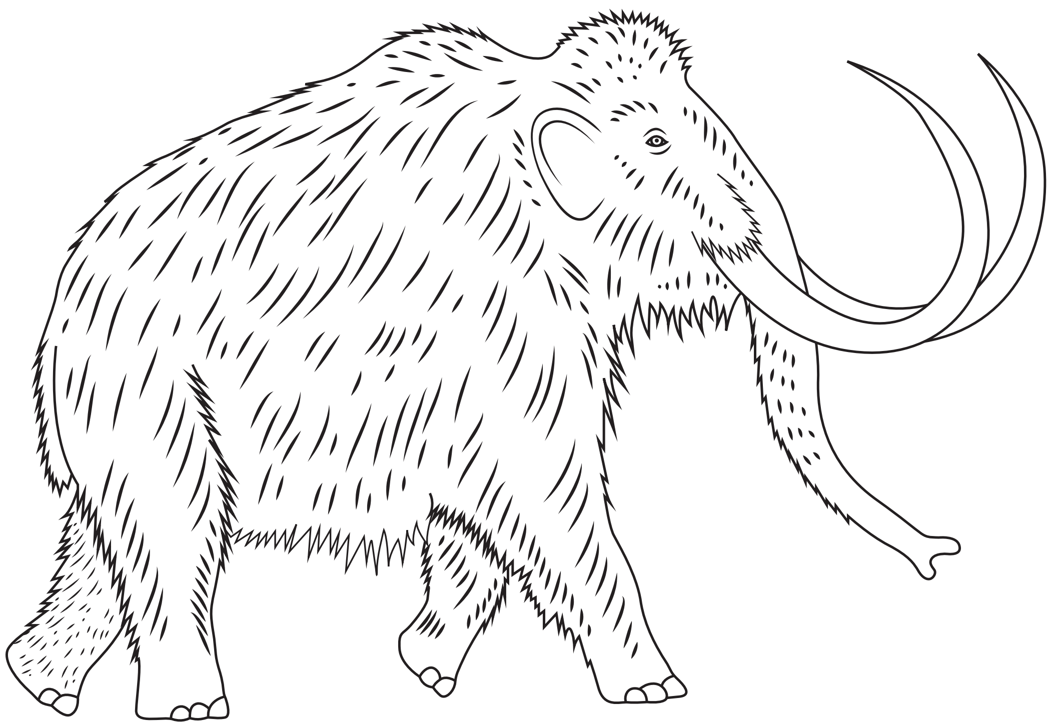
MODERN AFRICAN LION



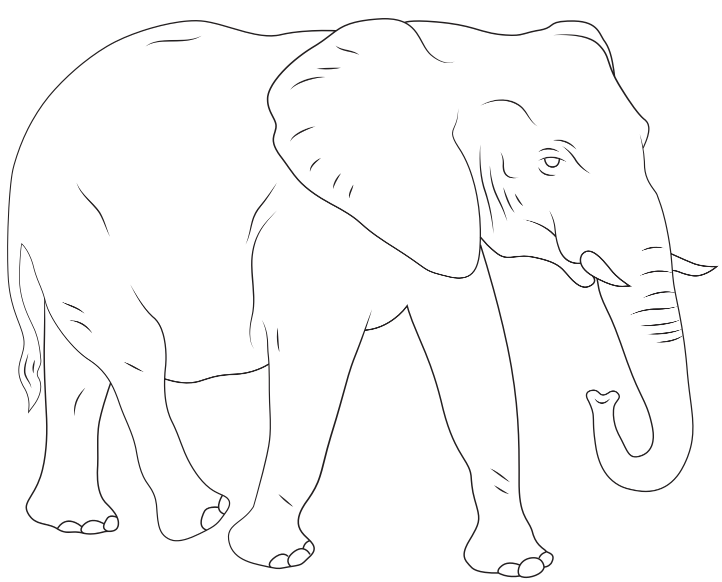
LIFE IN THE ICE AGES

Ancient Relatives

WOOLLY MAMMOTH



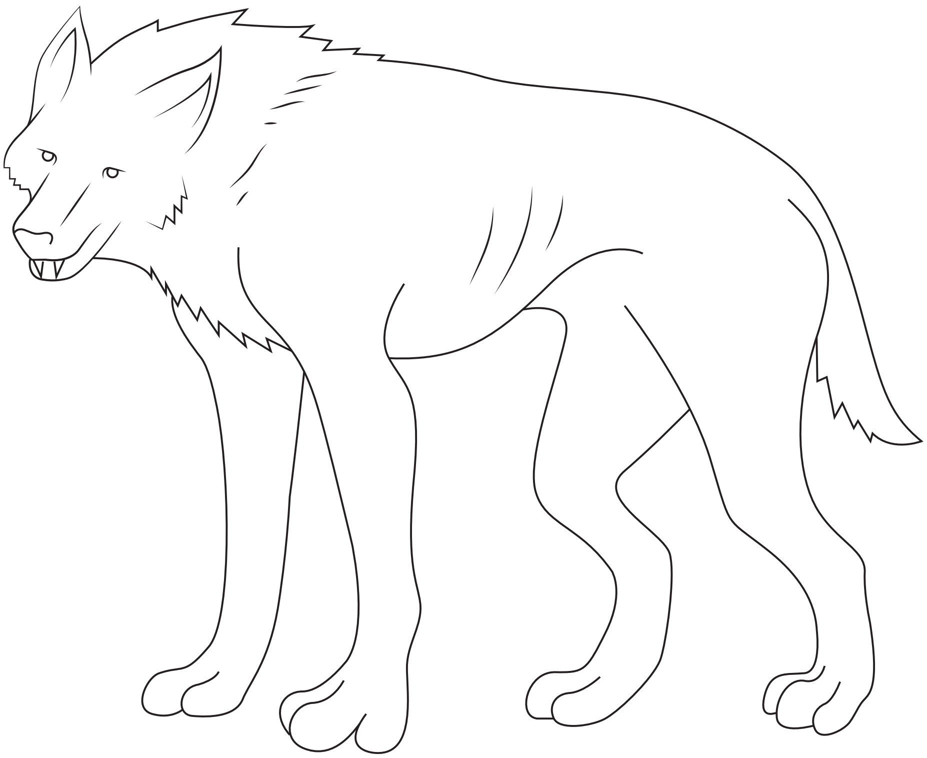
MODERN AFRICAN ELEPHANT



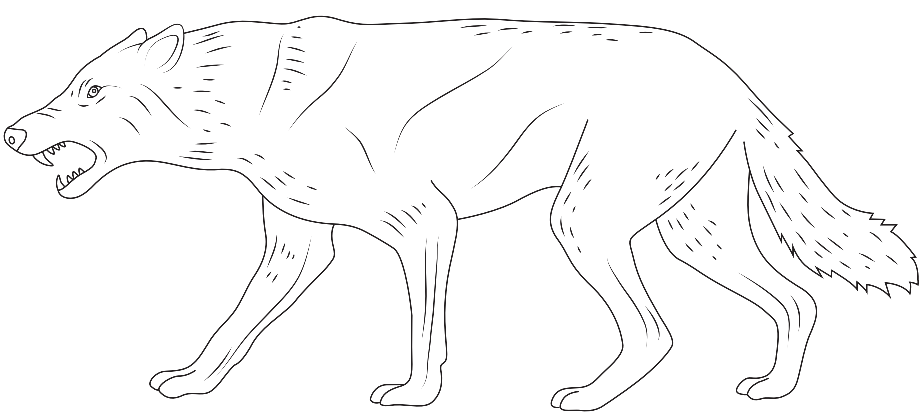
LIFE IN THE ICE AGES

Ancient Relatives

DIRE WOLF



MODERN GRAY WOLF



LIFE IN THE ICE AGES

Ancient Relatives

SHASTA SLOTH

MODERN TREE SLOTH

THE AWESOMELY ADAPTED WOOLLY MAMMOTH BY THE NUMBERS!

