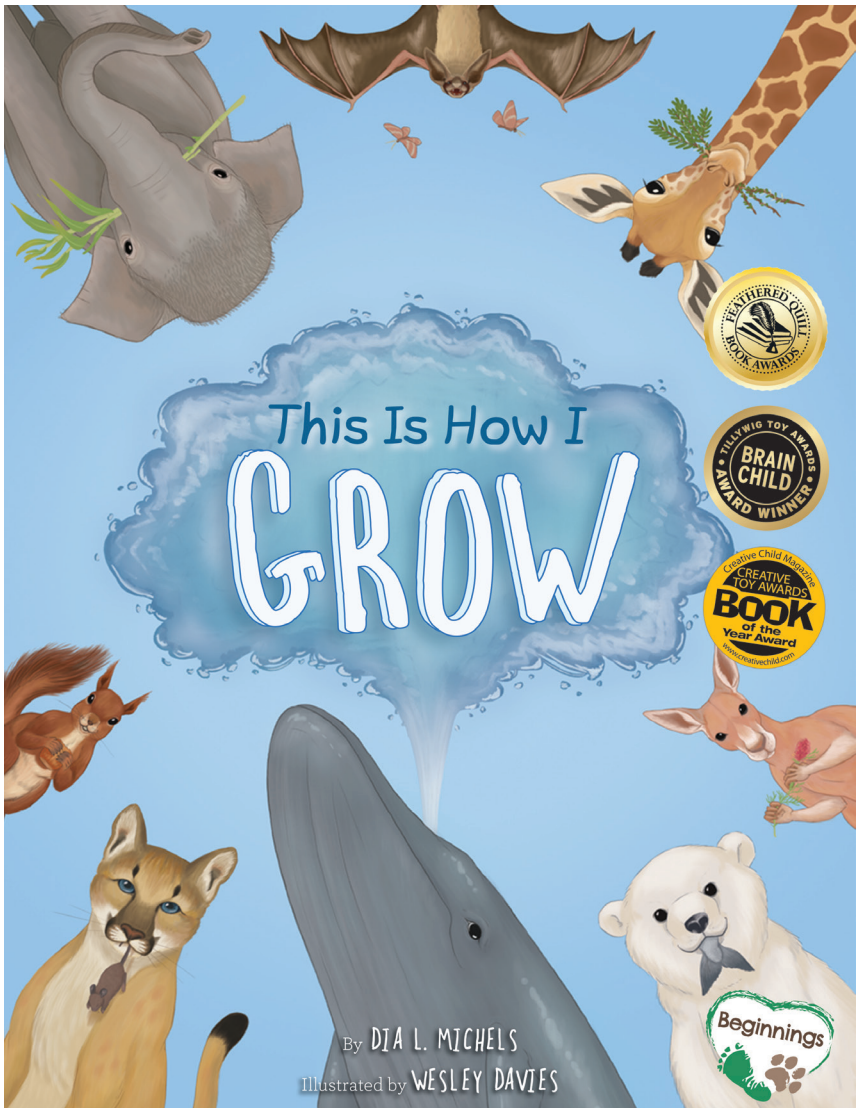
This Is How I Grow
Teacher's Guide

Written by Anna Cohen
Designed by Victoria Stingo



To be used with *This Is How I Grow*

Written by Dia Michels
Illustrated by Wesley Davies

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Table of Contents

Words that can be found in the glossary will be shown throughout this guide as bold, italicized, and as a color other than black. Example: ***mammal***

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Introduction

Why does a 52-page book need a Teacher's Guide?

Developing cognitive and literacy skills early in life helps children get a head start in their life-long education. Helping kids develop these skills by reading to them at an early age builds their vocabulary and grows cognitive and literacy competence. The evidence is clear that the more powerful a child's vocabulary is when they start school, the more successful they will be in the classroom. As they get older, it is just as important to continue to expand on those vocabulary skills.

When adults interact with children, speaking to them while using a wide range of words, neural connections of all kinds are strengthened. Studies show that children who are read to, whose parents have a large vocabulary, and who grow up in homes with a lot of adult/child conversations, have a large vocabulary, develop a larger vocabulary, and can describe things and feelings with vivid language.

For children who don't have this verbal advantage, this deficiency leads to a struggle with language that lasts a lifetime. As the *Atlantic Magazine* recently declared, "We believe that the poverty of vocabulary should be discussed with the same passion as child hunger."

What can you do? Keep your children safe, feed them nutritious foods, make sure they get exercise and fresh air… and talk, sing, and read to them. When you do these things with your child, use rich words, describe things with adjectives, use a large vocabulary, and, most importantly, engage and interact by asking questions.

This Teacher's Guide provides ideas and strategies for educators, parents, loved ones, childcare providers, and librarians to use *This Is How I Grow* as a teaching tool. We hope it will give you ideas to expand and extend the content and themes in the book.

Welcome to the Beginnings Collection

Dear Reader,

We're excited to introduce you to *This Is How I Grow*, part of our Beginnings collection. These beautifully illustrated, information-packed titles introduce youngsters to the fascinating world of animals, and, by extension, to themselves.

Scientific curiosity begins in childhood, with young minds thirstily absorbing information about the world around them. Exposure to animals—whether in nature or in a book—is often at the root of a child's interest in science. Young Jane Goodall loved to observe the wildlife near her home, a passion that inspired her groundbreaking chimpanzee research. Charles Turner spent hours reading about ants in the pages of his father's books before growing into a trailblazing entomologist. Spark curiosity in a child and watch them develop a lifelong enthusiasm for learning.

Beginnings books encourage children to make real-world connections that sharpen their analytical skills and give them a head start in STEM (science, technology, engineering, and math). Research shows that young children who are exposed to nonfiction develop strong vocabulary and reading comprehension skills, later translating to higher rates of student achievement.

More than an educational primer, these stories also illustrate and explore caring love in animal families. Showing children this type of attachment in the natural world fosters empathy, kindness, and compassion in both their interpersonal and interspecies interactions.

An easy choice for the home, library, or classroom, our Beginnings collection has something to spark or sustain budding curiosity in any child.

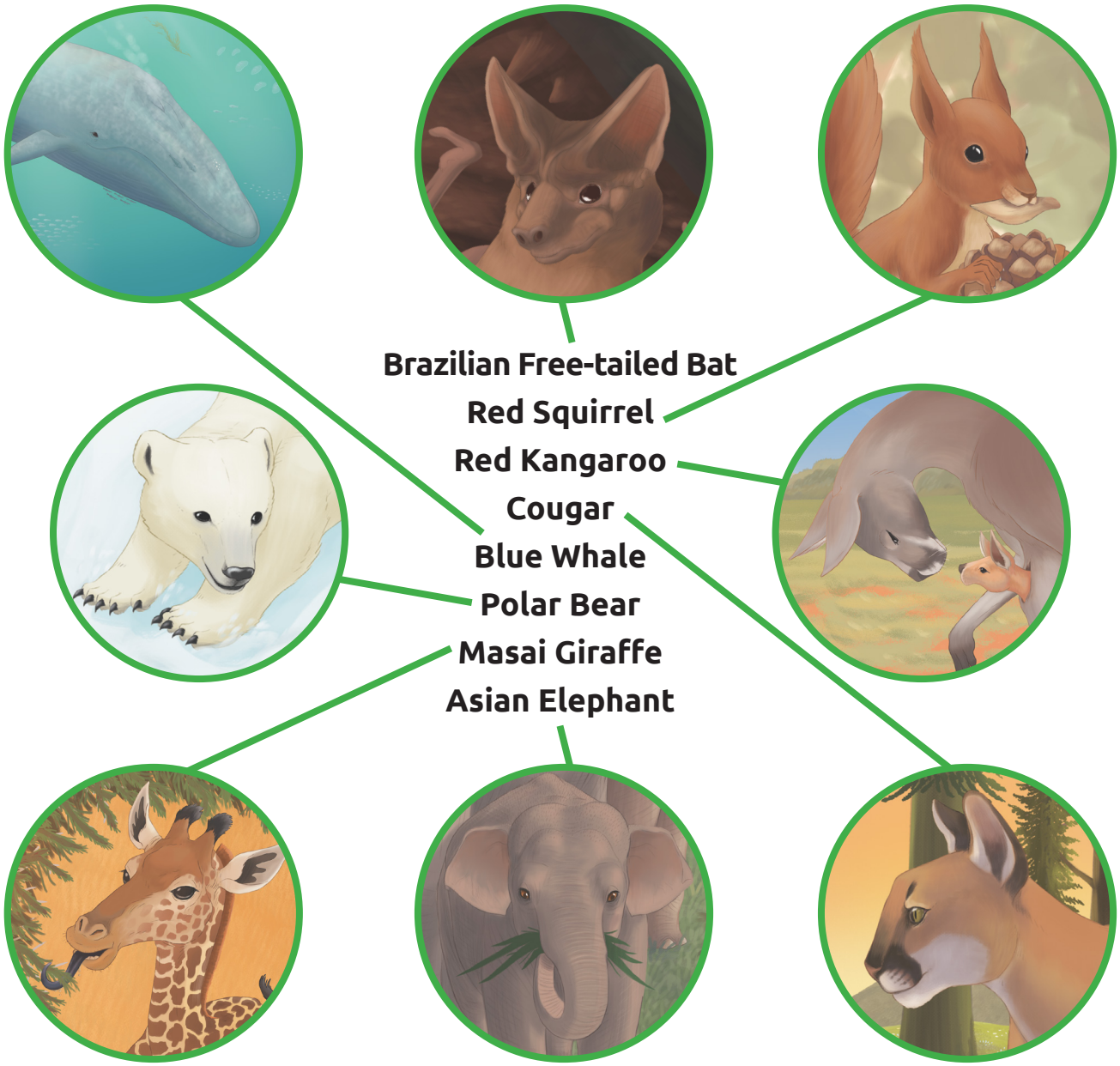
Enjoy!

