



EXTREME MAMMALS

THE **BIGGEST, SMALLEST, AND MOST AMAZING MAMMALS** OF ALL TIME

EDUCATOR'S GUIDE

amnh.org/education/extrememammals



INSIDE:

- Suggestions to Help You **Come Prepared**
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ESSENTIAL QUESTIONS

This exhibition uses both living and extinct mammals to trace the ancestry and evolution of this remarkable group of animals. It's a story full of surprises, with quite a cast of characters.

What is a mammal?

You might have grown up thinking that all **mammals** share certain traits, like fur and giving birth to live young – and most living mammals do. But some are hairless, like the river dolphin, while a few others, like the echidna, or spiny anteater, lay eggs. So what defines this diverse group of animals? They all are descended from a common ancestor shared with no other living animals. Mammals can look radically different from each other, but the underlying body plan is still strikingly similar.

What's “normal” for mammals?

The terms “extreme” and “normal” are relative, of course. In mammals, one way to define normal is in terms of traits that are inherited from ancestors, such as producing milk, warm-bloodedness, and four limbs for walking, or **quadrupedalism**. Another way to think about “normal” is what is typically observed in the group. For example, today the typical mammal weighs about one pound, although for most of their history they were generally even smaller. All mammals have both normal and extreme, sometimes unique, features.

How and why are some mammals “extreme”?

As **species** evolve over time, “extreme” traits can arise: **characteristics** that differ widely from those found in ancestors or from the most common condition. Examples include the tiny brain of the extinct, two-ton *Uintatherium*; the bipedal hopping of kangaroos; or the venom of species of *Solenodon*, large shrew-like mammals. Humans also have a mix of both normal traits inherited from early ancestors (we're warm blooded and have differentiated teeth and five fingers and toes) and specialized extreme features (upright **bipedalism**, and big brains relative to our body size).



The six-banded armadillo is almost completely covered by bony, keratin-capped armor plates.

How have mammals evolved in response to changing environments?

As environments change over time, living things must adapt or go extinct. Different traits are favored in different habitats and are passed on to future generations. For example, when various groups of mammals invaded the sea, adaptations like blubber and flippers – which are modified limbs – helped them survive. Gargantuan blue whales can grow far larger than any land animal because water helps support their bulk. Their ancestors lost their teeth but evolved baleen in the upper jaw: rows of flexible plates made of **keratin** that help them capture vast amounts of small crustaceans. Tails also evolved a wide array of forms to help mammals swim, balance, grasp tree limbs, or keep warm.

How have extreme or specialized traits helped mammals adapt and survive?

Over millions of years, every part of the mammalian body was shaped and reshaped through **evolution**, from snout to tail. Sometimes remarkable in form, these adaptations conferred evolutionary advantages, like the extremely long premolars of the extinct marsupial *Thylacoleo carnifex* or rodents' sharp incisors, which never stop growing. **Echolocation** evolved independently in a few specialized groups, including bats, cetaceans (dolphins and whales), and subterranean shrews. Evolving big brains relative to body size distinguishes mammals from other vertebrates, and humans from all other mammals. Much of the increase occurs in the cerebrum, the part of the brain largely associated with thought, memory, most senses, and information processing. Some of the most remarkable adaptations occurred when mammals evolved in isolated areas.

How do scientists study mammals?

Scientists observe mammals in their environments, and analyze modern and **fossil** specimens back in the laboratory. Combining physical and genetic data helps scientists recognize the relationships between species. Today, nearly 25 percent of living mammal species are threatened with **extinction**, even as new species are still being discovered. Scientists find them by exploring – and helping to protect – remote ecosystems in the ongoing quest to learn more about life on Earth.



USEFUL CONCEPTS

Natural Selection and Adaptation

Individuals inherit traits, or features, from their parents. Those members of a species with traits that help them survive in a particular environment — like the sharp, piercing canines and slicing molars of **carnivores** versus the flat grinding teeth of mammals that eat tough grasses — pass on these characteristics. Generation after generation, individuals with the advantageous trait, or **adaptation**, will survive longer and produce more offspring, until most or even all members of the species possess it. Called **natural selection**, this is an important mechanism of evolution.

Convergent Evolution

This refers to situations in which different groups evolve similar adaptations because they live in similar environments. These species may even live on different continents and be far apart on their family trees. For example, high-crowned grinding teeth for chewing tough grasses have evolved independently in a diverse suite of mammals, including bison, horses, elephants, some rodents, and many extinct mammal groups.

Mammal Reproduction

The ancestor of all mammals almost certainly laid eggs, as do most vertebrates and a tiny minority of living mammals, the **monotremes** — like the platypus and echidnas of Australia and New Guinea. But the vast majority of modern mammals are **placentals**. They've evolved to give live birth to babies that are nourished for a long time inside the mother's body, using an organ called a placenta. A few hundred other living species (and many more fossil forms), like koalas and kangaroos, are **marsupials**; their young are born very immature and much of their development occurs while drinking milk, typically inside a pouch on their mother's belly. The group Mammalia is named for mammary glands, which produce milk — as all mammal species do.



Koala, a marsupial

Come Prepared

Before your visit, review the **Essential Questions** to see how the exhibition's educational themes connect to your curriculum. Identify what you'd like your students to learn from **Extreme Mammals**, and how they could continue learning back in the classroom. Visit the *Extreme Mammals* website at amnh.org/extrememammals and thestoryoftexas.com/extrememammals/ to learn more about the exhibition.

This Guide includes **Activities** for **Before You Visit**, **During Your Visit**, and **Back in the Classroom**, and **Student Worksheets**. These activities are designed to be used together to focus your visit around one or two themes. Here are some other ways to explore the *Extreme Mammals* exhibition:

- You (and your class chaperones) can use the **Teaching in the Exhibition** section of this guide as you move through the gallery with students.
- You can create student worksheets using the **Teaching in the Exhibition** section.
- You can distribute copies of the **Map of the Exhibition** to chaperones and/or students, and let them choose their own paths.

Visit thestoryoftexas.com/extrememammals/ for:

- information on field trips, reservations, and other useful tips to help plan your visit
- free resources, including activities and references

Correlation to the Texas Essential Knowledge and Skills (TEKS)

Your visit to the *Extreme Mammals* exhibition can be correlated to the following Science TEKS:

- (K.10.A) Sort plants and animals into groups based on physical characteristics such as color, size, body covering, or leaf shape.
- (1.10.A) Investigate how the external characteristics of an animal are related to where it lives, how it moves, and what it eats.
- (2.10.A) Observe, record, and compare how the physical characteristics and behaviors of animals help them meet their basic needs such as fins help fish move and balance in the water.
- (3.10.A) Explore how structures and functions of plants and animals allow them to survive in a particular environment.

Continued

Correlation to the Texas Essential Knowledge and Skills (TEKS)

- (4.10.A)** Explore how adaptations enable organisms to survive in their environment such as comparing birds' beaks and leaves on plants.
- (5.10.A)** Compare the structures and functions of different species that help them live and survive such as hooves on prairie animals or webbed feet in aquatic animals.
- (7.11.C)** Identify some changes in genetic traits that have occurred over several generations through natural selection and selective breeding such as the Galapagos Medium Ground Finch (*Geospiza fortis*) or domestic animals.
- (7.12.A)** Investigate and explain how internal structures of organisms have adaptations that allow specific functions such as gills in fish, hollow bones in birds, or xylem in plants.
- (8.11C)** Explore how short- and long-term environmental changes affect organisms and traits in subsequent populations.
- (Biology.7)** The student knows evolutionary theory is a scientific explanation for the unity and diversity of life.
- (Biology.8.B)** Categorize organisms using a hierarchical classification system based on similarities and differences shared among groups.

TEACHING IN THE EXHIBITION

The *Extreme Mammals* exhibition uses fossils, models, live animals, interactives, videos, and more to engage individuals with all learning styles. This guide divides the exhibition into ten areas, which are indicated on the map and described below.

1. Introduction

Overview: Living and fossil mammals exhibit a huge range of shapes and sizes.

Exploration:

- **Animal models:** Have students compare and contrast these life-size models of the largest land mammal and the smallest mammal that have ever lived. Point out that despite all the differences, we're all mammals.

Guiding Questions:

- What do the largest and the smallest mammals have in common with each other? With humans?

2. What is a Mammal?

Overview: Mammals are defined by common ancestry, not by physical characteristics – although inherited traits do help us recognize relationships between mammals.

Exploration:

- **Video:** Encourage your students to watch the video, focusing on the traits shared by living mammals.

- **Skulls:** These show how specialized teeth and skull anatomy evolved in the ancestors of mammals. Ask students to compare the skulls and how they've changed over millions of years.

This opening on the skull of synapsids, like *Cynognathus* (below) and mammals, show that they are related.



- **Cladogram:** The wall-size evolutionary tree shows where mammals fit in the tree of life and how all mammals have evolved from a common ancestor. Point out the many branches. Ask students what this shows about mammal evolution.

Guiding Questions:

- Most living mammals have certain traits in common. Why? What are they?
- How do scientists determine what a mammal is?

3. What is Extreme?

Overview: "Extreme" traits differ widely from those found in ancestors, or from the most common, typical, or "normal" form at any moment in time. Most mammals possess a combination of extreme and normal features.

Exploration:

- **Human, *Uintatherium*, and opossum skeletons:**

Ask students to distinguish between normal and extreme characteristics in each of these species.

Guiding Questions:

- What are some examples of extreme and normal characteristics in these three mammals?
- Are humans extreme or normal? Why?

4. Head to Tail: Heads

Overview: Mammalian bodies have been modified by evolution. Some of these changes are found in the head.