Activity #8

ACTIVITY DESCRIPTION AND OBJECTIVES:

By observing a picture of a mammoth, students will identify some of the physical characteristics/adaptations that enabled it to survive in an ICE AGE climate. They will also do some mammoth math by using the information provided in a table.

BACKGROUND INFO:

An adaptation is a characteristic that enables an animal to survive in its environment. Woolly mammoths were well adapted to their very cold environment. Unlike some modern day elephants, they had tiny ears and tails to prevent heat loss. They also had thick coats of hair, sometimes as long as one meter. A thick layer of fat provided insulation. They used their tusks for digging through and moving snow. Finger-like projections at the ends of their trunks were used for plucking grass. They used their large molars for chewing and grinding vegetation.

MATERIALS:

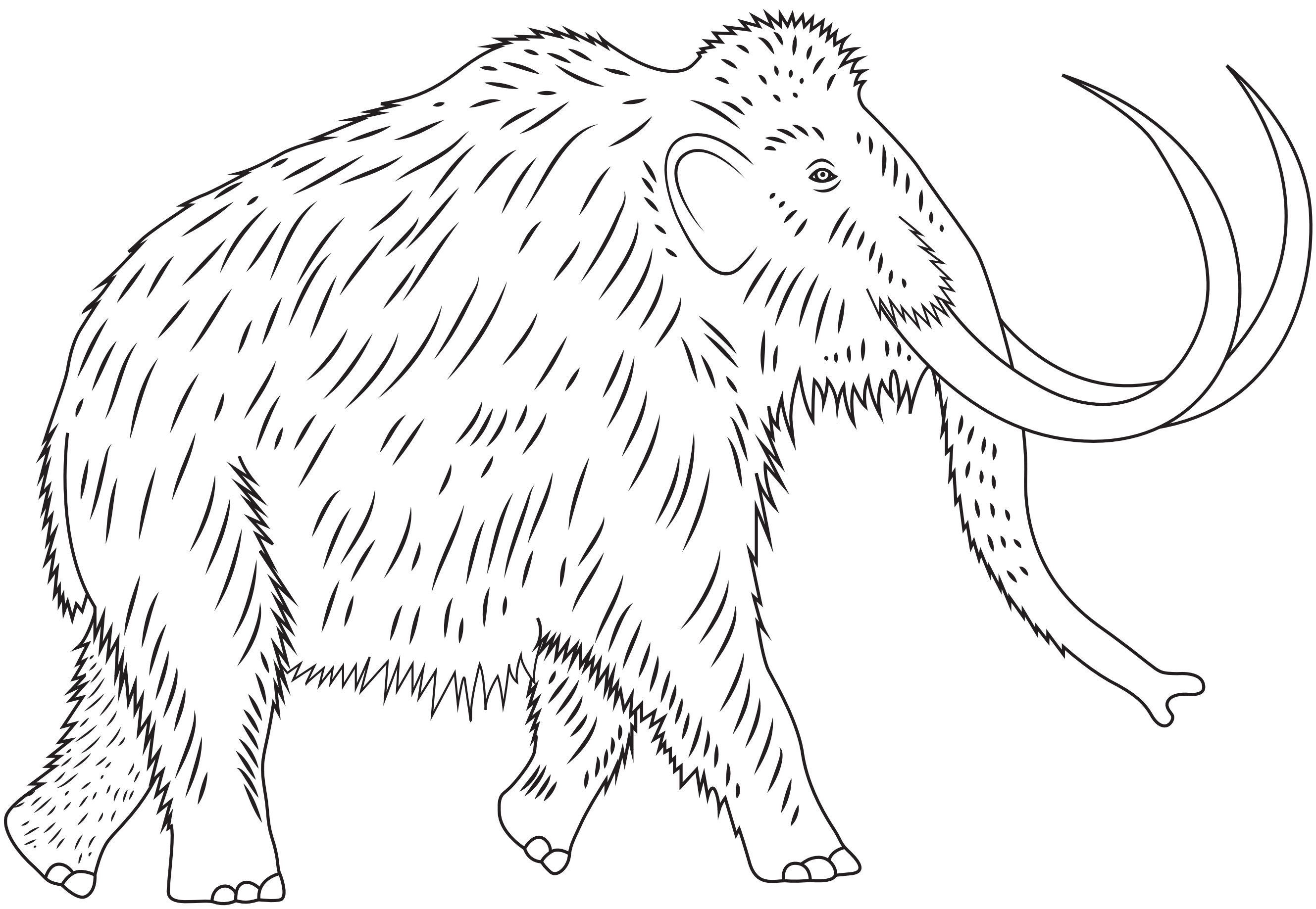
- The Awesomely Adapted Woolly Mammoth Worksheet
- Writing materials
- Calculators

PROCEDURE:

1. Ask students what they already know about woolly mammoths.
2. Write the definition of adaptation on the board. Give some modern day examples. Eagles have talons for grasping prey and sharp vision for seeing prey from afar. Cows have large flat molars for grinding plant material and lions have large canine teeth for tearing meat.
3. Tell students that they will doing a worksheet that deals with Mammoth adaptations and also some mathematical facts.
4. Put hint on the board: One ton = 2000 pounds.
5. Hand out worksheet.
6. Instruct students to work individually on the worksheet, and then allow them to work in small groups to compare answers and also to complete the worksheet.
7. Go over and discuss worksheet as a large group.

THE AWESOMELY ADAPTED WOOLLY MAMMOTH

CHECK OUT THIS PICTURE OF A WOOLLY MAMMOTH.



1. What are four adaptations that enabled woolly mammoths to survive in their tundra habitat?

a ______________________________

b. ______________________________

c ______________________________

d. ______________________________

LOOK OVER THE TABLE BELOW AND THEN ANSWER THE QUESTIONS THAT FOLLOW.

Fact	Woolly Mammoth
Scientific Name	Mammuthus primigenius
Common Name	Tundra Mammoth
Went Extinct	4000 Years Ago
Height at Shoulder–Male	9-11 Feet
Weight–Male	6-8 Tons
Height at Shoulder–Female	8.5-9.5 Feet
Weight–Newborn	200 Pounds
Tusk Length	15 Feet
Number of Sets of Teeth/Lifetime	6
Life Expectancy	60-80 Years
Vegetation Eaten	500 Pounds/Day
Gestation (pregnancy) Time	22 Months

2. How many pounds of vegetation would a woolly mammoth eat in a week? _____________

   In a year? _____________

   How many tons of vegetation would a woolly mammoth consume in a year? _____________

3. What year B.C. did the mammoth become extinct? _____________

4. How many inches tall was the tallest male woolly mammoth? _____________

   How many inches tall was the tallest female woolly mammoth? _____________

5. How many pounds did the largest male woolly mammoth weigh? _____________

6. The largest male woolly mammoth is _____________ times larger than a newborn mammoth.

7. By the age of six, mammoths had grown their first three sets of teeth. Each set consisted of four teeth, molars. At about age 13, a mammoth cut his fourth set of molars and at age twenty-seven his fifth set came in. His last set of molars arrived when he was in his forties. How many teeth did a mammoth grow during his lifetime? _____________