Dia L. Michels
Publisher, Science Naturally

Meet the Mammals

This Is How I Grow provides an up-close look at the fascinating world of mammals. As readers learn about each animal baby's journey from helplessness to self-sufficiency—and identify the important milestones along the way—they will see the incredible diversity of the mammal class and recognize those things that unify all mammals. Readers will see themselves reflected in each creature's dependence on its mother, the intimate bond of the nursing relationship, and the gradual acquisition of essential skills that lead them to become *all grown up*.

This Is How I Grow contains illustrations of the following animals:



About the Author: Dia L. Michels

Dia L. Michels is an award-winning science and parenting writer who has authored or edited over a dozen books for both children and adults. While her topics include science and math books for middle grade students, her passion is promoting attachment parenting and supporting breastfeeding. The mother of three grown children, she lives in the Capitol Hill neighborhood of Washington, D.C., with four cats and a corgi, named Izzi.

She can be reached at Dia@PlatypusMedia.com.

About the Illustrator: Wesley Davies

Wesley Davies is an artist from New England who specializes in illustration and comic art. He received a Bachelor of Arts in anthropology from Kenyon College in 2017, graduating with Phi Beta Kappa honors, and has been making art all his life. Though he provided back matter illustrations for Platypus Media's 2018 publication, *Babies Nurse*, this is his first book. He currently lives in Rhode Island with his growing collection of houseplants.

He can be reached at WesDaviesArts@gmail.com.

About Wesley's Creative Process

Visual authenticity is essential when creating a science book because there's so much you can learn from looking at the pictures—what an animal looks like, how the family group is structured, what plants and other animals are in their environment, how big the animals are, and much more. We asked Wesley how he researched and made his art for *This Is How I Grow*.

For me, drawing is about two things: observation and consideration. First, I have to look at the subject I am going to draw or paint so that I understand what it looks like and how it moves, and then I have to figure out how to put that movement on the page.

The first thing I do when I'm going to start an illustration is gather references such as pictures, videos, or books that I find online or at the local public library. Sometimes I already know about an animal or environment because I have seen that animal before in the wild, at zoos, or wildlife sanctuaries. I will also gather references on where a subject lives and what the environment is like there. Once I have enough information, I will do some practice sketches or studies of the subject in a sketchbook or digitally on my computer tablet, which is where I do most of my drawing and painting. I try to keep these sketches simple and quick so I can get a feel for the basic shapes that make up each animal's form, and will make note of small details to remember for later.

Next, I will plan out a rough version of the illustration. This rough version is monochromatic (all done in many shades of the same color) to help me understand how I want the composition to look with light and shadow. This rough version will go through many revisions, and once it looks and feels right, I start to add details. When this is done, I add in blocks of color to the animals, which I will later paint over and refine. Having multiple layers of paint also adds to the richness and luminosity of the color, although I have to be careful not to add too much and accidentally make the colors muddy.
As I finish the background, I adjust the colors and shading on the subjects so they are more cohesive, and after I have done more revisions and checked over the illustrations for mistakes, the pieces will be finished.

What did you learn from looking at the pictures in the book? What questions do you have about what you saw? Some of your questions may be answered on the following pages...

Science Naturally would like to thank the following people for their hard work, invaluable insight, and dedicated time in creating *This Is How I Grow* and its accompanying Teacher's Guide:

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Mammal Expert

Victoria Stingo
Designer / Researcher

Ellen Roberts
Editor

Wesley Davies
Illustrator

Pre-reading: Book Walk

Grades: K–4
Subject: Reading, language arts
Skills: Active listening, critical thinking, making predictions
Common Core English Language Arts: *CCSS.ELA-LITERACY.CCRA.R.1:* Key Ideas and Details

A book walk is a pre-reading activity that aids in reading comprehension and builds curiosity and enthusiasm about reading this book. It prepares students to think about the important questions they should be asking as they read. For younger students, this book walk (or picture walk) also helps develop their reading skills. They learn to use the visual text of the pictures to understand what the story means and make educated guesses about unfamiliar words.

Get set up for story time. Have students sit in a circle so they can all see you and can talk with one another.

Tell your students that you will be reading a book called *This Is How I Grow*. Discuss and ask them: ***What do you think this book will be about?***

Ask your students questions. ***How do you grow? What do you need to help you grow? How do you know if you're grown up?***

Then, show them the book's cover and ask them new questions. ***Now what do you think it will be about?*** Can they be more specific than before? ***Who is the "I" in the title? Who will be growing in this book? Can you name the animals on the cover? What do the animals have in their mouths? What does this have to do with growing?***

Slowly flip through the book, page by page (or looking at a few pages you selected in advance), without reading any of the words. Ask you students questions about the pictures they see. ***What is going on here? Who are the characters on the page? What do you think their relationship is? What are the animals doing? Is this the same day as the page before? Is it the same habitat as the page before?***

Give vague responses that don't give away the story. Say things like, "***Are you sure about that?"*** or ***"That's possible!"*** or ***"What makes you think that?"*** This will plant the seed for an enthusiastic discussion while you read the book or when the reading is done.

Flip the book over and read the back cover, then start your usual read-aloud session.

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Section 1: Book-Based Activities

The mammals in this book have been carefully chosen to illustrate the breadth and depth of the mammal class. They are found all over the globe, in a variety of climates, and each plays a unique and essential role in the harmonious existence of the other creatures in their respective habitats.

The activities in this section take advantage of this diversity to explore key concepts about the mammal class and the natural world at large.

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Grades
1–5

Subject
Mammal reproduction, classification, biodiversity, reading

Skills
Identifying, sorting, observation, active reading

Materials
- *This Is How I Grow*

Next Generation Science Standards
- *LS1B:* Growth and Development of Organisms
- *1-LS1-2:* From Molecules to Organisms: Structures and Processes
- *3-LS4:* Biological Evolution: Unity and Diversity

Common Core English Language Arts
- *CCSS.ELA-LITERACY.CCRA.R.1:* Key Ideas and Details

Activity: How Were You Born?

Background

Scientists divide mammals into categories based on how they develop both before and directly after birth. This book depicts animals in two of these categories:

Placentals: Mammals who carry their fetus in the uterus of the mother until a relatively late stage of development. The embryo completes its development while inside the uterus, nourished by an organ called the placenta.

Marsupials: Mammals who begin development inside the uterus of the mother but gestate for only a short time and are born incompletely developed. The embryo completes its development inside a pouch on the mother's belly, continuously suckling mother's milk for nourishment.

Activity

1. Review the above background as a class.

2. Read through the book together, paying special attention to how each animal's birth and very early childhood is described. Based on this, discuss how you would classify each of the animals in the book.

3. Return to the Teacher's Guide for answers.

Answers on back...

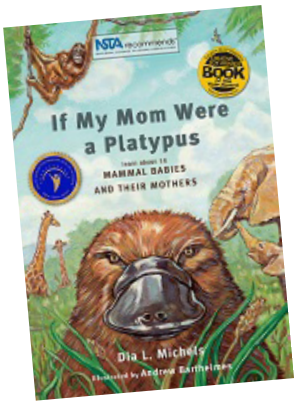
Brazilian Free-tailed Bat - Placental
Red Squirrel – Placental
Red Kangaroo – Marsupial
Cougar – Placental
Blue Whale – Placental
Polar Bear – Placental
Masai Giraffe – Placental
Asian Elephant – Placental

Additional Information

Did you know that there's a third type of mammal?

This third category is called ***monotreme***. Monotremes are more rare than placentals and marsupials. Unlike the other two categories, monotremes do not give birth to live young or gestate inside the mother's uterus at all. Instead, the embryo develops inside an egg.

Ask your students if they can think of any examples of monotremes. Check out the book *If My Mom Were A Platypus* to learn more about this very special kind of mammal.



If My Mom Were a Platypus:
Mammal Babies and Their Mothers
Written by Dia L. Michels
Illustrated by Andrew Barthelmes
Ages 8-12 • 7 x 10" • 64 pages
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Also available in Spanish, Hebrew, and Dutch!

Grades
1–5

Subject
Symbiotic relationships, biodiversity, reading

Skills
Identifying, observation, reading, inference

Materials
- *This Is How I Grow*

Next Generation Science Standards
- *K-ESS3-1:* Earth and Human Activity
- *1-LS1-2:* From Molecules to Organisms: Structures and Processes
- *5-ESS2:* Earth's Systems

Common Core English Language Arts
- *CCSS.ELA-LITERACY.CCRA.R.1:* Key Ideas and Details

Activity: Who Do You Know?

Background

Animals and other organisms that live in their environment rely on one another to maintain the status quo. Each species of animal has a relationship with every other creature in its habitat. These relationships fall into three categories:

Mutualism: A relationship where both members benefit.

Parasitism: A relationship where only one member benefits (this member is known as the parasite) while the other one suffers (this member is known as the host).

Commensalism: A relationship where one member benefits while the other is neither helped or harmed.

Activity

1. Review the above background as a class.

2. Page through the book together, paying special attention to the pictures. Ask the following questions:
   What kinds of animals do you see interacting with one another?
   How are they interacting?
   How do these relationships fit into the classifications outlined above?

3. Return to the Teacher's Guide for some answers.

Did you find any relationships that we don't have listed? We'd love to hear from you super sleuths!

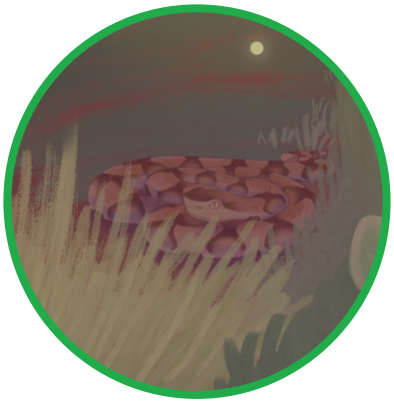
Tweet us @ScienceNaturally using the hashtag #TIHowIGrow, post on our Facebook wall (Facebook.com/Science-Naturally), or email us at TIHIG@ScienceNaturally.com.

Answers on back...