Exploration:

- **"Headgear" and skulls of living and extinct mammals:** Point out to students that headgear can be formed from teeth, bones, and even hair. Ask them how horns and antlers are similar, and different.
- **Skulls with teeth:** Invite students to compare and contrast the different types of mammal teeth, and to use the mirror to compare them to their own teeth.

Guiding Questions:

- What are different kinds of teeth used for?
- What are some of the functions of headgear?

5. Head to Tail: Reproduction

Overview: Reproduction is one of the main features that differentiates the three living groups of mammals: placentals, marsupials, and monotremes. (See "Useful Concepts.")

Exploration:

- **Taxidermy and fossil specimens:** Invite students to examine these specimens, as well as the video, and explore how each of these groups gives birth.

Guiding Questions:

- How do different types of mammalian mothers care for their young?
- How do the gestation periods for each of the three major groups compare? What are some of the benefits of a long pregnancy? The drawbacks?

6. Head to Tail: Bodies

Overview: All mammals share a common body plan, but evolution has resulted in astonishing variations on the arrangement of bones, muscles, and skin.

Exploration:

- **Glyptodont armor:** Students can “try on” the model and imagine having this much armor. Ask how it might compare to having spines or scales.
- **Hair and fur:** Point out that hair, horns, scales, hooves, and fingernails are all made of the same material, keratin. Invite students to touch and explore the specimens.

Guiding Questions:

- What are the various functions of hair and fur?
- How do different body coverings benefit mammals? How do these coverings relate to environmental conditions?
- Which would you rather have, venom or armor? Why?

7. Mammals in Motion

Overview: Ancestral mammals lived on land. Some groups of mammals later adapted to move through other environments like the sky and the ocean.

Exploration:

- **Walking whale model:**

Explain that like most other mammals, all whales are descended from an ancestor with four limbs and feet. Ask students whether *Ambulocetus* lived in water or on land, and to support their answers.



Ambulocetus, an amphibious early whale with legs, probably hunted small mammals much as today's crocodiles do.

- **“Lucy” pelvis:** Look closely at the diagram comparing “Lucy’s” pelvis with those of chimpanzees and humans. Ask students how these mammals moved, and how human locomotion is unique.
- **Bats, flying squirrel, and Mesozoic gliding mammal:** Have students note the similarities between the bat wing and their own arm. Ask them to compare bat flight to the gliding of the squirrel or the Mesozoic mammal (*Volaticotherium*).

Guiding Questions:

- How do most mammal bipeds (those that walk on two legs) get around?
- Many groups of mammals evolved to live in water. How did their bodies change?

8. Extreme Climates

Overview: Environments change with time, and so do the mammals that inhabit them.

Exploration:

- **Diorama of the Eocene and Images of Today:**

Ask students to compare conditions on Ellesmere Island 50 million years ago to those today.

Guiding Questions:

- How are the mammals in each scene adapted to their environment?
- What are some of the ways in which major climate change has affected mammal diversity?

9. Extreme Isolation

Overview: When mammals are geographically isolated, they can evolve extreme traits or can come to resemble unrelated species elsewhere. (See “Useful Concepts.”)

Exploration:

- **Monkey skull:** Have students read the displays, and ask them to explain how the skull solved the puzzle of how and when monkeys reached South America.
- **Scarrittia case:** Point out that these South American species all belong to the same group, and resemble a wide range of groups found on other continents.

Guiding Questions:

- What kinds of extreme forms have evolved in places that once were isolated?
- Why is isolation so important in the origin of different, distinctive, and “extreme” forms?

10. Extreme Extinction

Overview: Although sometimes rapid, and affecting vast numbers of species, extinctions are part of the history of life. One mammal, *Homo sapiens*, is contributing to what may become the next mass extinction (the “Sixth Extinction”).

Exploration:

- **La Brea Tar Pits walk-through display:** These mammals are only 11,000 years old, but all are extinct. What does this tell us about how fast extinction can occur? How does it affect species diversity?
- **Tasmanian wolf specimen:** Ask students to think about what is unusual about this marsupial.

Guiding Questions:

- What human activities contribute to extinction?
- How can preserving existing habitats slow extinction rates and lead to the discovery of new species?

ONLINE RESOURCES

Abundant online resources for grades K-12 are available through the Museum's Education site (amnh.org/education/resources) and the Bullock Texas State History Museum (thestoryoftexas.com/extrememammals/).

- **Extreme Mammals Exhibition:** amnh.org/extrememammals

(Grades K-12)

This online version of the exhibition highlights extreme mammals, fun facts, and videos.

- **Extreme Mammals for Educators:**
amnh.org/education/extrememammals

(Grades K-12)

This site provides resources related to *Extreme Mammals* that can be used across all grade levels. Additional resources are provided by the American Museum of Natural History, Scholastic Science, the Smithsonian, and National Geographic.

- **Zoology OLogy:** amnh.org/explore/ology/zoology

(Grades 3-5)

This site gives younger students the chance to explore big ideas about mammals and other animals through games, puzzles, and interactives. They can examine how six cool mammals move, explore the *Extreme Mammal* photo gallery, use masks to compare their teeth to those of different mammals, and make a moving-mammal flip book.

- **Science Bulletins:** amnh.org/explore/science-bulletins

(Grades 6-12)

Videos, interactives, and essays introduce middle- and high-school students to biologists and conservationists who study mammals around the world. Learn about the greening of the arctic, the benefit dung beetles provide to the environment, and why scientists are growing miniature brains.

FUN FACTS

- There are more than **5,400 species** of mammals living today!
- **Batodonoides** is the smallest mammal that ever lived. It weighed as much as a dollar bill.
- The **blue whale** is the largest animal – mammal or otherwise – ever known. It can grow to nearly 200 tons (400,000 pounds)!
- **Humans** are extreme in many ways: large brains, upright locomotion, and sparse body hair.
- The placid-looking male **platypus** has a secret weapon: spurs on its hindfeet that deliver toxic venom!
- **Koalas** are not bears. They're marsupials and are more closely related to kangaroos.

CREDITS

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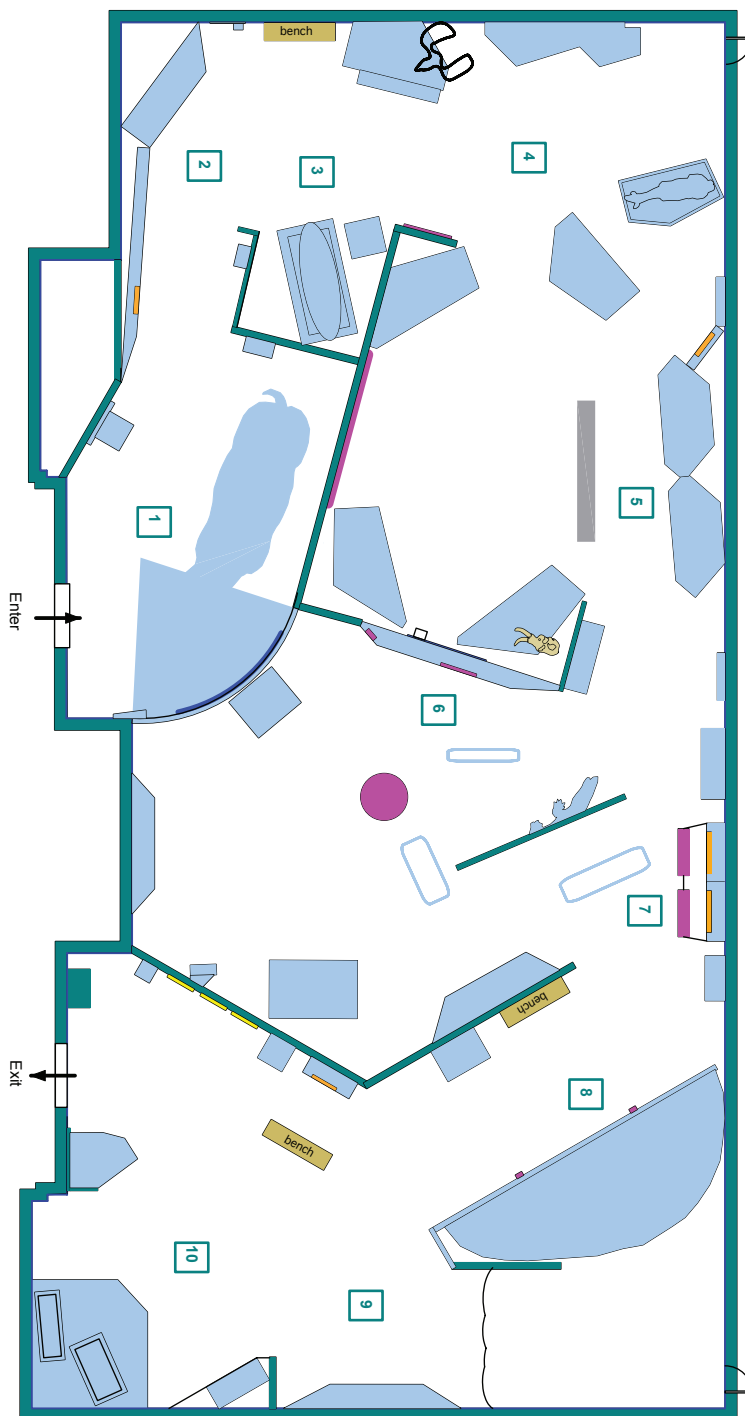
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MAP OF THE EXHIBITION



KEY

- Video
- Interactive

1. Introduction

Living and fossil mammals exhibit a huge range of shapes and sizes.

2. What is a Mammal?

Mammals are defined by common ancestry, not by physical characteristics – although inherited traits do help us recognize relationships between mammals.

3. What is Extreme?

“Extreme” traits differ widely from those found in ancestors, or from the most common, typical, or “normal” form at any moment in time. Most mammals possess a combination of extreme and normal features.