8. The gestation period of a mammoth was about _____________ months longer than that of a human.

THE AWESOMELY ADAPTED WOOLLY MAMMOTH

Answer Key

1. What are four adaptations that enabled woolly mammoths to survive in their tundra habitat?

a. **Tiny ears and tails to prevent heat loss**

b. **Thick coats of hair**

c. **Thick layer of fat**

d. **Tusks for digging through and moving snow**

2. How many pounds of vegetation would a woolly mammoth eat in a week? **3,500**

In a year? **182,500**

How many tons of vegetation would a woolly mammoth consume in a year? **91.25 rows**

3. What year B.C. did the mammoth become extinct? **1986 B.C.**

4. How many inches tall was the tallest male woolly mammoth? **132"**

How many inches tall was the tallest female woolly mammoth? **114"**

5. How many pounds did the largest male woolly mammoth weigh? **16,000 lbs**

6. The largest male woolly mammoth is **80** times larger than a newborn mammoth.

7. By the age of six, mammoths had grown their first three sets of teeth. Each set consisted of four teeth, molars. At about age 13, a mammoth cut his fourth set of molars and at age twenty-seven his fifth set came in. His last set of molars arrived when he was in his forties. How many teeth did a mammoth grow during his lifetime? **24 teeth**

8. The gestation period of a mammoth was about **13** months longer than that of a human.

COMPETING THEORIES

What Caused the Extinction of Woolly Mammoths and Other Large Herbivores?

Activity #9

ACTIVITY DESCRIPTION AND OBJECTIVES:

Students will read four articles that discuss the extinction of the mega fauna of the Ice Age. They will analyze the three hypotheses that are presented and conclude which hypothesis has the most supporting evidence. They will be able to define climate, climate change, herbivore and mega fauna.

BACKGROUND INFO:

In the last 10,000 to 12,000 years many of the Ice Age animals disappeared (became extinct). In fact, 72 percent of the North American mega fauna and about 32 percent of the Eurasian large faunal animals died out. It is probable that no one theory may explain all the extinctions at the end of the Pleistocene. It may be a combination of causes, or a cause that has not even been considered yet.

The three hypotheses that are presented in the articles for this activity are:

a. A huge comet collided with Earth causing massive wildfires and destroying the food supply of the grazing herbivores.

b. A rising human population over-hunted the herbivores or exposed them to new, fatal diseases carried by humans (or dogs).

c. A climate change resulting in warmer temperatures caused the disappearance of grasslands for grazing.

Definitions:

a. Climate: averages of precipitation, temperature, humidity, sunshine, wind velocity, phenomena such as fog, frost, and hail storms, and other measures of the weather that occur over a long period in a particular place.

b. Climate change: any significant change in the measures of climate lasting for an extended period of time, such as major changes in temperature, precipitation, or wind patterns that occur over several decades or longer.

c. Herbivore: an organism that feeds primarily on grasses and other plant materials

d. Megafauna: a term used by archaeologists and paleontologists to describe large or giant land animals, usually those over 100 lbs (45 kg).

MATERIALS:

- Writing tools
- Computer with Internet or Copies of Articles
- Large sheets of paper

ARTICLES:

Mammoth Killing Comet in Question: **http://news.bbc.co.uk/2/hi/science/nature/7854348.stm**

Mammoths Survived Late in Britain: **http://news.bbc.co.uk/2/hi/science/nature/8106090.stm**

Wooly Mammoth Extinction Not Linked to Humans: **http://www.bbc.co.uk/news/science-environment-11000635**

DNA Study Suggests Hunting Did Not Kill Off Mammoth: **http://www.bbc.co.uk/news/science-environment-24034954**

PROCEDURE:

1. Define climate, climate change, mega fauna and herbivore.
2. Briefly present/discuss the hypotheses regarding what caused the extinction of Ice Age megafauna.
   d. A huge comet collided with Earth causing massive wildfires and destroying the food supply of the grazing herbivores.
   e. A rising human population over-hunted the herbivores or exposed them to new, fatal diseases carried by humans (or dogs)
   f. A climate change resulting in warmer temperatures caused the disappearance of grasslands for grazing.
3. Divide students into groups and assign one article to read per group.
4. Ask each group to determine which one (or more) of the hypotheses the article is about.
5. Each group should record the evidence that supports the hypothesis as well as the evidence that refutes it.
6. Hang large pieces of paper around room. Title them Comet Collision, Human Hunting, and Climate Change. Divide each sheet in half, vertically. Label the left side, Supports, and the right side, Refutes.
7. Allow time for students to record the evidence on the sheets of paper.
8. Discuss results, and determine which hypothesis has the most evidence to support it.
9. Summarize by reminding students that these remain hypotheses, and also that more than one my have contributed to the extinction of Ice Age mega fauna.

BRINGING IT ALL TOGETHER

From conservation to climate to cloning, topics related to the Ice Age provide excellent opportunities to introduce your students to the challenges facing our society today—and the role scientists play in understanding and shaping our world.

Conserving a Legacy: The Surviving Cousins

The cousins of mammoths and mastodons—elephants—are with us today. But for how long? As human populations expand into once-wild places, elephant populations in Africa and Asia are declining. Scientists are investigating the extinction of mammoths and mastodons to gain insight into the conservation of elephants today. Zoologists, park rangers, and everyday people are working around the world to save the last of the great proboscideans.

The savanna elephant is one of two surviving species of elephant in Africa today. The other is the forest elephant. Savanna elephants travel in matriarchal herds—family groups led by older females. Male elephants leave the herd as teenagers and live mainly solitary lives. In the late 1800s, an estimated five million savanna elephants roamed Africa. Today there are less than half a million, due largely to poaching and diminishing habitat caused by climate change and competition with humans. Savanna elephants are at home in the grasslands of Africa, and wild populations currently survive in southern Africa, eastern Africa, and parts of western Africa. African forest elephants, however, are at home in the tropical and subtropical forests of Africa. Currently, wild populations of forest elephants live in West and Central Africa.

The Asian elephant is the most endangered species of elephant in the world today. Current estimates suggest that only about 30,000 Asian elephants survive worldwide. They are at home in tropical and subtropical forests of southeast Asia, and current wild populations survive in India, Nepal, Bhutan, Bangladesh, Sri Lanka, Myanmar, Thailand, Loas, Cambodia, Vietnam, China, Malaysia and Indonesia.

Is the Ice Age Over? Will It Return?

Scientists have established the fact of cycles, or rhythm, to the advance and retreat of continental ice. As a generality, it appears that ice advances (glacials) last about 100,000 years, and warm periods (interglacials) last about 10,000 years.