Who Do You Know?
Answers

Bats & Cockroaches
Commensalism

Cockroaches and other bugs live on the floors of caves that bats roost in. They eat the bat poop (guano) that accumulates on the cave floor. They also eat the carcasses of any bats that die and fall to the ground.



Bats & Snakes
Parasitism

These snakes eat bats for dinner. They wait by the cave entrance at dusk, which is when the bats leave to find food. If a bat flies too close to one of these snakes, the snake will attack!

Kangaroos & Dingos
Parasitism

Dingos are one of the few predators that hunt kangaroos. Adult kangaroos are too big, too fast, and too strong for a dingo to hunt effectively, but a kangaroo joey is the perfect meal.

Giraffes & Zebras
Commensalism

Giraffes have incredible eyesight—and are incredibly tall—which makes them the lookouts of the Savanna. When a giraffe spots a predator coming, it takes off running. This is a signal to the other animals in the area—including zebras—that they should run away too.

Giraffes & Oxpeckers
Mutualism

Oxpeckers are birds that sit on the backs of stationary or grazing giraffes. The birds eat ticks and dead skin off of the giraffes, which feeds the birds while cleaning the giraffes of the disease-carrying bugs.

Elephants & Tigers
Parasitism

Baby elephants make a great snack for a tiger. Tigers would happily eat adult elephants, but they're far too big to hunt. A tiger will only attack an adult elephant if it is desperate for food. They prefer to lurk near a herd with a newborn calf and wait until the little one is left unattended to strike.

Grades
1–5

Subject
Habitats, biomes, food chains, energy flow in organisms, reading

Skills
Identifying, observation, active reading, inference

Materials
- *This Is How I Grow*

Next Generation Science Standards
- *K-ESS3-1:* Earth and Human Activity
- *1-LS1-2:* From Molecules to Organisms: Structures and Processes
- *2-LS4-1:* Biological Evolution: Unity and Diversity
- *5-ESS2:* Earth's Systems

Common Core English Language Arts
- *CCSS.ELA-LITERACY.CCRA.R.1:* Key Ideas and Details

Activity: Where Do You Live?

Background

A ***habitat*** is the place where an animal lives. It has the food, water, and shelter that each animal native to the habitat needs. Each habitat is home to a variety of different animals that work together to keep the whole habitat and all the living beings in it in a healthy balance. *For more on these relationships, see the* ***Who Do You Know? Activity*** *(page 17).*

Every animal has unique needs that can only be met in particular habitats. There are many different kinds of habitats around the world.

Please see the next page for descriptions of the different habitats found around the world.

Activity

1. Review the above background as a class and review the different kinds of habitats on the back of this page (page 20).

2. Read through the book together, pausing on each animal for students to hypothesize in which habitat each animal lives. Ask them what clues they found in the visual and written text to lead them to this conclusion.

3. Return to the Teacher's Guide for answers.

More on back...

Different Habitats

The animals of the world can be found in the following habitats:

Forest: There are two main kinds of forests: ***deciduous forests*** full of trees that drop their leaves in the autumn and winter, and ***coniferous forests*** where the trees have needles instead of leaves and stay green all year. Whether or not the trees stay green throughout the year, forests change with the seasons. They're warm in summer and cold in winter. Animals that live in forest habitats have adapted to change with the seasons—to prepare for winter they gather and store food, grow thick coats, or migrate to warmer climates.

Grassland: This climate is too dry to support many trees; instead, the ground is covered in different kinds of grasses. This also means there aren't many places for animals to hide from predators, so many have adapted to make their homes underground. Here the land is so wide open, and larger grassland animals travel in large groups, called ***herds***. Grasslands cover much of the Earth's surface, but are called different things in different areas: *savannas, prairies, steppes, velds,* and *pampas* are all different kinds of grasslands.

Mountain: The high altitude of mountain climates means there's not much oxygen available to support the plants and animals that live in those habitats—and it's very, very cold. Luckily, many of the inhabitants of mountaintop habitats have adapted to tolerate lower oxygen levels and harsh temperatures. Animals that live there grow thick coats, hibernate through the winter, or migrate seasonally to warmer temperatures.

Desert: Deserts are the driest places on Earth! You might think that nothing can live in a desert because there's so little water, but most deserts are full of life. The plants and animals that live there have adapted to survive without much water. Some plants store water in their stems, while others only sprout and bloom while it rains. The animals that live in deserts get most of their water from their food, and stay underground or in the shade during the day, only coming out after the sun sets.

Rainforest: Rainforests are warm, wet, and bursting with plants and animals. More than half of the world's animals live in the rainforest. Trees and other plants here grow extremely tall, competing for sunlight, and form four distinct layers. The trees and vines form a solid connected layer of vegetation, called the canopy, where many of the animals in a rainforest habitat live.

Polar Ice: These freezing habitats are located at the north and south poles of the planet Earth. It's too cold to rain here, but the poles are covered in snow. It's hard for plants to grow on the polar ice because there's so little water and very little soil for their roots to take hold. While there are no trees in this habitat, some smaller plants do manage to grow for a few months out of the year. The animals that live in polar habitats have adapted to survive in the extreme cold.

Freshwater: *Rivers, ponds, lakes, creeks, streams, wetlands, swamps,* and *marshes* are all freshwater habitats. Although these habitats are defined by the water present, not all plants and animals in a freshwater habitat live under water. Some types of birds live off of the fish and other water-bound creatures, while many of the plants in freshwater habitats use their roots to filter pollution from the water.

Marine: Salt water covers more than 70% of the Earth's surface! The temperature, depth, and distance from the shore determines the types of creatures living in a particular part of the ocean. Oceans are home to the world's smallest and largest animals, as well as a huge variety of plant life.

Occasionally these habitats overlap. For example, forests may exist on mountainsides. Freshwater habitats may run through a rainforest. Can you think of any places in *your* habitat where this happens?

Habitat definitions adapted from Nat Geo Kids.

Brazilian Free-tailed Bat - Grassland and/or Forest*
Red Squirrel – Forest
Red Kangaroo – Grassland
Cougar – Forest and/or Mountain
Blue Whale – Marine
Polar Bear – Polar ice
Masai Giraffe – Grassland
Asian Elephant – Grassland and/or Forest

*As you see in the text, Brazilian free-tailed bats spend much of their times in caves. Caves are dark, rocky, underground caverns. They are home to a wide variety of life, many of which have adapted to live in total or complete darkness. This is why bats have such strong senses of smell and hearing, but cannot see very well.

However, bats do not spend all of their time inside the cave. Caves are where they sleep, and, most importantly, where they keep and care for their young—but caves do not contain everything a bat needs to survive. Mature bats leave their cave at night to hunt for food in nearby forests or grasslands.

The Brazilian free-tailed bat habitat depicted in *This Is How I Grow* is modeled after Devil's Sinkhole, Texas. Devil's Sinkhole is home to one of the largest colonies of Brazilian free-tailed bat species in the United States. This area is a grassland with an opening to an enormous below-ground cavern. The opening is 50 feet wide and continues underground for 140 feet before opening into an even larger cave (320 feet wide by 210 feet deep). Every summer, this cave is home to over 3 million mother and baby bats.

Expand the Activity: Food Chains

Because habitats are self-contained (meaning that each habitat holds everything that every creature living there needs to survive), and some of the animals are carnivores (meaning that they eat other animals), animals that share a habitat will hunt and eat one another.

These relationships typically only go in one direction: lions eat antelope, but antelope don't eat lions; antelope eat grass, but grass makes its own energy from the sun. When you map these relationships, you get a visual representation called a ***food chain:***

Look back through *This Is How I Grow*, examining the pictures to identify other animals in the habitat. Can your students make a food chain for each of the habitats depicted in the book?

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Grades
2–5

Subject
Sociality, biodiversity, reading

Skills
Identifying, sorting, observation, active reading, inference

Materials
- *This Is How I Grow*

Next Generation Science Standards
- *1-LS1-2:* From Molecules to Organisms: Structures and Processes
- *3-LS2-1:* Ecosystems: Interactions, Energy, and Dynamics

Common Core English Language Arts
- *CCSS.ELA-LITERACY.CCRA.R.1:* Key Ideas and Details

Activity: Who Do You Live With?

Background

In the wild, all mammals are raised by their mothers, but, for some species, this is the only time in their lives that they will live with someone else.

These animals are known as ***solitary mammals***, and will spend most of their adult life alone. The only exception to their solitude is when they have children of their own; they will live with their young until the offspring are weaned and can survive on their own. Scientists think that part of the reason these animals are solitary is because some species have a hard time getting enough food, so it's easier to live alone, keeping all the food in their home area, or ***territory***, for themselves.

Other animals are ***social mammals***, meaning that they spend most of their lives with others of their species—usually members of their own families. There are benefits to this, too. One benefit is defense from predators; it's much harder to fight a group than a single animal.

Activity

1. Review the above background as a class.

2. Read through the book together, pausing after each animal vignette. Hypothesize whether each animal is social or solitary. Ask prompting questions like:
   What clues in the visual and/or written text lead you to that conclusion?
   What other advantages can you think of for being social?
   What other advantages can you think of for being solitary?
   What are the downsides?

3. Return to the Teacher's Guide for answers.

Answers on back...

Brazilian Free-tailed Bat - Social
Red Squirrel – Solitary
Red Kangaroo – Social
Cougar – Solitary
Blue Whale – Solitary
Polar Bear – Solitary
Masai Giraffe – Social
Asian Elephant – Social

Additional Information

Some animals actually fall into a gray zone between social and solitary.

Masai giraffes and Asian elephants are good examples of this. Females spend their whole lives with the herd they were born into. As juveniles, they help take care of other calves in the herd. When they are older, they will have babies of their own that they will raise with the help of the herd.

However, males leave the herd as juveniles. They become aggressive as they age and reach maturity, and the matriarchal herd does not tolerate violence. Eventually, juvenile males leave or are driven out. While males spend more time alone, they often join up with other males to form a "bachelor herd." For this reason, giraffes and elephants are still both generally considered to be social animals.