4. Head to Tail: Heads

Mammalian bodies have been modified by evolution. Some of these changes are found in the head.

5. Head to Tail: Reproduction

Reproduction is one of the main features that differentiates the three living groups of mammals: placentals, marsupials, and monotremes.

6. Head to Tail: Bodies

All mammals share a common body plan, but evolution has resulted in astonishing variations on the arrangement of bones, muscles, and skin.

7. Mammals in Motion

Ancestral mammals lived on land. Some groups of mammals later adapted to move through other environments like the open skies and the deep sea.

8. Extreme Climates

Environments change with time, and so do the mammals that inhabit them.

9. Extreme Isolation

When mammals are geographically isolated, they can evolve extreme traits or can come to resemble unrelated species elsewhere.

10. Extreme Extinction

Although sometimes rapid, and affecting vast numbers of species, extinctions are part of the history of life. One mammal, *Homo sapiens*, is contributing to what may become the next mass extinction (the “Sixth Extinction”).

GLOSSARY OF TERMS

Bipedalism: using two feet to stand and move on land (by walking, hopping, or running). Relatively few modern mammal species are bipeds.

Smilodon, a saber-toothed cat, lived in the Americas between 2.5 million and 10,000 years ago.



Carnivore: an animal that eats primarily meat, whether scavenged or hunted. Most living species of the mammal order Carnivora (dogs, bears, cats, seals, and their relatives) are carnivores like their common ancestor, but some have evolved to eat primarily fish, fruit, or even leaves.

Cladogram: a tree-like diagram that depicts the evolutionary history of a group of organisms. Branching points are where new, advanced features appeared, and species diverged from common ancestors.

Characteristic: any feature or trait of an organism that can be measured, counted, or otherwise assessed, such as hair color or number of limbs. Characteristics help biologists distinguish one species from another.

Echolocation: the process of emitting sound waves and listening to the echoes to navigate and locate food – or “biological sonar.” Echolocation evolved independently in bats, cetaceans (dolphins and whales), shrews, and some other mammals.

Evolution: the process by which populations accumulate genetic changes over time that are passed on from ancestors to subsequent generations, or descent with modification. (See “Useful Concepts.”)

Extinction: the death of every member of a biological species or all species in a bigger group of organisms. The vast majority of species that have lived on Earth are now extinct.

Fossil: Typically preserved in rocks, fossils are any remains or traces of ancient life. Examples include bones, teeth, shells, leaf impressions, nests, and footprints. Fossils document how organisms changed over time, and how they’re related to one another.

Herbivore: an animal that eats plants, like horses and mice. In the food web, herbivores link primary producers (plants) and consumers such as predators (carnivores).

Keratin: a fibrous protein that is the main component of structures that grow from the skin, such as hair, hooves, nails, claws, and horns.

Mammal: a class of vertebrate animals descended from the common ancestor of living placentals, marsupials, and monotremes. Almost all mammals share certain physical characteristics: they have hair, they’re warm-blooded, and they produce milk to nurse their young.



Not a wolf at all, the **Tasmanian wolf** (*Thylacinus cynocephalus*) was a carnivorous marsupial that went extinct in 1936.

Marsupial: a group of a few hundred living (and many more fossil) mammal species named for a distinctive pouch (called the marsupium) in which many species carry their young. Born tiny and very undeveloped, the young feed on their mother’s milk for an extended period of time, often in a pouch.

Monotreme: a group of living mammals that lay eggs instead of giving birth to live young, as the vast majority of living mammals do.

Placental: Placental mammals bear live young, which are nourished before birth through a specialized organ (a placenta) that attaches to the mother’s uterus as an embryo grows. Although most living placental species are rodents and bats, this diverse group also includes whales, elephants, shrews, armadillos, and humans, among many other species.

Prehensile: adapted for grasping or holding. This adaptation confers many advantages, in feeding (the giraffe’s tongue), locomotion (the monkey’s tail), drinking and defense (the elephant’s trunk), and other activities.

Quadrupedalism: using four limbs or legs to move. Most land mammals are quadrupeds.

Species: a basic unit of biological classification. A species is often defined as a group of organisms that share ancestry and characteristics, and can interbreed and produce fertile offspring.



A tree-dwelling relative of the raccoon, the **kinkajou** can use its fully prehensile tail as a “fifth hand” when climbing.

GRADES K-2 ACTIVITIES

Welcome to *Extreme Mammals: The Biggest, Smallest, and Most Amazing Mammals of All Time*. Use this sheet to help your class explore mammals – what they look like, their shapes and sizes, and where they live. The activities below and on the Student Worksheet can be adapted to meet your students' interests and abilities.

BEFORE YOUR VISIT

Class Discussion: Introduce your students to the material covered in the **Essential Questions** section of this guide under *What is a mammal?* and *What is extreme?* Ask them to describe mammals that live in the water, on land, and in treetops.

Online Activity: Invite students to explore the diversity of mammals with this virtual tour at San Diego Zoo Kids (kids.sandiegozoo.org/animals/mammals). Describe similarities between the mammals during a group discussion. Explain that students will discover more about mammals when they visit the exhibition.

Classroom Activity: Download "What Teeth Tell Us" (amnh.org/explore/curriculum-collections/dinosaurs-ancient-fossils-new-discoveries/what-teeth-tell-us). After they've completed the activity, ask your students to describe the two different kinds of teeth and what they are used for.

Texas Essential Knowledge and Skills (TEKS)**K.10.A**

Sort plants and animals into groups based on physical characteristics such as color, size, body covering, or leaf shape.

1.10.A

Investigate how the external characteristics of an animal are related to where it lives, how it moves, and what it eats.

2.10.A

Observe, record, and compare how the physical characteristics and behaviors of animals help them meet their basic needs such as fins help fish move and balance in the water.

DURING YOUR VISIT

IN THE EXTREME MAMMALS EXHIBITION: Exploration

Use the activities and guiding questions in Sections 1 and 4 of **Teaching in the Exhibition** in this Guide to help students in their exploration of the biggest, smallest, and most amazing mammals. Have them share which mammal in the exhibit they liked the most, and why.

Go to the **Heads** area and ask students to compare the teeth of living and extinct mammals. Use Section 4 of **Teaching in the Exhibition** for strategies to explore this area.

Students can use the reproducible on the reverse side of this sheet to further explore these concepts. Provide chaperones with a copy of the **Map of the Exhibition** to help them find locations in *Extreme Mammals*.

IN THE EXTREME MAMMALS EXHIBITION: Extension

Visit the **What is a Mammal?** section. Ask students to choose one animal to sketch or draw on the back of their worksheet. Remind students to include characteristics such as body covering, ears, eyes, and feet that help the mammal meet its basic needs.

BACK IN THE CLASSROOM

Activity: Have students create their own "extreme mammal," including features like horns, fur, bony plates, flippers, and prehensile tails. Have them name their animal, explain to the class why they chose these special features, and describe how these features would help their animal survive.

Activity: Take a bite! Have students sample a variety of foods (an apple, a sandwich, a snack bar, or crackers), and ask them to think about which teeth they use for each bite. Ask what kind of diet their teeth are adapted for.

Texas Connection: Which mammal on the third floor of the Bullock Texas State History Museum has extreme horns? Sketch a picture showing the animal and its horns. What is special about this mammal?

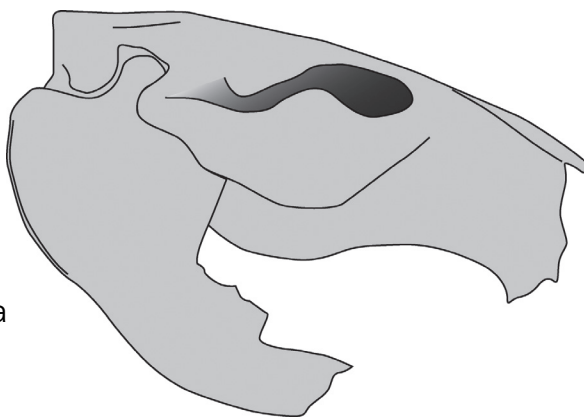
STUDENT WORKSHEET

GRADES K-2

What are teeth for?

Go to Section 4, HEAD TO TAIL: HEADS. Find the beaver skull in the TEETH area. **Draw its teeth in the skull here.** →

Now go to the HEADGEAR area and find the fossil beaver skull with horns. Compare it with the other beaver. How are they the same? How are they different?



Circle all the ways a beaver can use its teeth:

grabbing
slicing
cutting
chewing
whistling

Make a Face

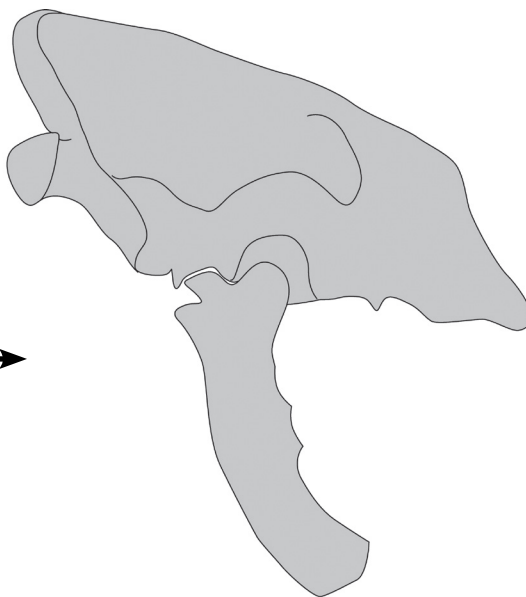
Look in the mirror in the TEETH section to see how your teeth compare with the teeth of other mammals. Which mammal is your favorite? Why? _____

How are your teeth like that animal's teeth? How are they different? Share your answers with your classmates.