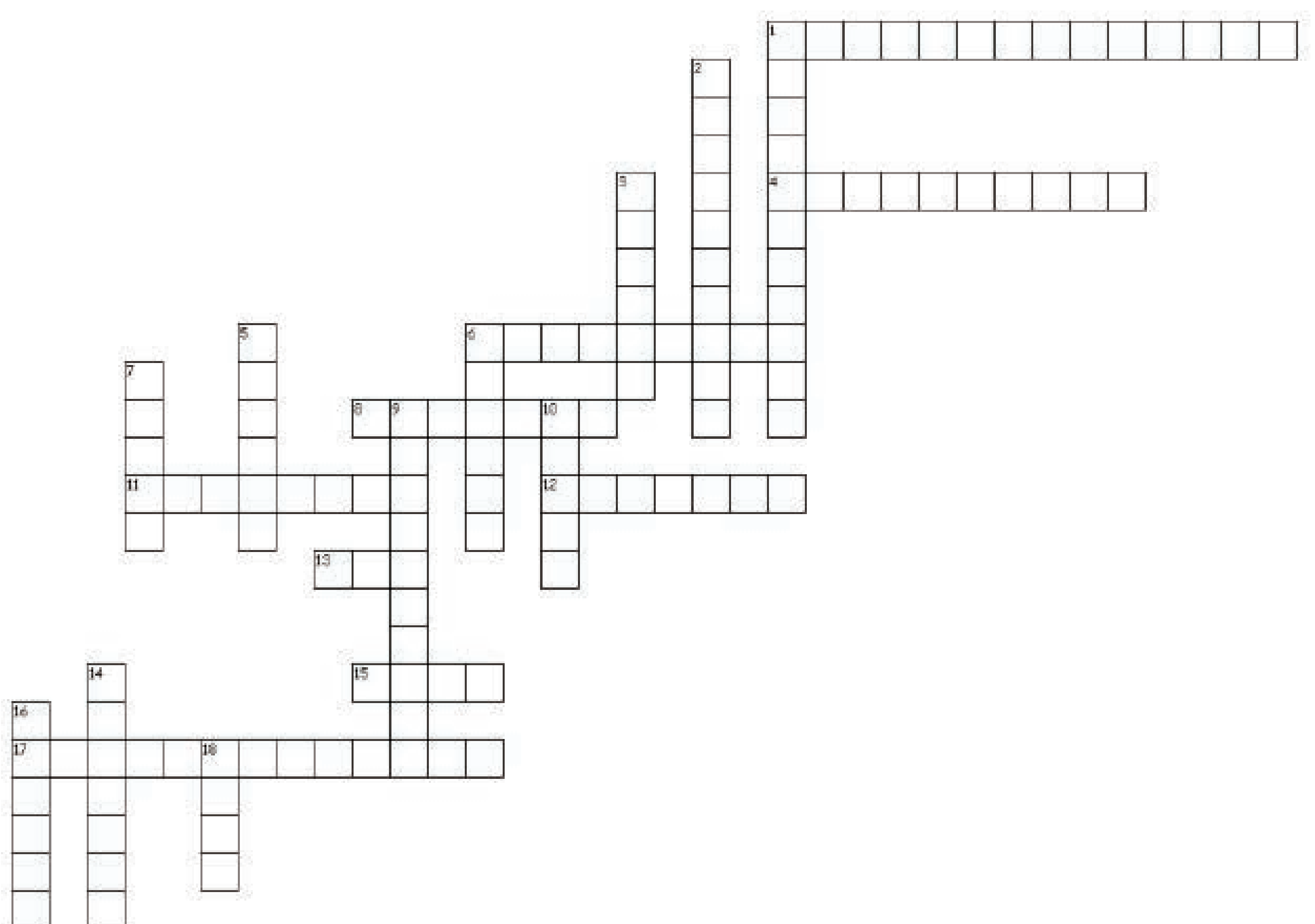
To look at Lyuba is to look back in time. Woolly mammoths—once ***Titans of the Ice Age***—are now extinct, while we, who lived among them, live on. Creatures from our frozen past continue to yield clues about their lives. And the more we learn about their world, the better we understand our own.

Compelling scientific evidence shows us that our climate is changing today. A lesson from our Ice Age ancestors is that human ingenuity and creativity can help us to survive the greatest environmental challenges. The resources section of this guide provides a variety of suggested sites, and materials that help will help you introduce your students to climate science and what we can do to protect our planet.

PUZZLING PLEISTOCENE

A Crossword

Activity #10



ACROSS

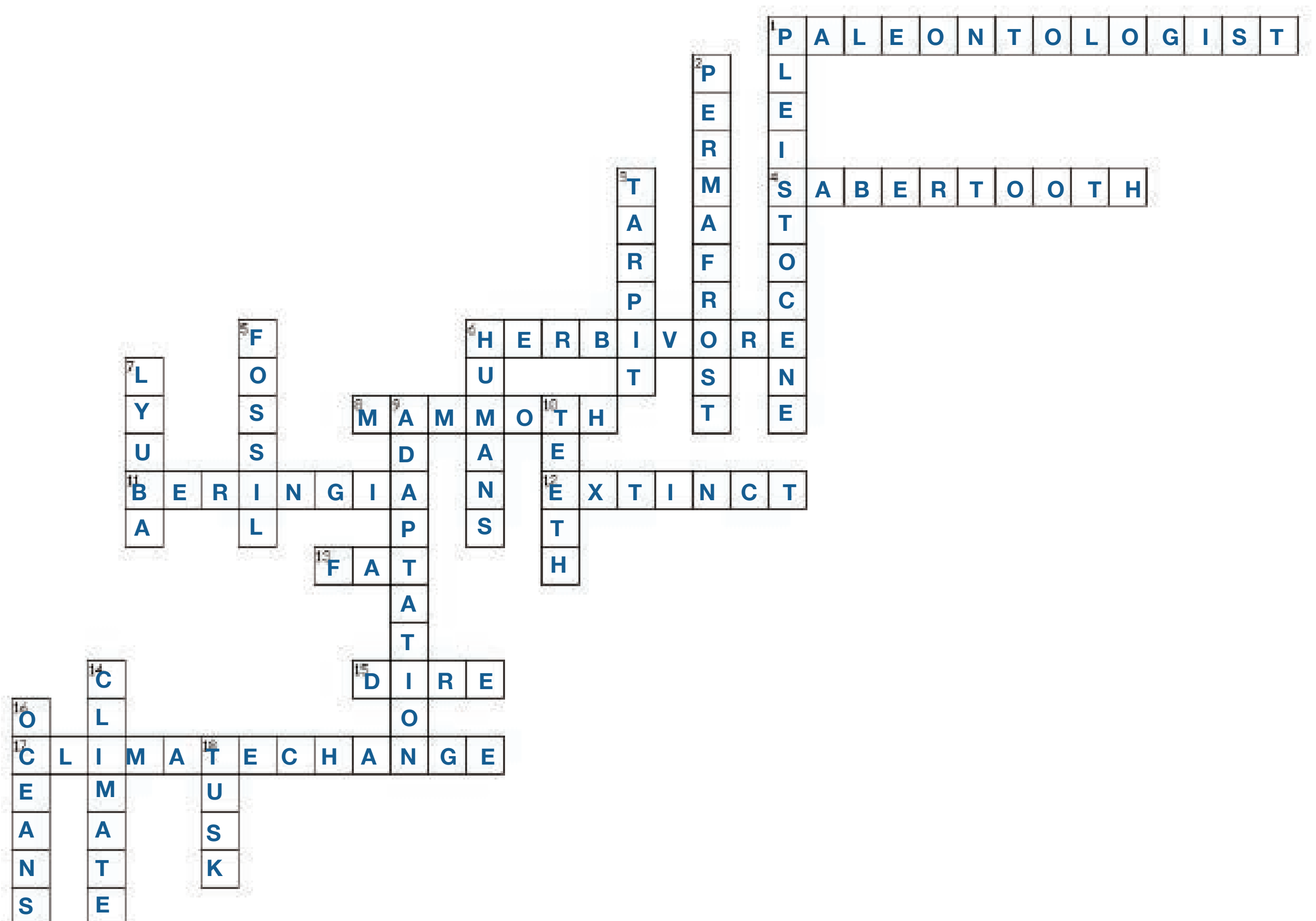
1. scientist that studies fossils
4. large predatory ice age cat
6. plant eater
8. ancient relative of the modern day elephant
11. ancient land bridge now covered by water
12. organism that has died out, no longer found
13. insulating layer beneath mammoth's skin
15. a kind of ice age wolf
17. a likely cause of mammoth extinction

DOWN

1. epoch of most recent ice age
2. permanently frozen layer of soil
3. place where animals are preserved in asphalt
5. preserved form of an ancient organism
6. hunters of mammoths
7. baby mammoth found in Siberia
9. trait that helps an animal survive
10. mammoths had six sets in a lifetime
14. long term weather conditions of an area
16. their levels sank during the ice age
18. mammoth part that has rings like a tree trunk

PUZZLING PLEISTOCENE

Answer Key



ACROSS

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18. mammoth part that has rings like a tree trunk

PLEISTOCENE PANDEMONIUM

So Much to Know!