Grades
4–5

Subject
Breastmilk, nutrition, nutrient density, parental care, reading

Skills
Observation, active reading, inference, hypothesizing

Materials
- *This Is How I Grow*
- What Did You Eat? Milk Composition Comparison Table (on back)

Next Generation Science Standards
- *LS1B:* Growth and Development of Organisms
- *K-LS1-1:* From Molecules to Organisms: Structures and Processes
- *1-LS1-2:* From Molecules to Organisms: Structures and Processes
- *3-LS4:* Biological Evolution: Unity and Diversity
- *4-LS1-1:* From Molecules to Organisms: Structures and Processes

Common Core English Language Arts
- *CCSS.ELA-LITERACY.CCRA.R.1:* Key Ideas and Details

Activity: What Did You Eat?

Background

Every mammal's first food is their mother's milk. Breastmilk is an amazing substance produced by the mother's body and released through the breast, usually via the nipple. This liquid contains the perfect balance of nutrients (carbohydrates, fat, protein, vitamins, and minerals) that each mammal needs to grow big and strong. Plus, breastmilk boosts the child's immune system, establishes their microbiome (good bacteria in their gut that aids in digestion), and provides hormones that help the baby adjust to life outside the womb.

Water is typically the most abundant ingredient in mammal milk, but this takes up a lot of space without giving any nutritional boost or energy. Its primary purpose is to help with ***thermoregulation***. Though there are hundreds of known ingredients in breastmilk, fat and protein are among the most important. These keep a baby full for a long period of time.

The amounts of each ingredient present in mother's milk can change based on each child's needs. This changes over time (newborn babies need a milk called colostrum that turbo-charges the child's immune system so they can survive outside of the mother's body, while older ones need higher levels of fat and lactose to help them grow), but also changes based on each baby's immediate needs; if a child is sick, their mother's body can tell and will make the antibodies needed to help the child get better.

Just like human breastmilk perfectly meets a human baby's needs, the breastmilk of different animals is perfectly designed to meet each animal baby's needs.

Activity

1. Review the above background as a class.

2. Look at the **What Did You Eat? Milk Composition Comparison Table** (page 26) together. Discuss what differences you see between the composition of different mammals' milk. What are the highest numbers? The lowest? Hypothesize why each mammal has their specific breastmilk composition.

3. Read through the book for clues about each animal's needs, and discuss how breastmilk with different compositions would meet those varied needs.

4. Return to the Teacher's Guide for some answers.

What Did You Eat? Milk Composition Comparison Table on back...

What Did You Eat?
Milk Composition Comparison Table

Milk composition for the animals in *This Is How I Grow.*

(Percentages are approximations, simplified to whole numbers for ease of reference and use)

Mammal	% Water	% Sugar	% Fat	% Protein
Brazilian Free-tailed Bat	Unknown*	Unknown*	20	8
Red Squirrel	Unknown*	Unknown*	18	8
Red Kangaroo	80	4	7	6
Cougar	77	3	6	12
Blue Whale	54	<1	30	13
Polar Bear	54	5	27	11
Masai Giraffe	81	5	7	5
Asian Elephant	75	3	12	5

**Limited data is available for Brazilian free-tailed bats and red squirrels.*

Note: Sugar attracts water, which displaces fat, so milk will never have high levels of both sugar and fat at the same time.

What Did You Eat?
Answers

Whales and polar bears have some of the fattiest milk in the animal kingdom. This ensures that whale calves and polar bear cubs fatten up quickly. They need a lot of body fat (known as ***blubber***) to keep themselves warm in their frigid environment.

Brazilian free-tailed bat milk has a high fat and protein percentage when compared to other bat species. Scientists hypothesize that this is because Brazilian free-tailed bats roost in a different area of the cave than their pups, reuniting to feed them twice a day. Since they spend so much time apart, the milk must have high concentrations of nutrients to sustain the pup between feeds.

This is in stark contrast to mammals like kangaroos. A kangaroo joey spends all of its time in its mother's pouch or at her feet, which means it can nurse on demand, whenever it gets hungry. Accordingly, we can see that a much lower percentage of a red kangaroo's milk is composed of fat and protein.

Expand the Activity: "Feed and Leave" or "Contact and Carry"

Scientists believe that the biology of a mother's milk actually predicts her species' mothering behavior. They identify two categories of mammals based on their care behaviors and the composition of their breastmilk:

"Feed and leave" species produce milk that is high in fat and protein, but low in carbohydrates. It is high in calories, allowing for a long interval between feedings.

"Contact and carry" species produce milk that is low in fat and protein, but high in carbohydrates. Their milk is low in calories, conforming to a short interval between feedings.

Can your students figure out which animals in *This Is How I Grow* are "feed and leave" and which are "contact and carry"?

*Information adapted from "Mother-Infant Cosleeping with Breastfeeding in the Western Industrialized Context: A Bio-Cultural Perspective," James J. McKenna and Lee T. Gettler (**http://www.walc.net/wp-content/uploads/2017/02/Bio-Cultural-Cosleeping-in-Industrialized-Context.pdf**).*

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Grades
K–3

Subject
Heredity, phenotype

Skills
Matching, making inferences, memory

Materials
- *This Is How I Grow*
- Who is Your Mother? Worksheet (on back)

Next Generation Science Standards
- *1-LS3-1:* Heredity: Inheritance and Variation of Traits

Activity: Who Is Your Mother?

Background

Some mammals are born quite immature and don't look much like they will when they're all grown up. In this activity, students will use their memory of the illustrations in the book to match the mammal baby to its mother.

Activity

1. Distribute the **Who Is Your Mother? Worksheet** (page 30). Instruct students to match the mammal baby to its mother.

2. Read through the book together, paying particular attention to the illustrations.

3. Discuss as a class:
   Which were easy to match and why?
   Which were difficult and why?
   What do these animals all have in common?

Who is Your Mother? Worksheet on back...

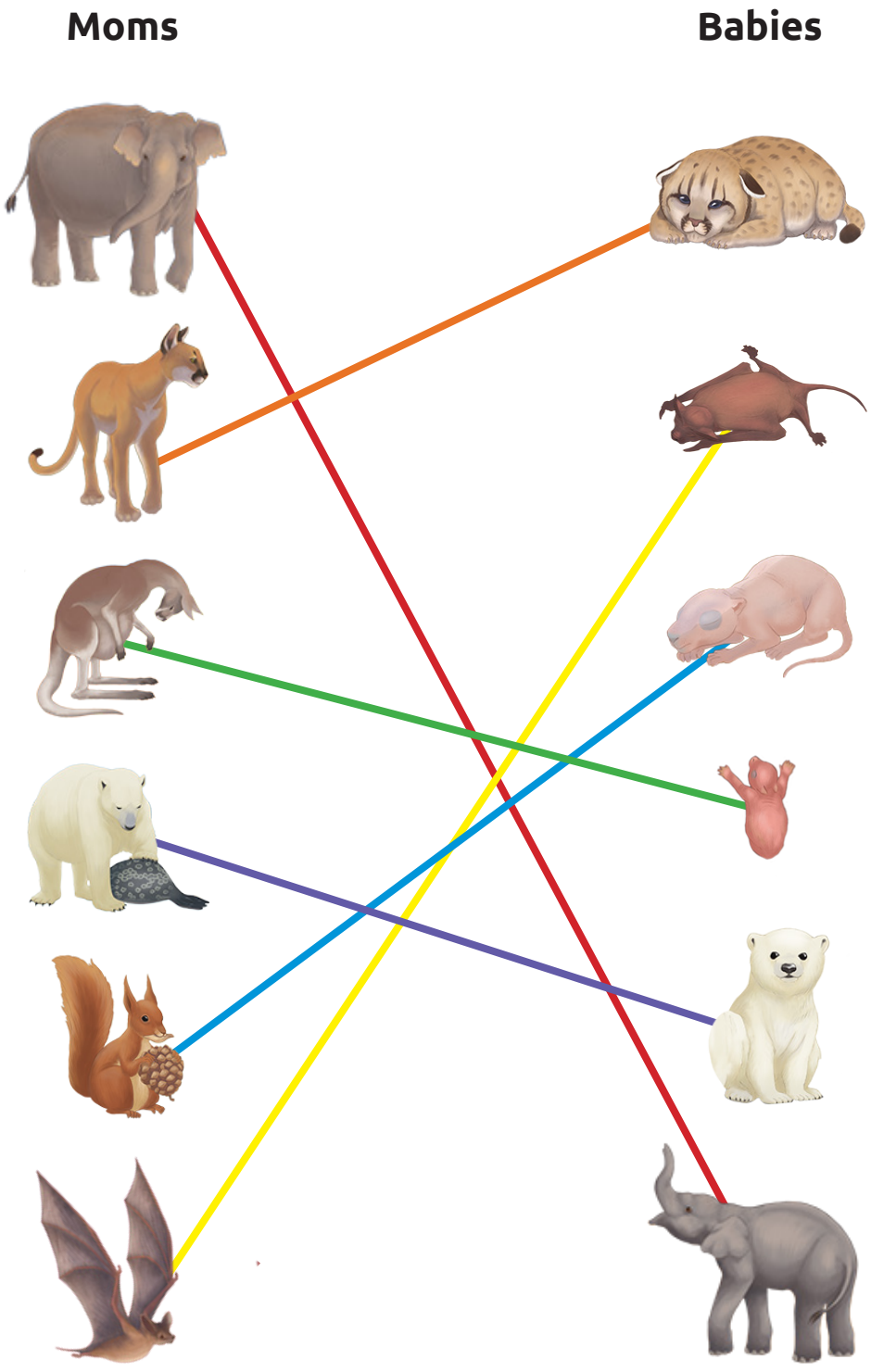
Who Is Your Mother?
Worksheet

Match the mammal moms to their babies by drawing a line connecting each image.