Find the saber-toothed cat!

Lion and tiger teeth may be impressive, but not compared to the giant teeth of these extinct cats!

Draw the teeth of the Saber-toothed cat in the skull. →



A saber-toothed cat was a:
(Circle your answer.)

plant-eater

meat-eater

Why do you think so?

GRADES K-2 ACTIVITIES

Welcome to Extreme Mammals: The Biggest, Smallest, and Most Amazing Mammals of All Time. Use this sheet to help your class explore mammals – what they look like, their shapes and sizes, and where they live.

The activities below and on the Student Worksheet can be adapted to meet your students' interests and abilities.

BEFORE YOUR VISIT

Class Discussion: Introduce your students to the material covered in the Essential Questions section of this guide under What is a mammal?

All mammals produce milk, are warm-blooded, and have four limbs. What is extreme? *Extreme mammals have features that are unique or special compared to other mammals.* Ask them to describe mammals that live in the water, on land, and in treetops.

These include:

Water — Seal, dolphin, and otter

Land — giraffe, deer, and tiger

Treetops — the wooly monkey and the sloth

Online Activity: Invite students to explore the diversity of mammals with this virtual tour at San Diego Zoo Kids (kids.sandiegozoo.org/animals/mammals). Describe similarities between the mammals during a group discussion. Explain that students will discover more about mammals when they visit the exhibition. *While looking at the animals and reading the descriptions, observe the characteristics that help the different mammals meet their basic needs. Fur keeps animals warm. Large ears help animals to hear sounds from far away. Quills protect a porcupine from predators. Sharp claws help large cats climb trees.*

Classroom Activity: Download "What Teeth Tell Us" (amnh.org/explore/curriculum-collections/dinosaurs-ancient-fossils-new-discoveries/what-teeth-tell-us).

After they've completed the activity, ask your students to describe the two different kinds of teeth and what they are used for. *Sharp teeth are used by carnivores, or meat-eating animals, for cutting meat into chunks that are then swallowed (chewing not necessary). Flat teeth are used by herbivores, or plant-eating animals, to grind plant material before swallowing; this helps with the digestion of plant material.*

DURING YOUR VISIT

IN THE EXTREME MAMMALS EXHIBITION: Exploration

Use the activities and guiding questions in Sections 1 and 4 of **Teaching in the Exhibition** in this Guide to help students in their exploration of the biggest, smallest, and most amazing mammals.

Have them share which mammal in the exhibit they liked the most, and why.

Go to the **Heads** area and ask students to compare the teeth of living and extinct mammals. Use Section 4 of **Teaching in the Exhibition** for strategies to explore this area.

IN THE EXTREME MAMMALS EXHIBITION: Extension

Visit the What is a Mammal? section. Ask students to choose one animal to sketch or draw on the back of their worksheet. Remind students to include characteristics such as body covering, ears, eyes, and feet that help the mammal meet its basic needs. *Example: The short beaked echidna is covered in quills which protect it from predators. The koala has claws that allow it to grasp tree limbs where it lives. The coyote has thick fur to keep it warm.*

ANSWER KEY

Texas Essential Knowledge and Skills (TEKS)

K.10.A

Sort plants and animals into groups based on physical characteristics such as color, size, body covering, or leaf shape.

1.10.A

Investigate how the external characteristics of an animal are related to where it lives, how it moves, and what it eats.

2.10.A

Observe, record, and compare how the physical characteristics and behaviors of animals help them meet their basic needs such as fins help fish move and balance in the water.

Students can use the reproducible on the reverse side of this sheet to further explore these concepts. Provide chaperones with a copy of the **Map of the Exhibition** to help them find locations in *Extreme Mammals*.

GRADES K-2 ACTIVITIES cont'd

Activity: Have students create their own “extreme mammal,” including features like horns, fur, bony plates, flippers, and prehensile tails. Have them name their animal, explain to the class why they chose these special features, and describe how these features would help their animal survive.

[Students can use crayons, markers, paper, cardboard, clay, model magic and other materials to sketch a drawing or create a model.]

ANSWER KEY

Activity: Take a bite! Have students sample a variety of foods (an apple, a sandwich, a snack bar, or crackers), and ask them to think about which teeth they use for each bite. Ask what kind of diet their teeth are adapted for.

Human teeth are adapted to eat meat or plants (omnivore). The front teeth are used for nipping chunks of food into “bite-sized” pieces and the flat back teeth (molars) are used for grinding food before swallowing.

Texas Connection: Which mammal on the third floor of the Bullock Texas State History Museum has extreme horns? Sketch a picture showing the animal and its horns. What is special about this mammal? *The longhorn is a hybrid resulting from the mixing of Spanish cattle and English cattle. Their horns can extend to 7 feet.*

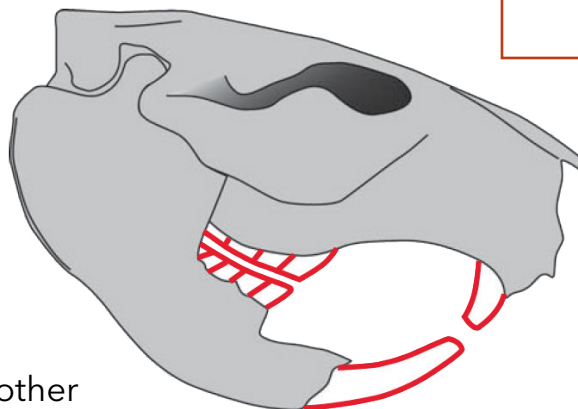
STUDENT WORKSHEET

GRADES K-2

What are teeth for?

Go to Section 4, HEAD TO TAIL: HEADS. Find the beaver skull in the TEETH area. **Draw its teeth in the skull here.** →

Now go to the HEADGEAR area and find the fossil beaver skull with horns. Compare it with the other beaver. How are they the same? *The teeth of the extinct beaver and the modern beaver have the same basic shape.* How are they different? *The extinct beaver has horns and the modern beaver doesn't. The modern beaver skull is much larger.*



ANSWER KEY

Circle all the ways a beaver can use its teeth:

grabbing

slicing

cutting

chewing

whistling

Make a Face

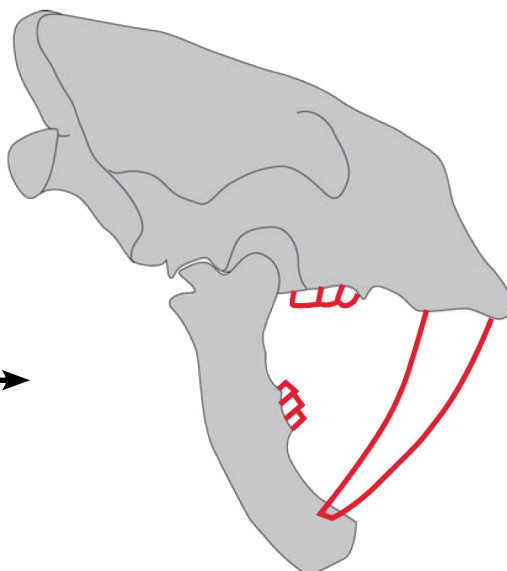
Look in the mirror in the TEETH section to see how your teeth compare with the teeth of other mammals. Which mammal is your favorite? Why? _____

How are your teeth like that animal's teeth? *Answers will vary.* How are they different? *Answers will vary.* Share your answers with your classmates.

Find the saber-toothed cat!

Lion and tiger teeth may be impressive, but not compared to the giant teeth of these extinct cats!

Draw the teeth of the Saber-toothed cat in the skull. →



A saber-toothed cat was a:
(Circle your answer.)

plant-eater

meat-eater

Why do you think so?

GRADES 3-5 ACTIVITIES

Welcome to *Extreme Mammals: The Biggest, Smallest, and Most Amazing Mammals of All Time*. Use this sheet to help your class explore what makes a mammal a mammal, and discover what's normal or extreme when it comes to this incredibly diverse group of animals. The activities below and on the Student Worksheet can be adapted to meet your students' interests and abilities.

BEFORE YOUR VISIT

Class Discussion: Mammals live everywhere from the sea to the treetops, and have evolved to swim, glide, burrow, run, hop, climb trees, and even fly. Start a discussion by asking students what they think is "normal" for a mammal when it comes to size, shape, or behavior. What's "extreme" or unusual, and why? For information to support the discussion, refer to the **Essential Questions** section of the Guide.

Research Activity:

Students go on a Web Hunt to explore the online dioramas at the American Museum of Natural History (amnh.org/exhibitions/permanent-exhibitions/mammal-halls/bernard-family-hall-of-north-american-mammals). Ask students to browse the mammals featured in the dioramas and find answers to these questions: What is a mammal? What characteristics are considered "normal" for mammals? What characteristics make some mammals "extreme?" What are some examples of mammals?

Texas Essential Knowledge and Skills (TEKS)

3.10.A

Explore how structures and functions of plants and animals allow them to survive in a particular environment.

4.10.A

Explore how adaptations enable organisms to survive in their environment such as comparing birds' beaks and leaves on plants.

5.10.A

Compare the structures and functions of different species that help them live and survive such as hooves on prairie animals or webbed feet in aquatic animals.

DURING YOUR VISIT

IN THE EXTREME MAMMALS EXHIBITION: Exploration

Use the activities and guiding questions in Sections 1 and 2 of **Teaching in the Exhibition** in this Guide to help students understand mammal fundamentals – *What is a mammal?* and *What's "normal" for mammals?*

Students can use the reproducible on the reverse side of this sheet to further explore these concepts. Provide each group of students with a copy of the **Map of the Exhibition** to help them find locations in *Extreme Mammals*.