Activity #11

ACTIVITY DESCRIPTION AND OBJECTIVES:

Students will complete a **mini-research project** by doing research and answering questions on a specific topic related to ***Titans of the Ice Age***. They will present their findings to the class. Students will be introduced to the vocabulary, facts, and issues related to the Pleistocene Epoch. Students will learn that expertise in many areas is necessary to study and understand the Earth's past.

MATERIALS:

• Paper slips, each with a set of mini-topic questions.

• Access to research materials, computers, etc.

PROCEDURE:

a. Prepare paper slips with questions by cutting apart the attached chart.

b. Have students randomly draw questions from a hat or if appropriate, assign them based on difficulty and student ability. Perhaps, students could work in pairs.

c. Allow time to work on questions in class. Finish up as homework.

d. Students will present their findings to the class. Class members are responsible for recording one important fact/idea from each presentation.

e. Summarize by discussing how all of these topics relate to the film, Titans of the Ice Age, and how many areas of science contribute to our understanding of this ancient time.

f. Display student work in the classroom.

g. Optional Homework Assignment: In complete sentences, summarize five things you learned about the Pleistocene Epoch. Be specific and include some details to support your statements.

Aerial photograph. Glaciers terminating inshore of the shoreline of College Fjord. Alaska, Prince William Sound. *Credit: Alaska ShoreZone Program NOAA/NMFS/AKFSC; Courtesy of Mandy Lindeberg, NOAA/NMFS/AKFSC.*

QUESTIONS:

EARTH'S CHANGES	ADAPTATION, SURVIVAL AND EXTINCTION	CLUES TO THE PAST
Explain the difference between weather and climate. 1. What are four factors that contribute to weather? 2. What are three factors that affect climate?	Compare and contrast the dire wolf with the gray wolf. 1. Describe two physical adaptations for each. 2. Describe a behavioral adaptation for each. 3. Name some typical prey for each.	Explain how a mammoth tusk is like a tree trunk. 1. Compare them in terms of size. 2. Compare the appearance of their cross sections. 3. What do the cross sections tell us about the weather conditions during their life times?
What does Earth's orbit have to do with climate change? 1. Draw and describe three characteristics of Earth's orbit that affect climate change. 2. What is the "wobble?" 3. How did these characteristics cause the last Ice Age.	Compare and contrast the saber-toothed cat with the African lion. 1. Describe two physical adaptations for each. 2. Describe a behavioral adaptation for each. 3. Name some typical prey for each.	Define cloning. 1. What animals have scientists successfully cloned? 2. Tell why cloning comes up as a topic of discussion when fossil remains are being studied.
What is the Mammoth Steppe? 1. On a world map, color in the location of the Mammoth Steppe. 2. Describe and give examples of the vegetation. 3. Name five herbivores that ate this vegetation.	Compare and contrast the woolly mammoth with the African elephant. 1. Describe two physical adaptations for each. 2. Describe a behavioral adaptation for each. 3. Name some typical food sources for each.	Define paleontologist. 1. Some paleontologists specialize as scatologists. What do they study? 2. What can we learn from analyzing fossilized dung?
What are greenhouse gases? Name four of them. 1. How are they produced naturally? 2. How do humans contribute to the production of greenhouse gases? 3. How do greenhouse gases affect climate change?	What is meant by the term megafauna? 1. Give four examples of Pleistocene mega fauna. 2. Describe three possible causes of the extinction of Ice Age megafauna.	What are the La Brea tar pits? 1. How did animals meet their death at the tar pits? 2. How were fossils preserved at the tar pits? 3. Name five animals whose remains have been found at the tar pits.
What is Beringia? What is another name for Beringia? 1. Locate Beringia on a map. 2. When and what caused it to form? 3. What is the significance of Beringia in terms of animal and human migration?	Compare a mammoth tooth with a mastodon tooth. 1. Make a sketch of each. 2. How are they alike? Different? 3. What do the teeth tell us about how the diet of the mammoth differed from that of the mastodon.	Why do paleontologists want to visit Hot Springs, South Dakota? 1. How did animals meet their death at the hot springs? 2. Name five animals whose remains have been found in the sink hole at this location. 3. What is the significance of finding both wooly mammoths and Columbian mammoths at this site?
	Draw an example of an Ice Age food chain. 1. What were some typical producers(green plants)? 2. What were some common herbivores? 3. What animals were at the top of the food chain(carnivores)? 4. Did any omnivores live during the Ice Age?	Who Is Lyuba? 1. Where was she found and how was she discovered? 2. Explain why Lyuba is such an amazing discovery. 3. By studying her remains, what have scientists learned about Lyuba and her short life?

CONSIDER A CLONING CONTROVERSY

Activity #12

ACTIVITY DESCRIPTION AND OBJECTIVES:

Students review two articles about using cloning to “revive” extinct species. They will learn about techniques, challenges to the process, and the ethical questions surrounding the process.

MATERIALS:

- Copies of “Bringing Them Back to Life” and “Mammoth’s Genome Pieced Together”
- Consider a Cloning Controversy Worksheets
- Writing tools

LINKS TO ARTICLES:

http://ngm.nationalgeographic.com/2013/04/125-species-revival/zimmer-text

http://news.bbc.co.uk/2/hi/science/nature/7738062.stm

PROCEDURE:

1. Distribute copies of the articles and worksheets to students.
2. Read first half of “Bringing Them Back To Life.” Answer and discuss the questions provided, as a class or in small groups.
3. Read the second article, “Mammoth’s Genome Pieced Together.” Answer and discuss the questions provided, as a class or in small groups.
4. Discuss as a group the different points of view as presented in the articles.

CONSIDER A CLONING CONTROVERSY

Bringing Them Back to Life: National Geographic, April 2013

1. What is meant by de-extinction? ______________________________

2. What is an ethicist? Why would an ethicist be meeting with a group of scientists who are discussing the possibilities of de-extinction? ______________________________

3. Which extinct species can we actually hope to revive? Why would it be impossible to revive a species like Tyrannosaurus Rex?

____

4. How have humans contributed to the extinction of more recent species? ______________________________

5. Explain how de-extinction of mammoths could restore mossy tundra to a more lush grassland. ______________________________

6. Though unlikely, what could scientists do if they were to find a live mammoth cell? ______________________________

7. What are the steps involved in cloning a mammoth? ______________________________

8. What is your opinion on de-extinction? Tell why or why not scientists should try to clone extinct species. ______________________________

9. Extra Credit: Continue reading more of the article and summarize something more that you learned. Be specific. ______________________________

CONSIDER A CLONING CONTROVERSY

Mammoth's Genome Pieced Together: BBC News, November 2008

1. Before reading the article, find the definitions of these words:

   a. Genome: ______________________________

   b. Permafrost: ______________________________

2. From where did scientists find the mammoth DNA they used to analyze its genome? ______________________________

____

3. How does the quality of DNA extracted from hair compare to that extracted from bone? ______________________________

____

4. Compare the genome of the African elephant to that of the mammoth. ______________________________

____

5. How does the size of the mammoth/elephant genome compare to that of humans? ______________________________

____

6. Why do some scientists believe that it will never be possible to clone mammoths, to bring them back from the dead?

____

____

7. Compare the point of view of this article, published in 2008, with the ***National Geographic*** article, **Bringing Them Back to Life,** published in 2013. Which one is more hopeful regarding the cloning process? Why do you suppose this is the case?