Moms

Babies

Who Is Your Mother?
Answers



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Grades
1–5

Subjects
Nutrition, feeding behaviors, classification, biodiversity, reading

Skills
Identifying, sorting, observation, active reading, inference

Materials
- *This Is How I Grow*
- What Do You Eat Now? Worksheet (on back)

Next Generation Science Standards
- *K-LS1-1:* From Molecules to Organisms: Structures and Processes
- *1-LS1-2:* From Molecules to Organisms: Structures and Processes
- *3-LS4:* Biological Evolution: Unity and Diversity
- *4-LS1-1:* From Molecules to Organisms: Structures and Processes
- *5-LS2:* Ecosystems: Interactions, Energy, and Dynamics

Common Core English Language Arts
- *CCSS.ELA-LITERACY.CCRA.R.1:* Key Ideas and Details

Activity: What Do You Eat Now?

Background

Even after weaning, every animal has different dietary needs. Different species have different diets, based on the food available in their habitat, their physical abilities, and what nutrients their bodies need to perform their particular functions. Each animal belongs to one of the following categories:

Herbivore: An animal that eats only plants.

Carnivore: An animal that eats only meat.

Insectivore: An animal that eats only bugs and insects.

Omnivore: An animal that eats a combination of plants and meat and/or insects.

Activity

1. Review the above background as a class.

2. Distribute the **What Do You Eat Now? Worksheet** (page 34).

3. Read through the book together, pausing after each animal's vignette for students to guess which category it falls into. Students should circle their prediction on the handout.

4. Return to the Teacher's Guide for answers and more information.

5. Discuss the answers as a class as each student checks their own worksheet. Ask prompting questions like:
   What clues in the visual and written text point to the correct answer?

What Do You Eat Now? Worksheet on back...

Herbivore, Insectivore, Carnivore, or Omnivore

Which animal becomes a herbivore, insectivore, carnivore, and omnivore when they grow up? As you read *This Is How I Grow*, circle your guess for each animal.

Brazilian Free-tailed Bat	Herbivore	Insectivore	Carnivore	Omnivore
Red Squirrel	Herbivore	Insectivore	Carnivore	Omnivore
Red Kangaroo	Herbivore	Insectivore	Carnivore	Omnivore
Cougar	Herbivore	Insectivore	Carnivore	Omnivore
Blue Whale	Herbivore	Insectivore	Carnivore	Omnivore
Polar Bear	Herbivore	Insectivore	Carnivore	Omnivore
Masai Giraffe	Herbivore	Insectivore	Carnivore	Omnivore
Asian Elephant	Herbivore	Insectivore	Carnivore	Omnivore

Brazilian Free-tailed Bat - Insectivore
Red Squirrel – Omnivore*
Red Kangaroo – Herbivore
Cougar – Carnivore
Blue Whale – Carnivore**
Polar Bear – Carnivore***
Masai Giraffe – Herbivore
Asian Elephant – Herbivore

Additional Information

*Squirrels mostly eat nuts and seeds, but sometimes add insects, mice, or young birds and eggs they steal out of nests.

A blue whale's main food is ***krill*, a tiny, shrimp-like animal that exists in open seas. It may seem odd that the world's largest animal eats such a tiny creature, but krill exist in such large quantities that whales can easily fill up after eating all day. Think of it this way: one grain of rice is unbelievably tiny, but a whole bowl full of rice is enough for a meal.

Blue whales eat in a really interesting way. Instead of teeth, they have something called baleen. Baleen are essentially a bunch of bristles which are used like a sieve or strainer. They look like they have a fine toothed-brush in their mouths! With these, baleen whales can swim through a cloud of krill with their mouths open, gulping up the krill and water. They will then push the water back out through the baleen, keeping the krill and other fish in their mouths. *To see how the baleen works, see the **Baleen Scene Activity** (page 89).*

Polar bears mostly eat seals, but some scientists don't actually consider polar bears to be carnivores. This is because the polar bear doesn't eat most of the seal meat. Instead, adult polar bears mostly eat the fatty parts of the seal. For this reason, some scientists consider polar bears to be ***lipivores—meaning fat eaters.

*Wondering what happens to the rest of the seal meat that polar bears leave behind? See the **Who Do You Know? Activity** (page 17) to learn more.*

*For more information on how an animal's diet affects and is shaped by their anatomy, see the **Elephant Teeth Activity** (page 81).*

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Grades
3–6

Subjects
Habitats, ecosystems, communities, phenotype

Skills
Research, identification, asking questions, making predictions, using visual context clues, describing evidence

Materials
- *This Is How I Grow*
- Animal Research Reputable Resources List (page 70)
- Computer with Internet access

Next Generation Science Standards
- *2-LS4-1:* Biological Evolution: Unity and Diversity

Common Core English Language Arts
- *CCSS.ELA-LITERACY.CCRA.R.1:* Key Ideas and Details
- *CCSS.ELA-LITERACY.CCRA.R.7:* Integration of Knowledge and Ideas

Activity: Visual Cues Research

Background

Wesley Davies' detailed illustrations provide more information about each animal's habitat than the written text can convey. As you read the book you may notice that no habitat is home to only one kind of animal. In fact, there are only two illustrations in the whole book that depict only one animal species; can you find them?

In this activity, students will focus on one of these "background characters" from the illustrations in *This Is How I Grow*. They will analyze the visual text to determine as much information as they can about their chosen animal.

This activity can be completed individually or in pairs or groups, depending on the skills of your students. It can also be expanded or truncated to suit your class' needs. It can be a shorter in-class activity or a longer take-home project (or completed over several class periods).

Activity

1. Review the above background as a class.

2. Review online research/searching strategies. It may be appropriate to collaborate with your school librarian for this lesson. Discuss with your students what makes a reputable resource. Direct them to the resource list in *This Is How I Grow* (page 42 in the book) or pass out the **Animal Research Reputable Resources List** found in this Teacher's Guide (page 70). The resources this list contains are a good place for your students to start their research.

3. Pass out copies of *This Is How I Grow* to each student (or group of students). Instruct them to page through the illustrated pages and find an animal (not the main species featured) to research further. You may want the students to register their choice with you so no student is working with the same animal as another. Alternately, you might want to conference with each student individually and look through the book together as they select which animal they want to investigate. Based on the information they discover, each student will be guessing the identity of their chosen animal.

More on back...

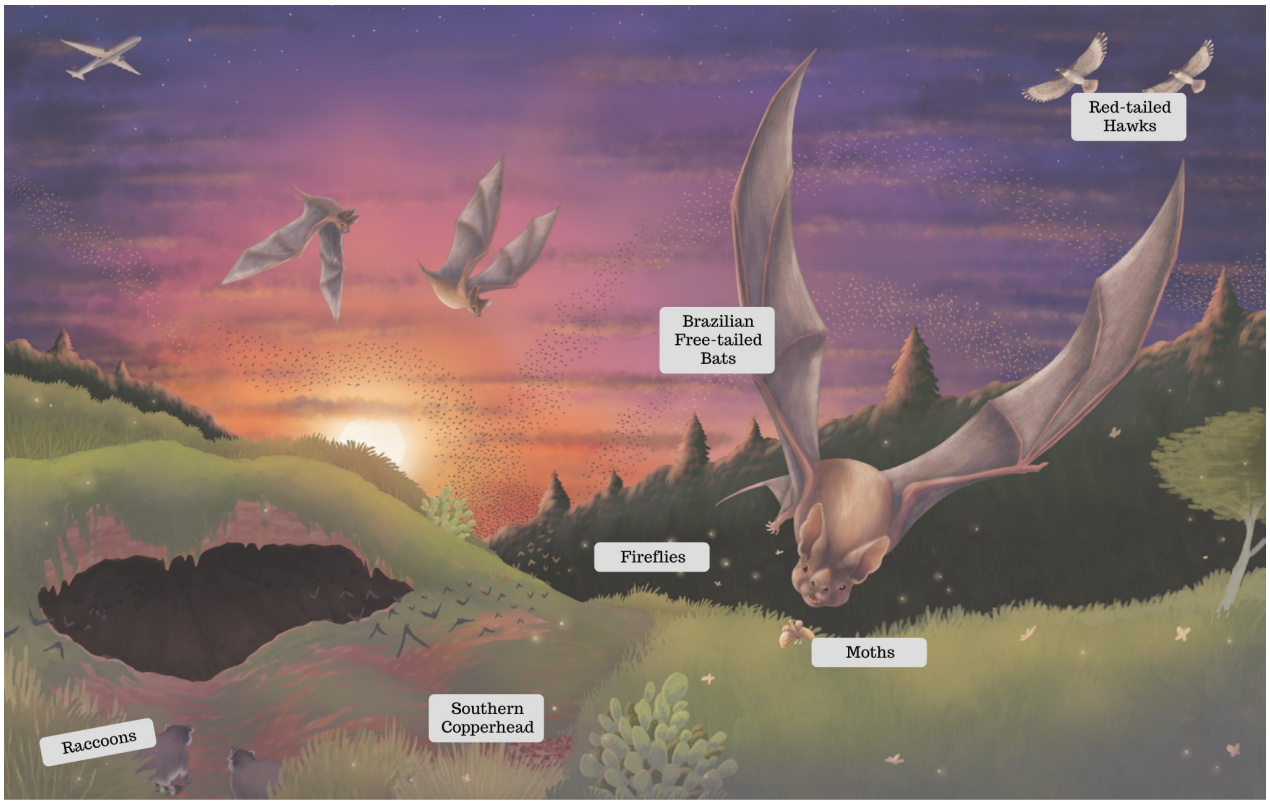
4. Students should examine the context clues provided in the illustrations to learn more about their chosen animal. They may want to consider the following specific questions:

What does the animal look like? Is it big or small? Does it have fur?
How many legs does it have?
What's at the end of the animal's arm? Flippers? Wings? Paws? Hooves?
Based on these visual cues, do you think it is an insect, reptile, amphibian, mammal, or bird?
What habitat is the animal in? *(Hint: students can search the name of the main animal in the picture, the one that they know for sure, to determine where in the world and what kind of habitat their research subject lives in.)*
Is the animal social or solitary?
What does it eat? Can you tell if it is a carnivore, herbivore, or omnivore?
Is it active during the day or at night?