IN THE EXTREME MAMMALS EXHIBITION: Extension

As students move through the exhibit, ask them to choose one mammal to sketch or draw on the back of their worksheet. Remind students to include characteristics such as body covering, ear shape, eyes, and feet that help the mammal survive in its environment.

BACK IN THE CLASSROOM

Activity: Create a grid on the board. At the top of each column, list five extreme mammals your class observed in the *Extreme Mammals* Exhibition. Beneath each mammal list unique adaptations such as body covering, size, and shape. Ask students to work in groups to list their findings. Once the grid is complete, engage the class in discussing the following questions:

- Which mammals are adapted to live on land? In water? Or both?
- What can you discover about where and how mammals move by observing features such as the shape of bodies and limbs?
- What other information or questions do you still have?

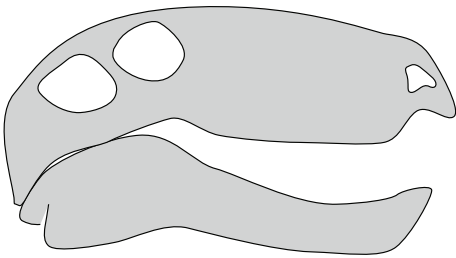
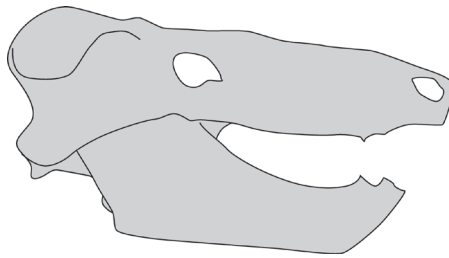
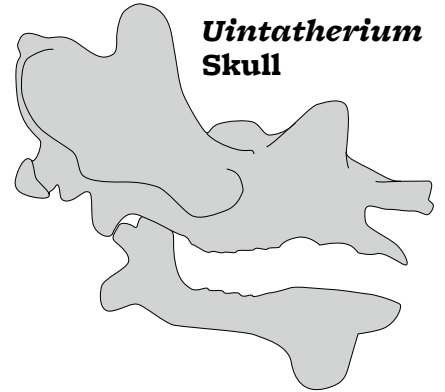
Texas Connection: Students identify a mammal they observed inside the Bullock Texas State History Museum. What characteristics make the mammal unique? Is it extreme? Why or why not?

STUDENT WORKSHEET

GRADES 3-5

My, What Big Teeth You Have!

Go to Section 2 of the exhibition **What is a Mammal?** and look for the skull case. Look at the skulls of *Dimetrodon* and *Cynognathus*, two extinct animals that are related to mammals but are not mammals. Then find the skulls of *Uintatherium*, an extinct mammal. **Draw in their teeth on the skulls below.**

Dimetrodon Skull*Cynognathus* Skull*Uintatherium* Skull

What's different about the *Dimetrodon*'s teeth? _____

How do the shapes of *Uintatherium* teeth differ from the shapes of *Dimetrodon* and *Cynognathus* teeth? _____

On the back of this sheet, write one or two sentences describing how one of these animals might have used their teeth. Here are some good words to use: bite, tear, slice, grind, and chew. Can you think of any more?

Heads, Limbs, Bodies, and Tails

Draw a part of the body – head, limbs, body, or tail – of two different mammals in the exhibition.

MAMMAL NAME: _____

MAMMAL NAME: _____

How are these examples similar?

How are they different?

How does this body part help each animal survive in the environment where it is found?

GRADES 3-5 ACTIVITIES

Welcome to *Extreme Mammals: The Biggest, Smallest, and Most Amazing Mammals of All Time*. Use this sheet to help your class explore what makes a mammal a mammal, and discover what's normal or extreme when it comes to this incredibly diverse group of animals. The activities below and on the Student Worksheet can be adapted to meet your students' interests and abilities.

ANSWER KEY

BEFORE YOUR VISIT

Class Discussion: Mammals live everywhere from the sea to the treetops, and have evolved to swim, glide, burrow, run, hop, climb trees, and even fly. Start a discussion by asking students what they think is "normal" for a mammal when it comes to size, shape, or behavior.

"Normal" is what is typically observed in the mammal group. For instance if you take a typical house cat

(Felis catus), what students might consider being

"normal" for this mammal might be the following compared to other mammals:

Size: small body size

Shape: four limbs, tail

Behavior: quadruped—walks on four limbs, nurture their young

What's "extreme" or unusual, and why? For information to support the discussion, refer to the **Essential Questions** section of the Guide.

"Extreme" is what is not typically observed in a mammal group. Taking the example again from house cats compared to other mammals:

Shape: has claws to climb trees and attack

Behavior: can be domesticated as pets

Research Activity:

Students go on a Web Hunt to explore the online dioramas at the American Museum of Natural History (amnh.org/exhibitions/permanent-exhibitions/mammal-halls/bernard-family-hall-of-north-american-mammals). Ask students to browse the mammals featured in the dioramas and find answers to these questions:

What is a mammal? *Mammals are warm-blooded vertebrates that have hair or fur, produce milk for their young, and usually give birth to live young.*

What characteristics are considered "normal" for mammals? *Characteristics considered to be normal for mammals include the ability to walk on four limbs (quadrupedalism), give birth to live young, and produce milk.*

What characteristics make some mammals "extreme?" *Extreme mammals are those that have features that are unique or special compared to other mammals. Extreme features develop in response to environmental conditions.*

What are examples of mammals? *Alaska brown bear, bison, cougar, coyote, moose, and badger.*

Texas Essential Knowledge and Skills (TEKS)

3.10.A

Explore how structures and functions of plants and animals allow them to survive in a particular environment.

4.10.A

Explore how adaptations enable organisms to survive in their environment such as comparing birds' beaks and leaves on plants.

5.10.A

Compare the structures and functions of different species that help them live and survive such as hooves on prairie animals or webbed feet in aquatic animals.

Students can use the reproducible on the reverse side of this sheet to further explore these concepts. Provide each group of students with a copy of the **Map of the Exhibition** to help them find locations in *Extreme Mammals*.

DURING YOUR VISIT

IN THE EXTREME MAMMALS EXHIBITION: Exploration

Use the activities and guiding questions in Sections 1 and 2 of **Teaching in the Exhibition** in this Guide to help students understand mammal fundamentals – *What is a mammal?* and *What's "normal" for mammals?*

GRADES 3-5 ACTIVITIES

IN THE EXTREME MAMMALS EXHIBITION: Extension

As students move through the exhibit, ask them to choose one mammal to sketch or draw on the back of their worksheet. Remind students to include characteristics such as body covering, ear shape, eyes, and feet that help the mammal survive in its environment.

Examples include the short beaked echidna that is covered in quills. The quills protect it from predators. The koala has claws that allow it to grasp tree limbs where it lives. The coyote has thick fur to keep it warm.

ANSWER KEY

BACK IN THE CLASSROOM

Activity: Create a grid on the board. At the top of each column list five extreme mammals your class observed in the *Extreme Mammals* Exhibition. Beneath each mammal list unique adaptations such as body covering, size, and shape. Ask students to work in groups to list their findings. Once the grid is complete, engage the class in discussing the following questions:

- Which mammals are adapted to live on land? In water? Or both?
- What can you discover about where and how mammals move by observing features such as the shape of bodies and limbs?
- What other information or questions do you still have?

Example:

<i>Indricotherium</i>	<i>Macrauchenia</i>	<i>Repenomamus</i>	<i>Baleen whale</i>	<i>Flying squirrel</i>
<i>Weighed up to 20 tons Largest mammal to ever walk on the Earth</i>	<i>Had a trunk</i>	<i>Size of opossum, but ate dinosaurs</i>	<i>No teeth; only baleen</i>	<i>Have membranes of fur-covered skin running along the sides of their bodies</i>

Texas Connection: Students identify a mammal they observed inside the Bullock Texas State History Museum. What characteristics make the mammal unique? Is it extreme? Why or why not?

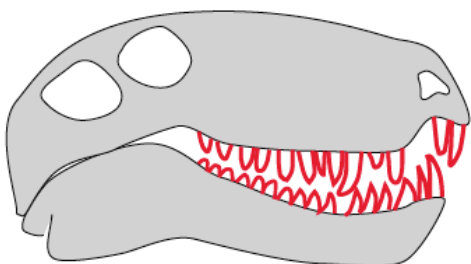
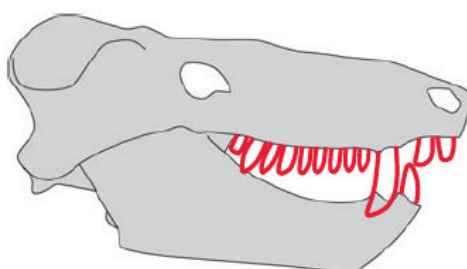
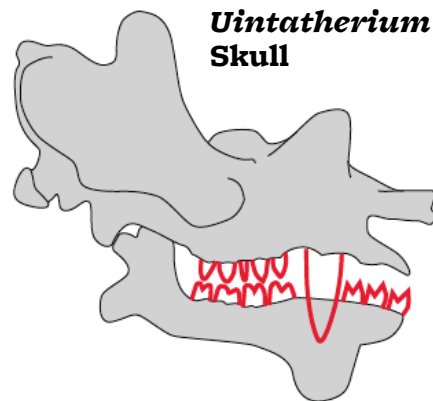
The longhorn is unique because of its long horns. The buffalo is unique for its size, thick fur coat, and short curved horns.

STUDENT WORKSHEET

GRADES 3-5

My, What Big Teeth You Have!