____

____

BRINGING THEM BACK TO LIFE

National Geographic, April 2013 Answer Key

1. What is meant by de-extinction?
   Bringing a vanished or extinct species back to life.

2. What is an ethicist? Why would an ethicist be meeting with a group of scientists who are discussing the possibilities of de-extinction?
   An ethicist is a person who is an expert in studying principles of right and wrong. He or she would contribute to the conversation by

3. Which extinct species can we actually hope to revive? Why would it be impossible to revive a species like Tyrannosaurus Rex?
   We can only hope to revive those species that have vanished within the past few tens of thousands of years. Tyrannosaurus Rex became extinct 65 million years ago, and much of its DNA would have decayed by now.

4. How have humans contributed to the extinction of more recent species?
   By over-hunting, habitat destruction, and introduction of diseases.

5. Explain how de-extinction of mammoths could restore mossy tundra to a more lush grassland.
   Mammoths would help to break up the soil, and their manure would fertilize the soil. This would encourage the growth of grass.

6. Though unlikely, what could scientists do if they were to find a live mammoth cell?
   With modern cloning techniques, they could stimulate it to divide, resulting in millions of cells. These could be made to grow into embryos, and then implanted in female elephants. Hopefully, a live mammoth would result.

7. What are the steps involved in cloning a mammoth?
   - **Obtain an intact nucleus from mammoth remains.**
   - **Transfer to elephant egg whose own nucleus has been removed.**
   - **Nucleus takes over cell and starts dividing.**
   - **Develops into an embryo.**
   - **Transfer embryo to elephant uterus.**
   - **Wait for about two years, gestation time in elephants.**

8. What is your opinion on de-extinction? Tell why or why not scientists should try to clone extinct species.

9. Extra Credit: Continue reading more of the article and summarize something more that you learned. Be specific.

MAMMOTH'S GENOME PIECED TOGETHER

BBC News, November 2008 Answer Key

1. Before reading the article, find the definitions of these words:

   a. Genome—**a full set of chromosomes; all of the genetic information possessed by an organism; all of an organism's inheritable traits**

   b. Permafrost—**permanently frozen soil or subsoil**

2. From where did scientists find the mammoth DNA they used to analyze its genome?
   They found it in mammoth hair found on frozen carcasses from Siberia.

3. How does the quality of DNA extracted from hair compare to that extracted from bone?
   The DNA found in bone is often contaminated with DNA from bacteria and fungi. That extracted from hair is more likely to belong only to the mammoth.

4. Compare the genome of the African elephant to that of the mammoth.
   The two genomes differ very little, only by .6%.

5. How does the size of the mammoth/elephant genome compare to that of humans?
   The genome of the mammoth/elephant is about 1.4 times larger than the human genome.

6. Why do some scientists believe that it will never be possible to clone mammoths, to bring them back from the dead?
   DNA deteriorates after an organism's death. It is very difficult to obtain a complete genome. It is difficult distinguish mutation and variation within the DNA from damage to the DNA.

7. Compare the point of view of this article, published in 2008, with the ***National Geographic*** article, **Bringing Them Back to Life,** published in 2013. Which one is more hopeful regarding the cloning process? Why do you suppose this is the case?

CAREER EXPLORATIONS

Activity #13

Bringing a Science Story to Life

ACTIVITY DESCRIPTION AND OBJECTIVES:

By reading interviews of five specific people involved in the production of the movie, ***Titans of the Ice Age,*** students will be introduced to the types of jobs/careers associated with the production of this type of documentary film. This exercise provides the opportunity to consider careers that relate to science in non-traditional ways.

MATERIALS:

- Interviews of five people associated with the production of ***Titans of the Ice Age*** (Career Profiles, page 49–56)
- Poster paper
- Career Explorations Worksheet

PROCEDURE:

1. After viewing ***Titans of the Ice Age,*** ask students to brainstorm all of the tasks that had to be accomplished before the film could be completed. This can be done in small groups or as a large group. Write all of the ideas on the board. Make sure to encourage thinking about the details and minor jobs.
2. Read the interviews provided by five people actually involved in the production of the film. One approach would be to assign one interview to each of five groups. Provide each group with a poster size piece of paper. Have each group summarize the interview by writing the main ideas on the paper: name of person, name of career, what led person to career, education requirements, description of what career involves, exciting things about the job, etc. Each group can then share the career with the class. Discuss and have students tell which career or careers would appeal to them and why.
3. Another approach would be to divide the class into groups of five and have each member read and summarize one of the featured career interviews. These questions could be used as a guide:

   a. Name of person/career

   b. Summarize the interview for the other group members.

   c. How would this person have contributed to ***Titans of the Ice Age***?

   d. Was there anything that surprised you about this person's experiences?

Share the information within each group and then discuss: of the five careers, which do you think you would most enjoy doing? Why?

CAREER EXPLORATIONS

interview with Aisling Farrell

What is the name of your job/career?

In the USA I am the collections manager at the Page Museum at the Rancho La Brea tar pits. In Europe I would be referred to as the curator.

If you were to write a job description for yourself, what would be the two or three most important things that you do?

I oversee one of the largest collections of late Pleistocene fossils in the world, as well as manage the day-to-day excavation of Project 23, which includes 16 new fossil deposits found during construction of an underground parking garage in Los Angeles. My most important responsibilities are to organize, multi-task, collaborate, and pay attention to detail.

When did you first become interested in this job/career? Explain what inspired your interest?

I spent most of my childhood outside. I have always been interested in collecting things, the natural world, scrapbooking and documenting. I also spent a huge amount of time reading ***National Geographic*** magazines. When I was a child I visited the American Museum in New York and was mesmerized.

What kinds of training, experience, and education qualified you to have this job/career?

I have an undergraduate degree in Earth Science and a Master's degree in Systematics. I spent over a year volunteering in various departments at Natural History Museums after my degree. I have also worked in the Education Department and as a Curatorial Assistant for the Dinosaur Institute at the Natural History Museum of Los Angeles County where I led expeditions and curated Mesozoic specimens.

How would you describe an ordinary day on the job? What sorts of things do you do?

I have quite a wide variety of daily 'to do's! We are excavating fossils 7 days a week from a large salvage project at the moment, which I oversee. I also identify fossils, catalog them, and add the catalog information to a database. I answer questions from researchers or our education department about the collections, I train and supervise volunteers in curatorial duties, I arrange for specimens to be either returned or sent out on loan for research and keep up with current research in the Pleistocene. We are also attempting to capture all of our cataloged records over the past 100 years on a database.

How would you describe an extraordinary day, an exciting day, on the job? What kinds of things might happen?

The most exciting would probably be uncovering an unusual fossil and then trying to figure out what it is! I love to follow clues, cross-reference data and solve little mysteries!

If a middle or high school student would tell you that they want to pursue a career like yours, what advice would you give them?

I would suggest a whole lot of reading and a degree in one of the earth sciences preferably. I would also suggest that they contact their local museum and see if they can volunteer. Hands on experience and networking with people in the field are invaluable.

Read an article about Dr. Farrell online:

Farrell Career Article: www.gsfd3d.com/TOTIAFarrellArticle

CAREER EXPLORATIONS

interview with David Clark

What is the name of your job/career?

I am a documentary filmmaker. My jobs include producing, directing and writing movies that you might see on cable TV, PBS, or in an IMAX or Digital 3D theater.

If you were to write a job description for yourself, what would be the two or three most important things that you do?