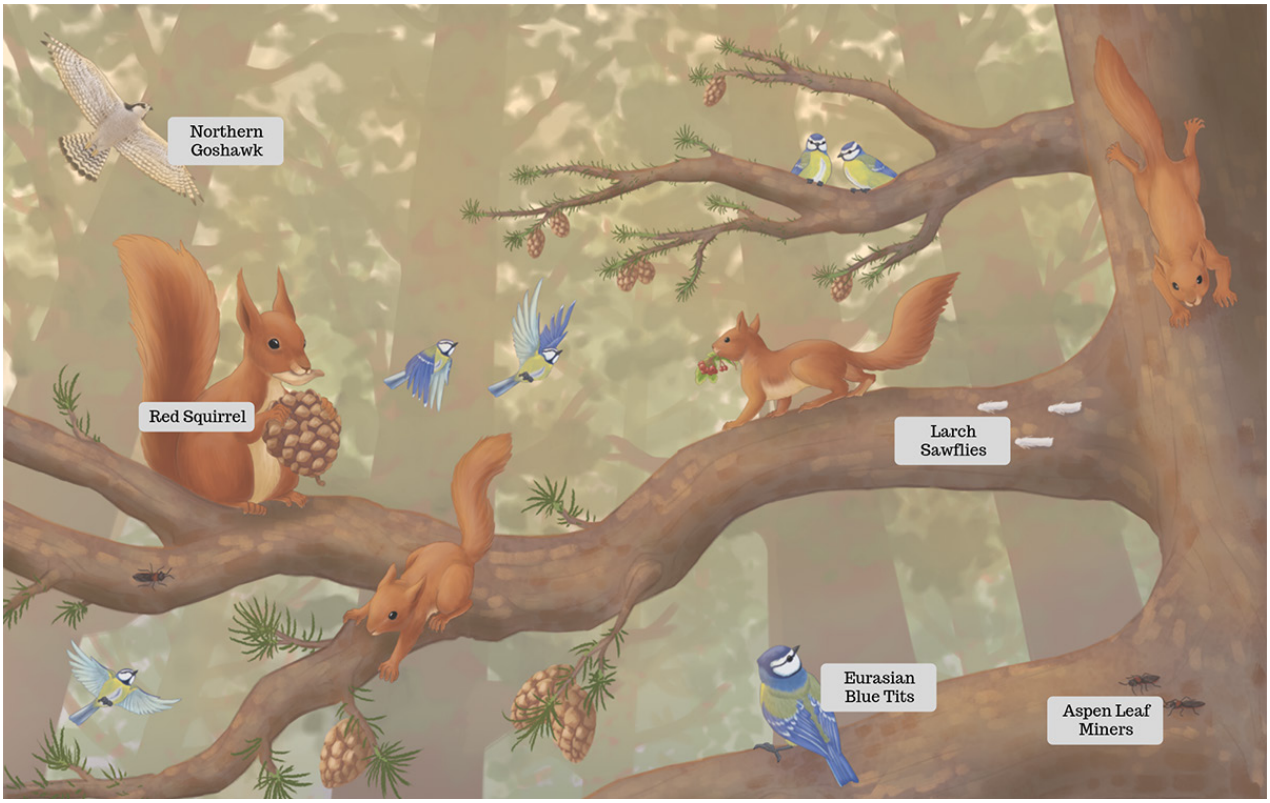
5. Based on each student's visual analysis of the illustrations and using the resources provided, students should present their hypothesis about what animal they have chosen and discuss what clues led them to this belief. This could take the form of an essay (formal or informal) or an in-class presentation.