Go to Section 2 of the exhibition **What is a Mammal?** and look for the skull case. Look at the skulls of *Dimetrodon* and *Cynognathus*, two extinct animals that are related to mammals but are not mammals. Then find the skulls of *Uintatherium*, an extinct mammal. **Draw in their teeth on the skulls below.**

Dimetrodon Skull*Cynognathus* Skull*Uintatherium* Skull

What's different about the *Dimetrodon*'s teeth? *All of Dimetrodon's teeth are pointed, about the same shape, and get smaller towards the back of the jaw.*

How do the shapes of *Uintatherium* teeth differ from the shapes of *Dimetrodon* and *Cynognathus* teeth? *Uintatherium has many different types of teeth: their front teeth have two points, they have large blade-like canines much larger than their front teeth, and broad and square back teeth.*

On the back of this sheet, write one or two sentences describing how one of these animals might have used their teeth. Here are some good words to use: bite, tear, slice, grind, and chew. Can you think of any more?

Heads, Limbs, Bodies, and Tails

Draw a part of the body – head, limbs, body, or tail – of two different mammals in the exhibition.

MAMMAL NAME: _____

Students' drawings and answers will vary depending on the species and body part selected, which may include...

MAMMAL NAME: _____

*HEADS: horns, antlers, teeth, and brains
LIMBS: legs, paddles, and wings
TAILS: curly, super long, short and flat
BODIES: fur, spines, quills, thick rough skin, scales and body armor*

How are these examples similar?

Answers may include the purpose they serve (i.e. protections, insulation)

How are they different?

Answers may include locomotion, shape, or size

How does this body part help each animal survive in the environment where it is found?

Possible answers may include: serving as protection from climate conditions, for finding or obtaining food, or for moving around in a particular environment (e.g. climbing trees or swimming).

GRADES 6-8 ACTIVITIES

Welcome to *Extreme Mammals: The Biggest, Smallest, and Most Amazing Mammals of All Time*. Use this sheet to help your students explore how mammals evolved and how incredibly diverse they are. The activities below and on the Student Worksheet can be adapted to meet your students' interests and abilities.

BEFORE YOUR VISIT

Class Discussion: Share the **Useful Concepts: Natural Selection and Adaptation** section of the Guide with your students. Discuss how evolution has modified mammalian bodies over time. What helped some species survive and caused others to die out?

Online Activities:

Students watch the video *Prehistoric Predators of the Past - Episode 1: What Killed the Megabeasts* (youtube.com/watch?v=gyTs32wcWtY). Students may also test their knowledge of the Woolly Mammoth at Seven Steppes to a Woolly Mammoth. (school.discoveryeducation.com/schooladventures/woollymammoth/steppe1.html). Discuss new learning gained from the activity.

DURING YOUR VISIT

IN THE EXTREME MAMMALS EXHIBITION: Exploration

Use the activities and guiding questions in Sections 1 and 2 of **Teaching in the Exhibition** in this Guide to guide your students' exploration of mammal evolution, as well as the strategies in Section 9 to support your students' investigation of isolation and adaptation.

IN THE EXTREME MAMMALS EXHIBITION: Extension

What do skeletons tell us? Find the **ground sloth**, **uintatherium**, and **glyptodont** skeletons. Students sketch each of these mammals and answer the following questions: Is the mammal alive or extinct? What are its extreme features? What purposes do the extreme features serve?

BACK IN THE CLASSROOM

Research Activity: Direct students to the video *Lemurs of Madagascar: Surviving on an Island of Change* (youtube.com/watch?v=JB5r2_Yxnj0). Ask students to recall the **Extreme Isolation** section of the exhibition, which explained how geographic isolation can lead to the evolution of extreme traits. Ask students why it's important for scientists to study how animals adapt to changing environments.

Texas Connection: Students identify a mammal they observed inside the Bullock Texas State History Museum. What characteristics make the mammal unique? Is it extreme? Why or why not?

Texas Essential Knowledge and Skills (TEKS)**7.11.C**

Identify some changes in genetic traits that have occurred over several generations through natural selection and selective breeding such as the Galapagos Medium Ground Finch (*Geospiza fortis*) or domestic animals.

7.12.A

Investigate and explain how internal structures of organisms have adaptations that allow specific functions such as gills in fish, hollow bones in birds, or xylem in plants.

8.11C

Explore how short- and long-term environmental changes affect organisms and traits in subsequent populations

Students can use the reproducible on the reverse side of this sheet to further explore these concepts. Provide your students with a copy of the **Map of the Exhibition** to help them find locations in *Extreme Mammals*.

STUDENT WORKSHEET

GRADES 6-8

Go on an Expedition

As you go through the exhibition, imagine you're a scientist in the field looking for a mammal with "extreme" and "normal" characteristics. Choose one mammal. Write down its scientific name and common name (if available), and label its "extreme" and "normal" traits.

SCIENTIFIC NAME: _____ **COMMON NAME:** _____

EXTREME TRAITS: _____

NORMAL TRAITS: _____

Head to Tail

With a partner, visit the **Heads, Hair & Armor**, and **Mammals in Motion** sections of the exhibition. Observe similarities and differences in head gear, hair and armor, and locomotion (the way animals move). Together, answer the following questions:

Heads: What are some of the functions of headgear? _____

Hair & Armor: How do different body coverings benefit these animals in their environments? _____

Locomotion: Many groups of mammals evolved to live in water. How do their bodies differ from mammals that live on land? _____

Check out the computer interactive in **Section 7: Mammals in Motion** to compare the different ways that mammals move on land, in the water, or through the air.

Spectacular Adaptations

Go to the **Extreme Climates** diorama in Section 8 to explore the conditions on Canada's Ellesmere Island 50 million years ago. Using the information on the display and your observations, write a short description predicting how this environment might change over time, and how this could affect the mammal groups that live there.

Look through the viewers at the sides of the diorama to see Ellesmere Island as it is today. How has the environment actually changed? On the back of this sheet, write a detailed description using this new information.

What Happens in Isolation? (Answer the questions below on the back of this sheet.)

View the **Scientist at Work** video in the **Extreme Isolation** section, which explains the role of geographic isolation in evolution. What kinds of extreme features have evolved in places that were once isolated? Why is isolation so important in the evolution of "extreme" traits?

Observe one South American mammal in the **Extreme Isolation** section and read the information that describes it. What does the fossil evidence tell us about this extinct mammal?

STUDENT WORKSHEET

GRADES 6-8

What do skeletons tell us?

Find the **uintatherium**, **ground sloth**, and **glyptodont** skeletons in the *Extreme Mammals* exhibition. Sketch each skeleton in the boxes below and answer the questions.

uintatherium

Is the mammal living or extinct?

What are its extreme features?

What are the purposes of the extreme features?

Give evidence to support your answers.

giant sloth

Is the mammal living or extinct?

What are its extreme features?

What are the purposes of the extreme features?

Give evidence to support your answers.

saber-toothed cat

Is the mammal living or extinct?

What are its extreme features?

What are the purposes of the extreme features?

Give evidence to support your answers.

GRADES 6-8 ACTIVITIES

Welcome to *Extreme Mammals: The Biggest, Smallest, and Most Amazing Mammals of All Time*. Use this sheet to help your students explore how mammals evolved and how incredibly diverse they are. The activities below and on the Student Worksheet can be adapted to meet your students' interests and abilities.

BEFORE YOUR VISIT

Class Discussion: Share the **Useful Concepts: Natural Selection and Adaptation** section of the Guide with your students. Discuss how evolution has modified mammalian bodies over time.

Mammals show a great deal of diversity. Evolution has modified mammalian bodies in many ways, producing a wide range of shapes, sizes, and body characteristics. For example, marine mammals may have flippers and torpedo-shaped bodies that help them swim. Review the Essential Questions in the Educator Guide to guide this discussion.

What helped some species survive and caused others to die out?

As environments change over time, living things must adapt or go extinct. Different traits are favored in different habitats, and are passed on to future generations.

Many mass-extinctions from the past appear to have been caused by severe climate change. Recent extinctions are caused by human activities, such as habitat destruction, pollution, and the introduction of invasive species. The species most likely to go extinct include the largest organisms, with low reproductive rates, and species with very limited distributions.

Online Activities:

Students watch the video *Prehistoric Predators of the Past - Episode 1: What Killed the Megabeasts* ([youtube.com/watch?v=gyTs32wcWtY](https://www.youtube.com/watch?v=gyTs32wcWtY)).

Students may also test their knowledge of the Woolly Mammoth at Seven Steppes to a Woolly Mammoth (school.discoveryeducation.com/schooladventures/woollymammoth/steppe1.html). Discuss new learning gained from the activity.

DURING YOUR VISIT

IN THE EXTREME MAMMALS EXHIBITION: Exploration

Use the activities and guiding questions in Sections 1 and 2 of **Teaching in the Exhibition** in this Guide to guide your students' exploration of mammal evolution, as well as the strategies in Section 9 to support your students' investigation of isolation and adaptation.

IN THE EXTREME MAMMALS EXHIBITION: Extension

What do skeletons tell us? Find the **ground sloth**, **uintatherium**, and **glyptodont** skeletons. Students sketch each of these mammals and answer the following questions: Is the mammal alive or extinct? What are its extreme features? What purposes do the extreme features serve?

ANSWER KEY

Texas Essential Knowledge and Skills (TEKS)

7.11.C

Identify some changes in genetic traits that have occurred over several generations through natural selection and selective breeding such as the Galapagos Medium Ground Finch (*Geospiza fortis*) or domestic animals.

7.12.A

Investigate and explain how internal structures of organisms have adaptations that allow specific functions such as gills in fish, hollow bones in birds, or xylem in plants.

8.11C

Explore how short- and long-term environmental changes affect organisms and traits in subsequent populations

Students can use the reproducible on the reverse side of this sheet to further explore these concepts. Provide your students with a copy of the **Map of the Exhibition** to help them find locations in *Extreme Mammals*.