Perhaps the most important job I have is to come up with interesting ideas of what to make films about. The topics need to be ones that audiences want to watch, and broadcasters or investors are willing to pay for. Equally important is actually making the film, which must be to the highest professional standards, that is visually exciting, and succeeds in communicating that original idea that started the whole process.

When did you first become interested in this job/career? Explain what inspired your interest?

When I was young I was always interested in reading non-fiction books—topics about real people, places and events. I was also interested in visual arts like photography and video. I think these interests drove me to become a documentary filmmaker. And then when I started my career I quickly realized that this is what I love to do, and eventually became successful at it.

What kinds of training, experience, and education qualified you to have this job/career?

I think my most basic qualification for what I do has been my lifelong interest in the world around me. I have always been interested in learning about new places, past adventures, history, and science topics. I attended New York University Film School and learned about film theory, history, and writing, and got lots of hands on training with equipment, and the opportunity to actually make movies with my fellow classmates. Early in my career I worked closely with an older, experienced filmmaker who became a mentor to me. I learned a lot about the craft of film by working with this mentor and observing what he did.

How would you describe an ordinary day on the job? What sorts of things do you do?

I would say there is no ordinary day in filmmaking. There are so many aspects to it and each of them is interesting and challenging in its own way. Weeks and sometimes months are spent researching and writing a film idea. Then usually many months and sometimes a year or more is spent during the actual filming and editing. So an "ordinary day" could be anything from sitting at my desk reading and writing, to traveling to the ends of the earth—sometimes in boats, planes, submarines, or other unusual conveyances.

> *"Extraordinary moments can happen at any phase of making a film."*
>
> David Clark

How would you describe an extraordinary day, an exciting day, on the job? What kinds of things might happen?

Extraordinary moments can happen at any phase of making a film. When you are out in the field, filming, you might capture some incredible event or dramatic action. Sometimes the satisfaction comes from filming what you intended to, but sometimes the excitement comes from capturing something totally unexpected. Special moments can also happen during the editing process, when a certain edit, or piece of music, or animation suddenly really clicks and communicates your story in a way you hadn't planned. I think the unpredictable nature of filmmaking is exciting and never knowing when, where, or how those magical moments are going to happen.

If a middle or high school student would tell you that they want to pursue a career like yours, what advice would you give them?

I would tell aspiring filmmakers to immerse themselves in the medium. Watch a lot of films, read about them, and think about how they affected you. Then go out and make your own movies. You can make a film with a smart phone or inexpensive camera and a laptop these days.

Going to film school is one option for learning about filmmaking tools and the process of making films. But getting an overall education is equally important. The next step is getting into the industry, usually be interning first, or getting an entry-level job. There are so many aspects to filmmaking that it may take a while to determine what you like best, whether it be writing, producing, doing one of the technical crafts like photography or editing, etc. Try to get exposed to all the fields and you will find out which appeals to you the most.

But the most important advice is to pursue something that you love and are passionate about. And equally important is to be patient and persistent. Those who ultimately succeed are those who try the hardest and keep trying.

CAREER EXPLORATIONS

interview with Andy Wood

What is the name of your job/career?

I am a Senior Vice President at Giant Screen Films and Producer of 3D documentary films.

If you were to write a job description for yourself, what would be the two or three most important things that you do?

My job involves bringing all of the filmmaking talent together for a project. I will hire the director and visual effects teams, the composers, the photographers, the sound designers, etc. I then supervise the production so that it is delivered on time and on budget. I also work closely with the many advisors on each show. This is one of the most exciting things about my job: working with all of the top scientists in the field. Finally, when the movie is finished, I help to promote the film to audiences all over the world. It is very gratifying to know that my films are inspiring young people to learn more about this fascinating planet.

When did you first become interested in this job/career?

When I was very young, I wanted to be a biologist. I loved animals and the natural world. My parents would encourage me to explore nature and I loved going to the zoo and natural history museums. But I also loved art: drawing, music, and filmmaking. In middle school, my friends and I spent countless hours videotaping each other skateboarding, which is what started my interest in film. The challenge was that I wanted to pursue all my passions as a career. While there are not many careers that combine both art and biology, I feel that my job delivers exactly what I had dreamed.

What kinds of training, experience, and education qualified you to have this job/career?

When I went to college, I decided to pursue biology at the University of Wisconsin - Madison, specifically a degree in zoology with an emphasis on field research and animal behavior (Ethology). After a couple years, I felt something was missing and decided to augment my science degree with a few classes in film production. While two degrees was a lot of work, it ended up being precisely what I was looking for—the perfect mix of art and science. I knew that someday I wanted to direct or produce wildlife films and my degrees would give me the tools to follow this dream. After college, I started a job at the Franklin Institute in Philadelphia, where I oversaw the programming for the IMAX theater and planetarium. In this role, I was able to start working with IMAX film producers on various projects. It also gave me a very good sense for what documentary film viewers liked to see and how to best communicate science concepts to a broader audience. After a few years, I left the museum to work directly for one of my producing partners, Giant Screen Films.

How would you describe an ordinary day on the job? What sorts of things do you do?

Many of my days are spent working at an office, preparing for the next film production. There are many people and ideas involved in such an undertaking and my job is to glue them all together. This means lots of phone calls and emails. Partnerships are the key to a successful project, so I spend much of my time exploring new partnerships and conducting audience research on possible film ideas. Once we have a film funded and all of the partnerships in place, my job changes for awhile. Much more of my time is spent focusing on the film production, which can mean traveling to the film shoots, sometimes in faraway places. The actual shooting and editing phase is the most fun. This is the reward for having worked very hard at my desk the rest of the year…and for having stayed committed to my dreams going all the way back to childhood.

> *"I feel that my job delivers exactly what I had dreamed."*
>
> Andy Wood

How would you describe an extraordinary day, an exciting day, on the job? What kinds of things might happen?

In addition to biology and filmmaking, I love world travel. This job allows me to travel to beautiful places and experience new cultures while in production. So, really, I am fulfilling THREE passions together. The most exciting days for me are to be on location for a film shoot, or scouting for possible shooting locations. As producer, it is important that I strive to become very knowledgeable on the film subject so that every fact in the script, every location is scientifically accurate and ethically captured. Working with world-renowned academic advisory teams is key. It is very rewarding for me to spend time immersed in their world for awhile, vicariously becoming a specialist in their field. So my extraordinary day is when I see it all coming together on a film shoot. Looking through the camera, I can see the vision of the creative team and the science advisory teams becoming a reality.

If a middle or high school student would tell you that they want to pursue a career like yours, what advice would you give them?

A passion for science is very important if you aim to produce science documentaries. But just as important is a commitment to understanding film technology, storytelling and art. My degrees are in zoology and film theory. Understanding science and filmmaking theory (history, technique, and story structure) has served me very well. Production technology and shooting instincts, on the other hand, was something that I learned primarily from my own experience, making skateboarding videos in middle school to volunteering for film shoots throughout college. Business experience is very important as well. There are many people that I see trying to break into this industry that are good at production or science but lack business savvy and experience. I recommend that everyone spend some time working to understand the underlying business skills necessary to be successful. Master spreadsheets, budgets, business writing, negotiating skills, marketing and market research techniques. Finally, learn everything you can about the industry. Become a documentary fanatic—watch all kinds of docs: old ones, new ones, good ones, bad ones. Get engaged – attend film festivals, join a film club, go to talks, meet people. I would attribute all of this to the success I've had in my career.

CAREER EXPLORATIONS

interview with Daniel Fisher

What is the name of your job/career?

Paleontologist/Professor, Museum Curator

If you were to write a job description for yourself, what would be the two or three most important things that you do?