6. Use the answer key on the following pages to determine the actual identity of the animal(s) in question.

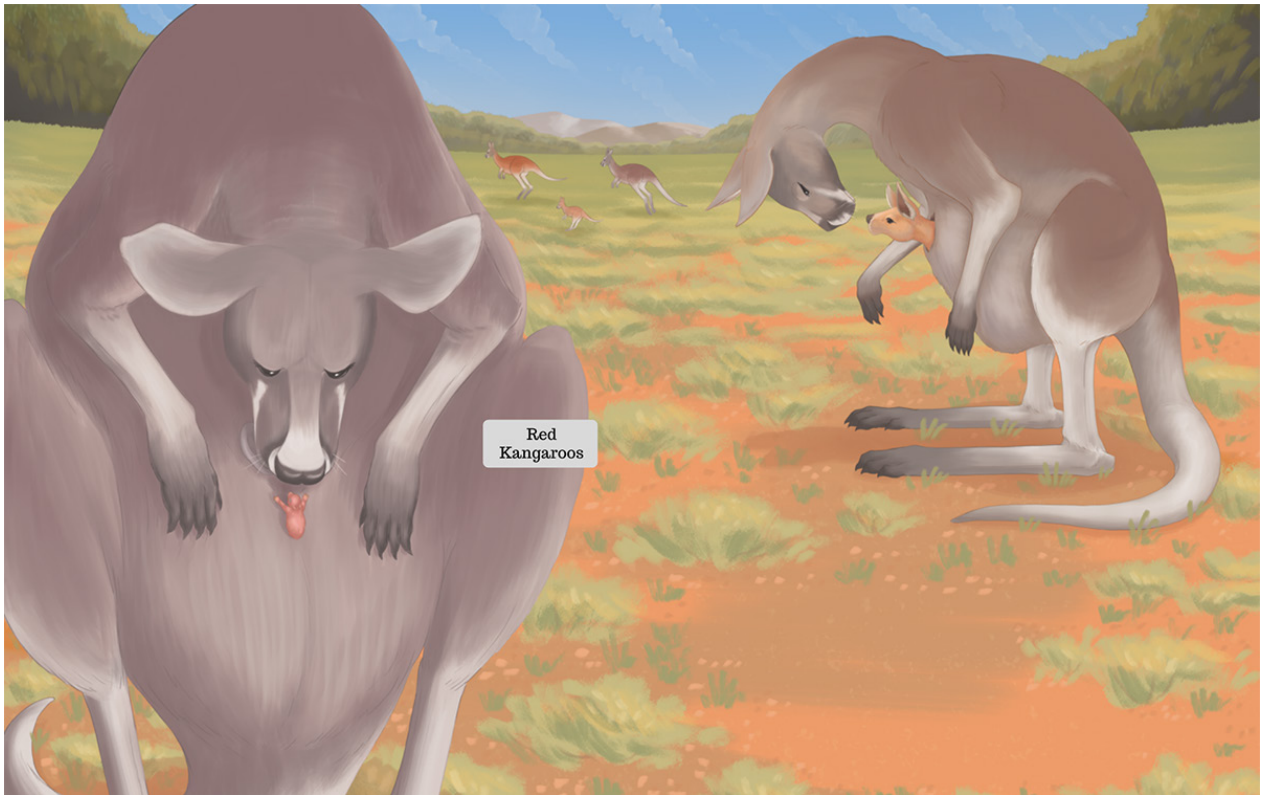
Visual Cues Research
Answers

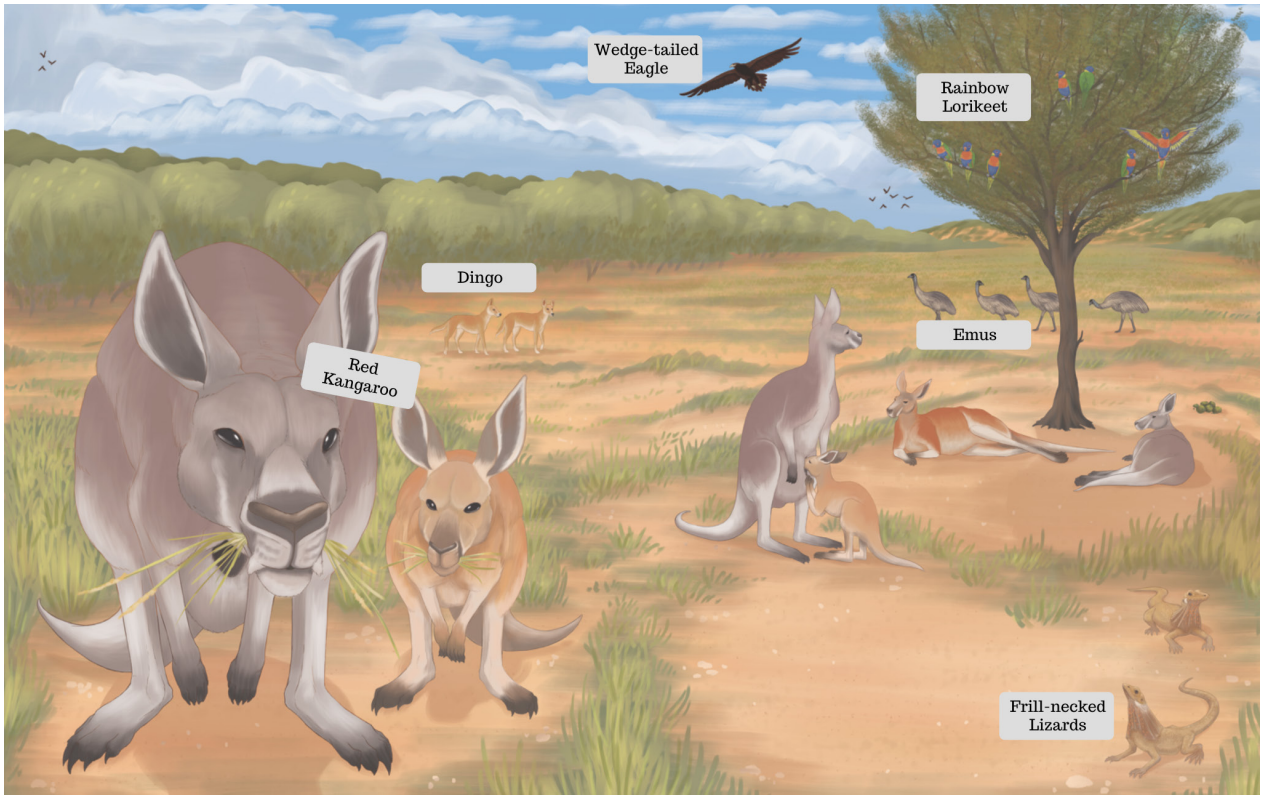


Visual Cues Research
Answers

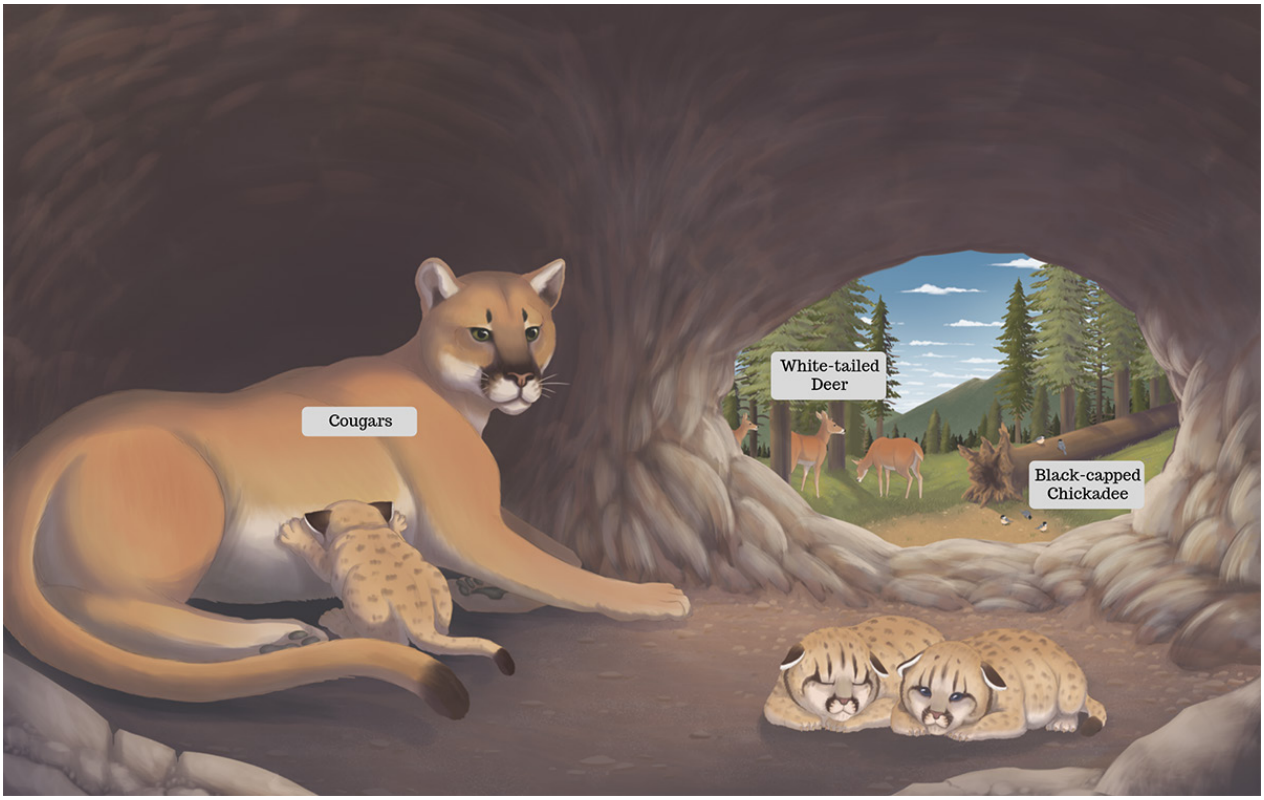


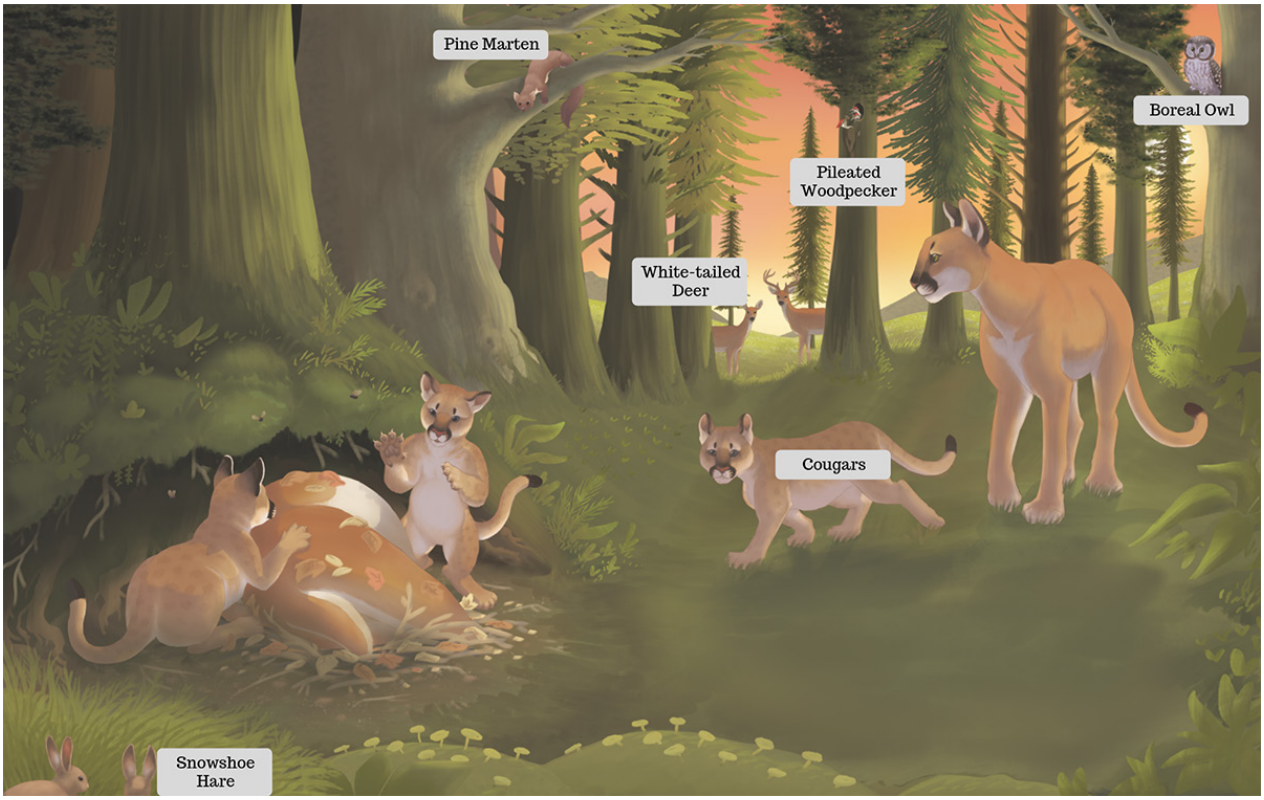