GRADES 6-8 ACTIVITIES

BACK IN THE CLASSROOM

Research Activity: Direct students to the video *Lemurs of Madagascar: Surviving on an Island of Change* (youtube.com/watch?v=JB5r2_Yxnj0).

Ask students to recall the **Extreme Isolation** section of the exhibition, which explained how geographic isolation can lead to the evolution of extreme traits. Ask students why it's important for scientists to study how animals adapt to changing environments. *It can give scientists information about how organisms might react to man-made (anthropogenic) changes in the future. Careful study can also help create conservation strategies to help protect species.*

ANSWER KEY

Texas Connection: Students identify a mammal they observed inside the Bullock Texas State History Museum. What characteristics make the mammal unique? Is it extreme? Why or why not?

The longhorn is unique because of its long horns. The buffalo is unique for its size, thick fur coat, and short curved horns.

STUDENT WORKSHEET

GRADES 6-8

Go on an Expedition

As you go through the exhibition, imagine you're a scientist in the field looking for a mammal with "extreme" and "normal" characteristics. Choose one mammal. Write down its scientific name and common name (if available), and label its "extreme" and "normal" traits.

EXAMPLE OF STUDENT WORK:

SCIENTIFIC NAME: *giraffe camelopardalis*

COMMON NAME: *giraffe*

EXTREME TRAITS: *Very tall, elongated neck, extreme circulatory system*

NORMAL TRAITS: *4 limbs, 2 eyes, fur, provides milk to young*

ANSWER KEY

Head to Tail

With a partner, visit the **Heads, Hair & Armor**, and **Mammals in Motion** sections of the exhibition. Observe similarities and differences in head gear, hair and armor, and locomotion (the way animals move). Together, answer the following questions:

Heads: What are some of the functions of headgear? *Defense, digging for food/shelter, sexual selection.*

Hair & Armor: How do different body coverings benefit these animals in their environments?
Warmth, defense, camouflage.

Locomotion: Many groups of mammals evolved to live in water. How do their bodies differ from mammals that live on land? *(Extreme features among aquatic mammals) Blubber/insulation, fins/flippers, flap over nose (often at top of head), collapsible lungs.*

Check out the computer interactive in **Section 7: Mammals in Motion** to compare the different ways that mammals move on land, in the water, or through the air.

Spectacular Adaptations

Go to the **Extreme Climates** diorama in Section 8 to explore the conditions on Canada's Ellesmere Island 50 million years ago. Using the information on the display and your observations, write a short description predicting how this environment might change over time, and how this could affect the mammal groups that live there. *Answers will vary.*

Look through the viewers at the sides of the diorama to see Ellesmere Island as it is today. How has the environment actually changed? *The environment has changed from tropical swamps to frozen tundra.* On the back of this sheet, write a detailed description using this new information.

Description should these key concepts:

- *Different mammals are living there today:*
 - Herbivores: Musk Ox, Caribou, Rabbits, Lemmings*
 - Carnivores: Polar Bears, Wolves, Wolverines, Foxes.*
- *The colder climate drastically altered the ecosystem.*
- *The physical environment changed: water supply, shelter, weather, etc.*
- *Plant life changed and there is less food available for herbivores.*
- *Thick hair/fur is needed to survive this colder environment.*

STUDENT WORKSHEET

GRADES 6-8

What Happens in Isolation?

(Answer the questions below on the back of this sheet.)

ANSWER KEY

View the **Scientist at Work video** in the **Extreme Isolation** section, which explains the role of geographic isolation in evolution. What kinds of extreme features have evolved in places that were once isolated? *Examples of South American extreme features include large and small body size and headgear. Many closely related species had very different body sizes living in the same environment — the equivalent of having tiny horses live in the same location as very large horses.*

Why is isolation so important in the evolution of “extreme” traits? *Isolation can cause groups of similar species to evolve specialized and extreme traits and become more distinct from each other.*

Observe one South American mammal in the **Extreme Isolation** section and read the information that describes it. What does the fossil evidence tell us about this extinct mammal?

Students should be able to determine some of the following about their chosen mammal:

- *Diet (herbivore, carnivore, omnivore, browser, grazer, scavenger, predator)*
- *Locomotion (biped, quadruped, swimming, climbing, burrowing, etc.)*
- *Other Behaviors (reproduction, display, male competition, finding shelter, etc.)*

Students should be prepared to list normal and extreme features.

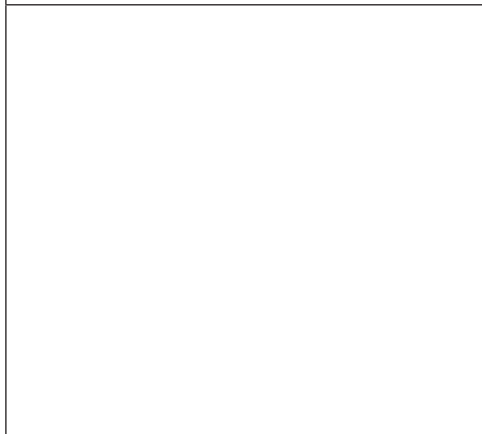
STUDENT WORKSHEET

GRADES 6-8

What do skeletons tell us?

Find the **uintatherium**, **ground sloth**, and **glyptodont** skeletons in the *Extreme Mammals* exhibition. Sketch each skeleton in the boxes below and answer the questions.

ANSWER KEY

uintatherium


Is the mammal living or extinct?

extinct

What are its extreme features?

Huge body – about 11 feet

Multiple knobby, bony horns

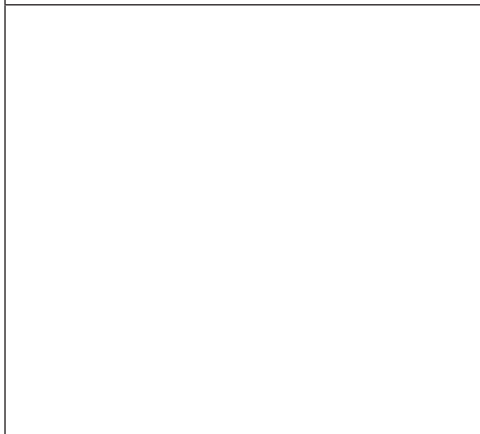
Large, dagger-like teeth

What are the purposes of the extreme features?

Horns could have been used for defense and pulling plants from swamps

Give evidence to support your answers.

Horns were shaped for digging: Sharp teeth would injure an enemy and help dig into the ground to uproot plants

giant sloth


Is the mammal living or extinct?

extinct

What are its extreme features?

Long, sharp claws

Walked on knucklebones

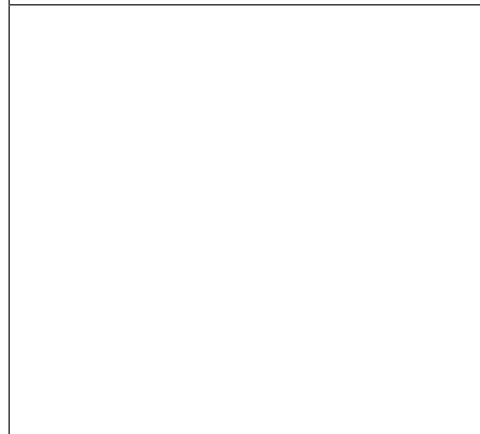
Grew to 20 feet and weighted 20 tons

What are the purposes of the extreme features?

Used claws to rip branches and bark from trees and to support body while walking.

Give evidence to support your answers.

Giant sloths ate only plants and were not hunters, so claws could have been used for gathering food and defense.

saber-toothed cat


Is the mammal living or extinct?

extinct

What are its extreme features?

Massive upper canines,

large shoulders, and

forelimbs, sharp teeth

What are the purposes of the extreme features?

Massive upper canines were used for stabbing prey. Large shoulders could hold down prey.

Give evidence to support your answers.

The teeth have sharp edges, and were sometimes serrated, like a steak knife.

GRADES 9-12 ACTIVITIES

Welcome to *Extreme Mammals: The Biggest, Smallest, and Most Amazing Mammals of All Time*. Use this sheet to help your class investigate mammals' evolutionary relationships and the role that environment plays in adaptation and distribution. The activities below and on the Student Worksheet can be adapted to meet your students' interests and abilities.

BEFORE YOUR VISIT

Online Activities: Students learn how to read a cladogram at the *Tree of Life* interactive website (<http://www.amnh.org/ology/features/treeoflife/index.php>). Ask students to explain the different parts of a cladogram and how the cladistic method helps us understand how all organisms are related.

Activity: Download the "Making Cladograms" PDF (http://www.amnh.org/content/download/1921/25393/file/dino_13_cladistics.pdf) and distribute it along with the required materials. Students use coins to explore the concept of grouping organisms based on shared characteristics.

Texas Essential Knowledge and Skills (TEKS)**Biology.7**

The student knows evolutionary theory is a scientific explanation for the unity and diversity of life.

Biology.8.B

Categorize organisms using a hierarchical classification system based on similarities and differences shared among groups.

DURING YOUR VISIT

IN THE EXTREME MAMMALS EXHIBITION: Exploration

Use the activities and guiding questions in Sections 1 and 2 of **Teaching in the Exhibition** in the Guide to help students develop their understanding of how scientists classify and define mammals. Refer to Section 10 for strategies to help your students explore the **Extreme Extinction** section.

IN THE EXTREME MAMMALS EXHIBITION: Extension

How does a cladogram represent evolutionary history? As students move through the exhibit, ask them to select a group of mammals from the **Heads to Tails** section. Students compare and contrast the feet of two different animals and then consider how particular types of feet may have helped them survive. Ask students to apply this process of observation and inference to a second feature such as teeth, headgear, or general body shape.