Discover and interpret fossil specimens; teach and inspire the next generation of natural scientists

When did you first become interested in this job/career? Explain what inspired your interest?

I became interested in rocks and fossils in early grade school, mainly because I learned that they could tell us about the remote history of the earth and life on it. I became even more committed to paleontology in high school, through a biology teacher who took students to collect fossils in the Mohave Desert. I loved the sense of freedom and exploration that came with living and working in remote areas and the excitement of finding new fossil material.

"It is the prospect of new insights into history and the way our world works that most energizes us."

Daniel Fisher

What kinds of training, experience, and education qualified you to have this job/career?

This career requires broad training in all of the physical and life sciences, and mathematics, as it is one of the most interdisciplinary of fields. Field work experience also makes a difference, and formal education including graduate training through the Ph.D. is almost essential.

How would you describe an ordinary day on the job? What sorts of things do you do?

An ordinary day would probably be on-campus at the university where I teach, preparing and giving a lecture to students, working in my laboratory on fossil specimens and supervising student workers, plus probably going to some meetings or handling administrative duties that inevitably come with the position. Days are almost always busy and challenging, but with the chance of new discoveries and developments, as well as generally gratifying interactions with colleagues.

How would you describe an extraordinary day, an exciting day, on the job? What kinds of things might happen?

An exciting day on campus would involve some discovery of a new way to get information about ancient life from fossil material, or finding that some new source of information helps to answer questions that have puzzled scientists for years, decades, or even centuries. An exciting day in the field would mean the discovery of a spectacular specimen, such as the frozen body of a mammoth. Again, it is the prospect of new insights into history and the way our world works that most energizes us.

If a middle or high school student would tell you that they want to pursue a career like yours, what advice would you give them?

I would warn them that this career requires extraordinary commitment, but can be extraordinarily rewarding (in a non-monetary fashion). They would need to seek broad training and be willing to be flexible in seeking employment, but there is an opportunity to contribute significantly to our understanding of the world.

Learn more about Dr. Fisher's work here:

http://www.lsa.umich.edu/paleontology/research/danielfisher

CAREER EXPLORATIONS

interview with Nathalie Girard

What is the name of your job/career?

Digital Compositing Supervisor

If you were to write a job description for yourself, what would be the two or three most important things that you do?

Digital compositing is the process of digitally assembling multiple images to make a final image, typically for motion picture, television series, advertising and many more. Compositing often also includes scaling, retouching and color correction of images.

In my job, that means integration of the computer imagery with film backgrounds—in the case of , my job was to take the computer generated animals (like the mammoths and giant sloth) and integrate those images with the real footage of grassland, caves etc., so that they appeared to be in their real environments and part of the natural world. To do this well, it's my job to create the illusion that all those elements are parts of the same scene. This makes the experience of special effects to the viewer more seamless and enjoyable.

When did you first become interested in this job/career? Explain what inspired your interest?

At a very young age, I saw ***Star Wars Episode 4*** (1977) in the theater. The movie was an inspiration to work behind the scenes and create special effects on feature films. At that time I was too young to know what was the path to get that kind of job, but finally found my way to work on ***Star Wars Episode 3*** and even played in it.

After getting my college degree, I worked for a while in graphic design, but never felt accomplished. In Montreal the National Animation and Design Centre had just opened its doors, so I decided to back to school and take the plunge to pursue my dream to work on great visual effects for movies.

What kinds of training, experience, and education qualified you to have this job/career?

In 1995 I got my college degree in Program Design Presentation. This was a 3-year degree that offered technical training for careers that use creativity, aesthetic sense and manual skills to promote products or services. Art and photography classes helped me sharpen my skill in colors and image composition.

My degree program emphasized collaboration between the design community and concrete projects. Real world on the job training was offered in fashion (and magazine advertising), graphic design, display-window, event decor, set design, creating accessories and exhibition stands.

In 1997 I studied at the National Animation and Design Center, a school specifically created to learn all the steps on creating computer generated imagery. I graduated in the film and television program. The classes covered all the basics for creating special effects and being able to get a job in the industry. It one of Canada's major training centres for new technologies and new media. It offers innovative and comprehensive training programs, using the latest software, beginning with 3D Animation, lighting and rendering, compositing and post production.

After a few years working in Montreal, I decided to take a chance and got to California where the real magic happens. I worked for many years for LucasDigital at Industrial Light and Magic, where I got all of my best experiences, training and

"Aim high, don't be scared to take chances...reach for the stars!"

Nathalie Girard

know how. I gained experience on all kinds of different projects, from traditional visual effects movies, to full computer animated features, to 3D feature films and finally Disney and Universal Studios theme park rides.

How would you describe an ordinary day on the job? What sorts of things do you do?

- I look at a huge amount of images.
- I perfect and make constant tweaks to shots in production.
- I read the latest tech updates in the industry on any software that we use in production.
- I create research and development projects to perfect my skills.
- I meet new clients.
- I evaluate potential new projects.

How would you describe an extraordinary day, an exciting day, on the job? What kinds of things might happen?

- We might discover new technical issues that can appear on a shot or on a new project.
- I enjoy being creative and using all of my skills to solve these new problems.
- It's also very rewarding to originate new effects and see the great imagery I've used my artistic vision and technical skill to develop.
- It's great to find time to deepen and explore new frontiers with all the tools that we use in production.
- I also really enjoy teamwork, putting our heads together to perfect our pipeline.

If a middle or high school student would tell you that they want to pursue a career like yours, what advice would you give them?

Get the appropriate degree in a good computer graphics school. Work hard, putting in the hours to get the best knowledge and experiences. Have a mentor, listen to your supervisor for any advice and comments that you get in production. Aim high, don't be scared to take chances...reach for the stars! Any challenge is as important as the next one. No matter what the project is, give it all that you've got to have a great product. Make the client happy and make them want to come back. Teamwork, teamwork, teamwork. Keep smiling and have fun doing this great great job.

Watch a reel of Nathalie's work here:

http://vimeo.com/69630303
password: nathalie2003to2011

CAREER EXPLORATION WORKSHEET

For Group Discussion

NAME OF PERSON BEING INTERVIEWED ____

Summarize the interview for the other group members. How would this person have contributed to ***Titans of the Ice Age***? Was there anything that surprised you about this person's experiences?

Of the five careers you've discussed, which do you think you would have most enjoyed doing? Why?

Having read the interview for that career, what other questions would you like to ask that professional? Write 4.

Share your thoughts with your group or with the rest of the class.

ADDITIONAL RESOURCES

ONLINE RESOURCES

The Field Museum's *Mammoths and Mastodons* Web site:
fieldmuseum.org/mammoths

The Encyclopedia of Life:

education.eol.org/educators/mammoths_mastodons

The Encyclopedia of Life (EOL) *Mammoths and Mastodons* species pages will feature new fossil photographs from The Field Museum Collections accompanied by reliable and comprehensive species descriptions. These and related pages can be used as a way for your students to learn and share their knowledge about the animals and plants of the Pleistocene Epoch. Visit EOL to find activities that engage your students in learning about Pleistocene biodiversity and ecosystems. There are a wide range of activities for students of different ages and abilities that can be used for quick reinforcement or as a long-term project. Activities include: adding information about Pleistocene species to the EOL and uploading original artwork of Mammoths and Mastodons based on the featured fossil photographs. Your students will not only enjoy learning about Mammoths and Mastodons, but also help build the Encyclopedia of Life!

University of Michigan – Museum of Paleontology:
paleontology.lsa.umich.edu/

The Mammoth Site:
https://www.mammothsite.com/#

La Brea Tar Pits:
www.tarpits.org

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