BACK IN THE CLASSROOM

Class Discussion: Have students refer to the cladogram on the Student Worksheet. Ask students to explain why *Ambulocetus* is classified as a member of the hooved animal group Artiodactyla, even though it doesn't have hooves. What does this tell them about the way scientists classify animals?

Class Discussion: Based on their exploration of the **Extreme Extinction** section of the exhibition, prompt students to think of ways that major climate change has affected the diversity of mammals. How is one type of mammal, known as a *Homo sapien*, contributing to current extinctions?

Texas Connection: Students identify a mammal they observed inside the Bullock Texas State History Museum. What characteristics make the mammal unique? Is it extreme? Why or why not?

Students can use the reproducible on the reverse side of this sheet to further explore these concepts. Provide your students with a copy of the **Map of the Exhibition** to help them find locations in *Extreme Mammals*.

STUDENT WORKSHEET GRADES 9-12

Scientists observe mammals in their environments, and analyze modern and fossil specimens back in the lab. Today, use the *Extreme Mammals* exhibition as your laboratory: examine specimens, listen to scientists and learn about their work, collect data, and ask questions!

The Quest to Learn More About Life on Earth

Draw on information from the exhibition, as well as your prior knowledge, to complete this chart. Review each mammal, and place an "X" to indicate which features it possesses. When the chart is complete, answer these questions on the back of this sheet:

- Which feature appears most frequently?
- Which feature appears least frequently?
- What does this suggest about relationships between mammals?

FEATURES	Platypus	Human	Cow	Sugar Glider	Frog	Ambulocetus
Hooves			X			X
Live Birth			X			
Placenta			X			
Backbone			X			
Milk Glands			X			

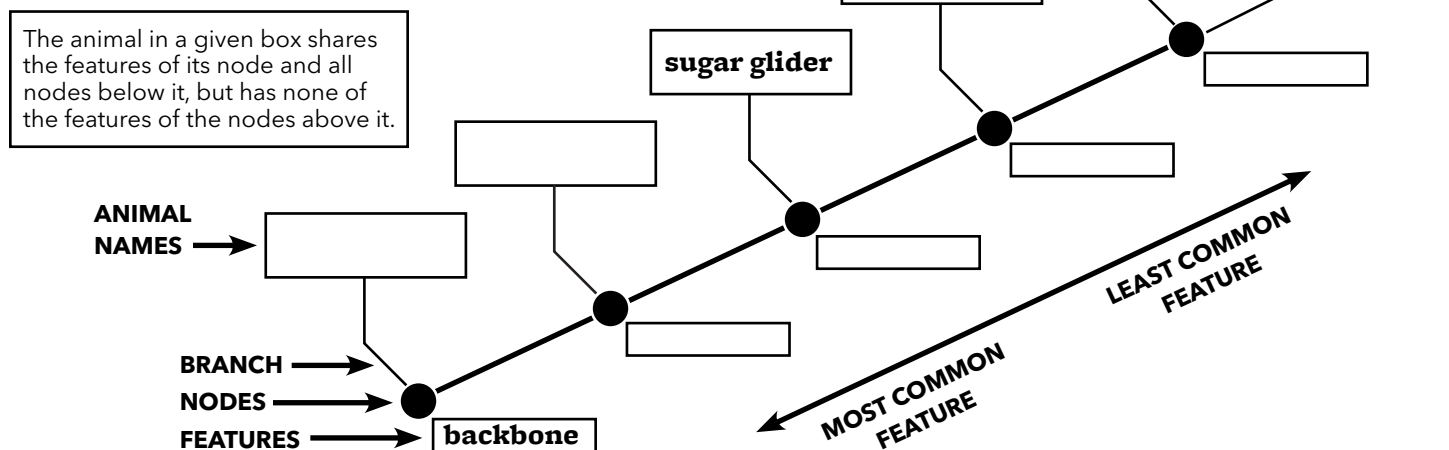
While *Ambulocetus* may not appear to have hooves, its flippers evolved from feet with hooves!

Make Your Own Cladogram

Using the data from your feature chart, complete the cladogram.

Two boxes have been filled in as an example.

(Note: You may want to do this back in the classroom.)



Our Changing Environment

As environments change over time, so do the mammals that inhabit them. In the **Extreme Climates** section of the exhibition, observe the diorama that depicts Ellesmere Island 50 million years ago. Choose one mammal, list three of its physical characteristics, and write how these features helped it survive.

MAMMAL: _____

- _____
- _____
- _____

Now use the viewers at the sides of the diorama to take a look at what the environment of Ellesmere Island is like today. List three characteristics that would help a mammal survive in this environment.

- _____
- _____
- _____

GRADES 9-12 ACTIVITIES

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How does a cladogram represent evolutionary history? As students move through the exhibit, ask them to select a group of mammals from the **Heads to Tails** section. Students compare and contrast the feet of two different animals and then consider how particular types of feet may have helped them survive. Ask students to apply this process of observation and inference to a second feature such as teeth, headgear, or general body shape. *The webbed feet on a platypus help it to swim. The giant sloth had huge claws for ripping branches and bark from trees. The sea lion uses flippers to swim.*

BACK IN THE CLASSROOM

Class Discussion: Have students refer to the cladogram on the Student Worksheet. Ask students to explain why *Ambulocetus* is classified as a member of the hooved animal group Artiodactyla, even though it doesn't have hooves. *The Ambulocetus has flippers that evolved from feet with hooves.* What does this tell them about the way scientists classify animals? *Scientists classify an animal using past characteristics even though they may have changed over the course of time.*

Class Discussion: Based on their exploration of the **Extreme Extinction** section of the exhibition, prompt students to think of ways that major climate change has affected the diversity of mammals. *Climate change can alter the components of an environment, making it unsuitable for a species living in that environment. This could decrease the diversity of species living there.* How is one type of mammal, known as a *Homo sapien*, contributing to current extinctions? *Humans, or homo sapiens, cause changes in the environment that impact animal species.*

ANSWER KEY

Texas Essential Knowledge and Skills (TEKS)

Biology.7

The student knows evolutionary theory is a scientific explanation for the unity and diversity of life.

Biology.8.B

Categorize organisms using a hierarchical classification system based on similarities and differences shared among groups.

Texas Connection: Students identify a mammal they observed inside the Bullock Texas State History Museum. What characteristics make the mammal unique? Is it extreme? Why or why not? *The longhorn is unique because of its long horns. The buffalo is unique for its size, thick fur coat, and short curved horns.*

Students can use the reproducible on the reverse side of this sheet to further explore these concepts. Provide your students with a copy of the **Map of the Exhibition** to help them find locations in *Extreme Mammals*.

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Draw on information from the exhibition, as well as your prior knowledge, to complete this chart. Review each mammal, and place an "X" to indicate which features it possesses. When the chart is complete, answer these questions on the back of this sheet:

- Which feature appears most frequently? *backbone*
- Which feature appears least frequently? *hooves*
- What does this suggest about relationships between mammals? *All mammals have backbones.*

FEATURES	Platypus	Human	Cow	Sugar Glider	Frog	Ambulocetus
Hooves			X			X
Live Birth		X	X	X		X
Placenta		X	X			X
Backbone	X	X	X	X	X	X
Milk Glands	X	X	X	X		X

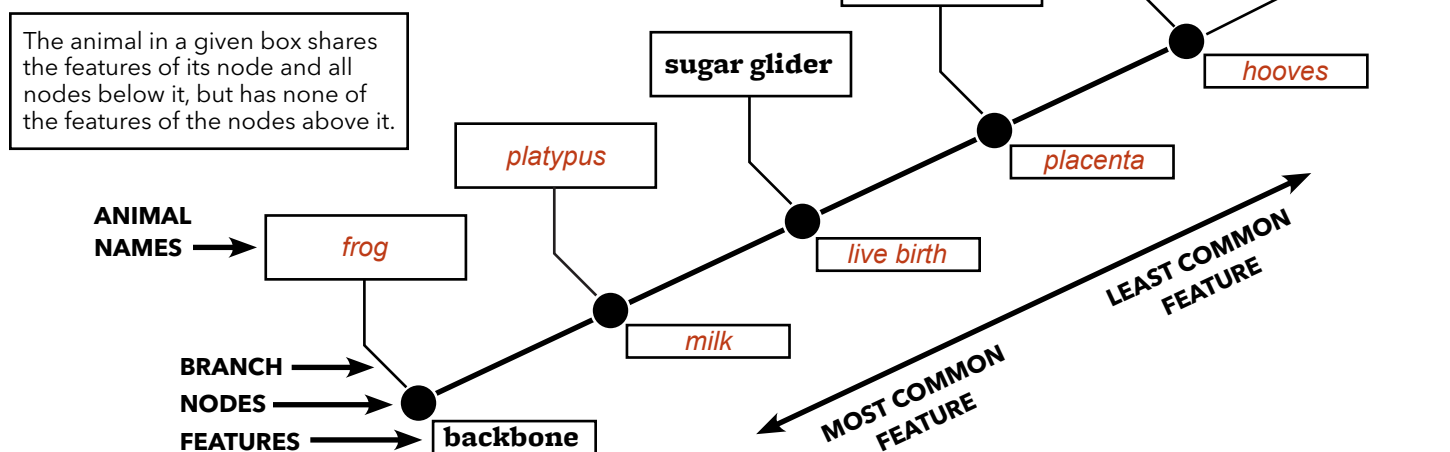
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MAMMAL: *Coryphodon*

1. *massive, sharp-edged tusks – uproot swamp plants*
2. *strong neck – uproot swamp plants*
3. *short lower limbs – support weight*

Now use the viewers at the sides of the diorama to take a look at what the environment of Ellesmere Island is like today. List three characteristics that would help a mammal survive in this environment.

1. *fur – warmth*
2. *short ears – reduce heat loss*
3. *white fur – camouflage*