Visual Cues Research
Answers





Visual Cues Research
Answers





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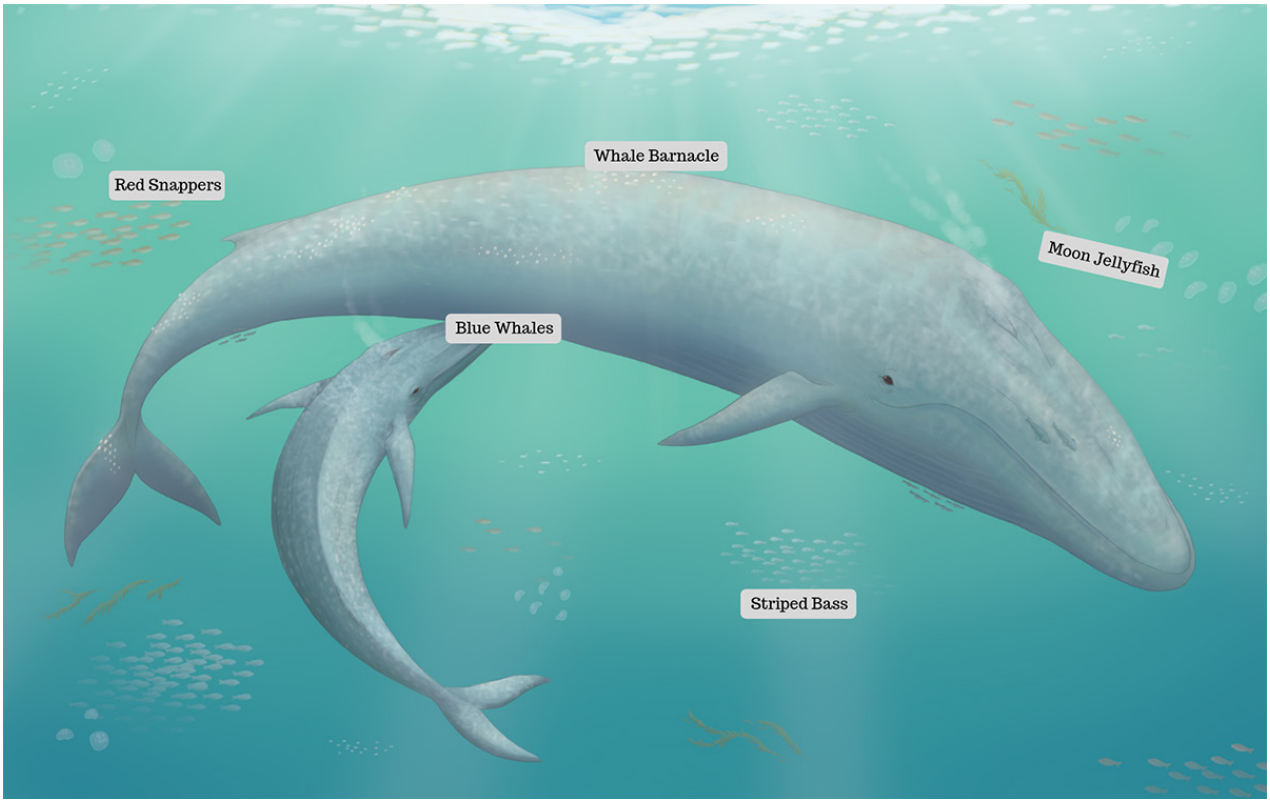
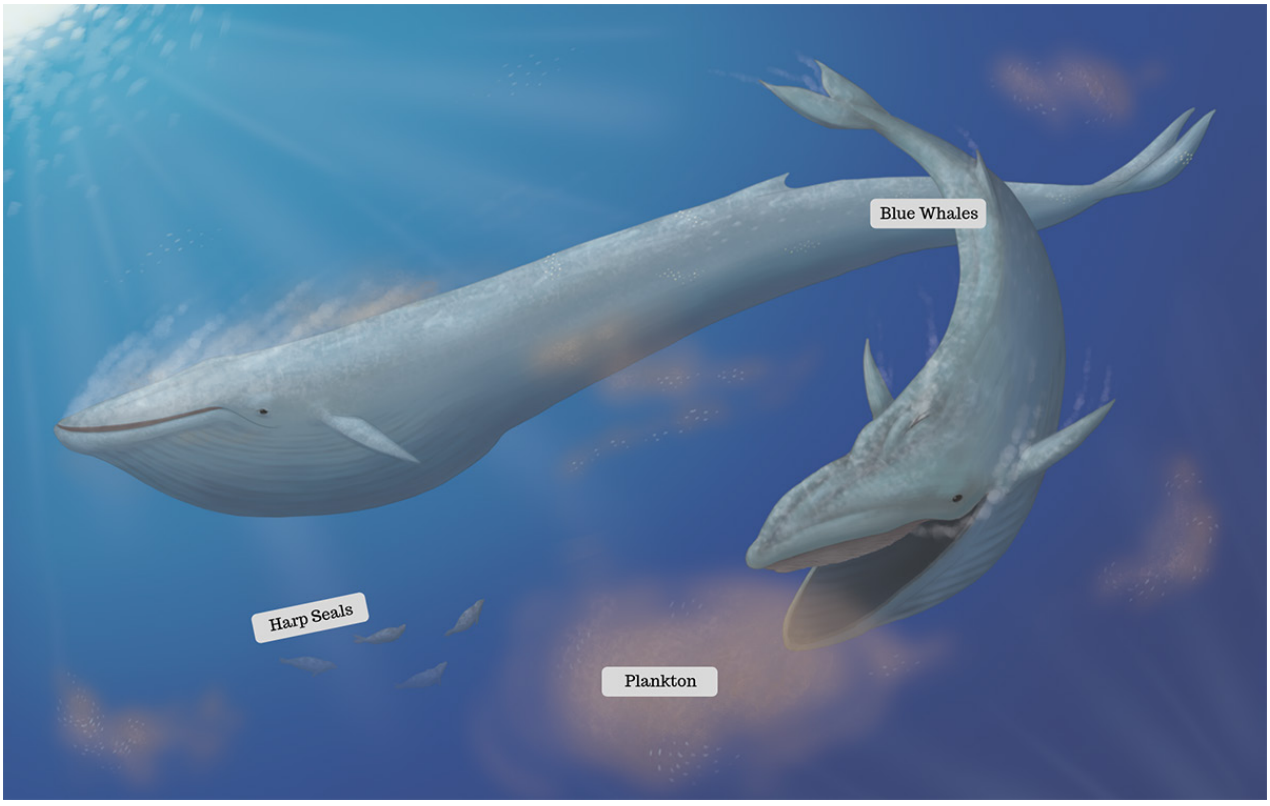
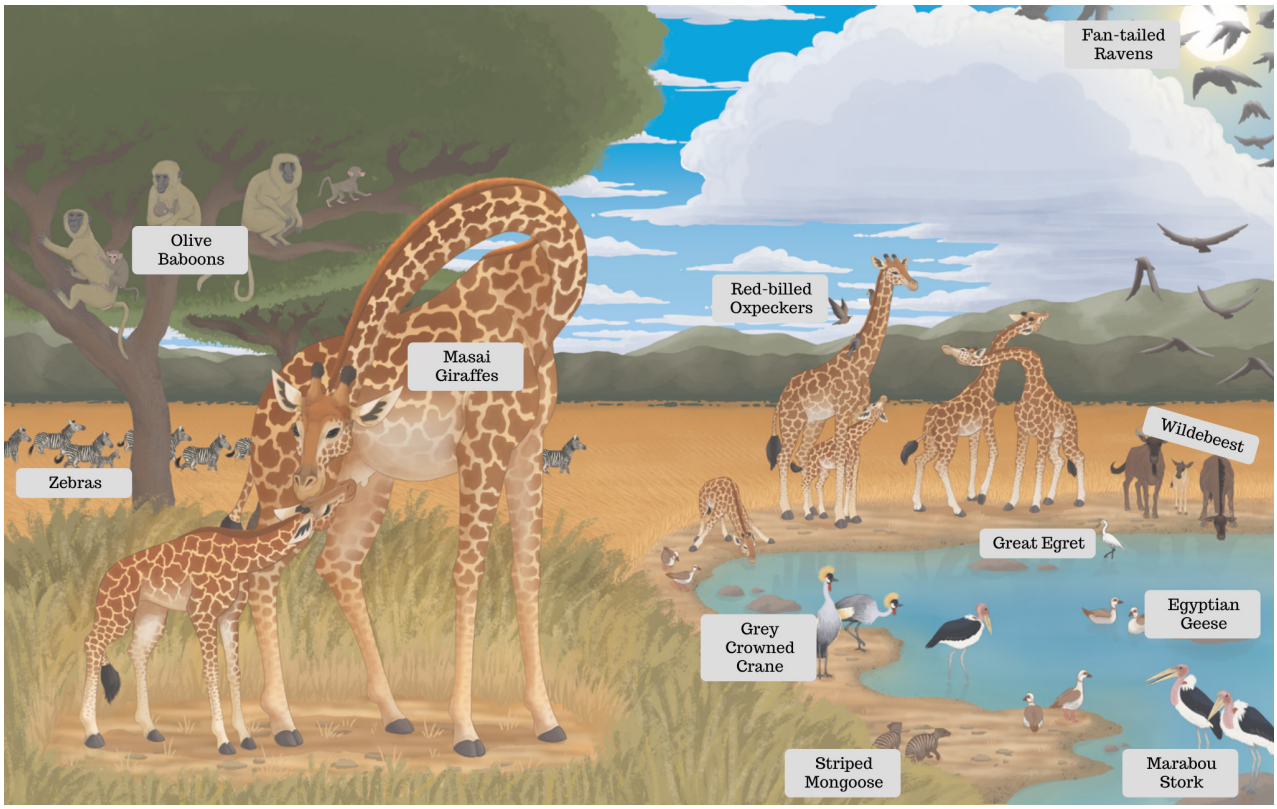
Answers

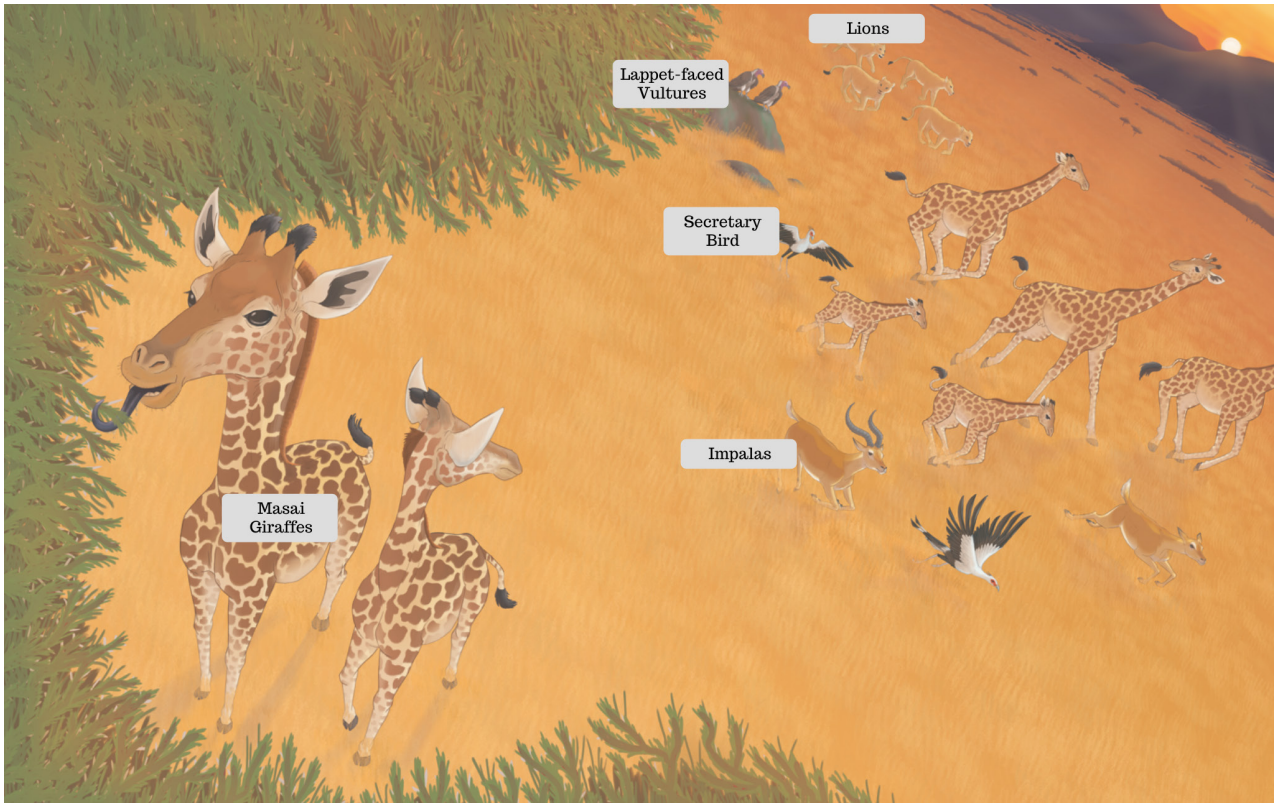




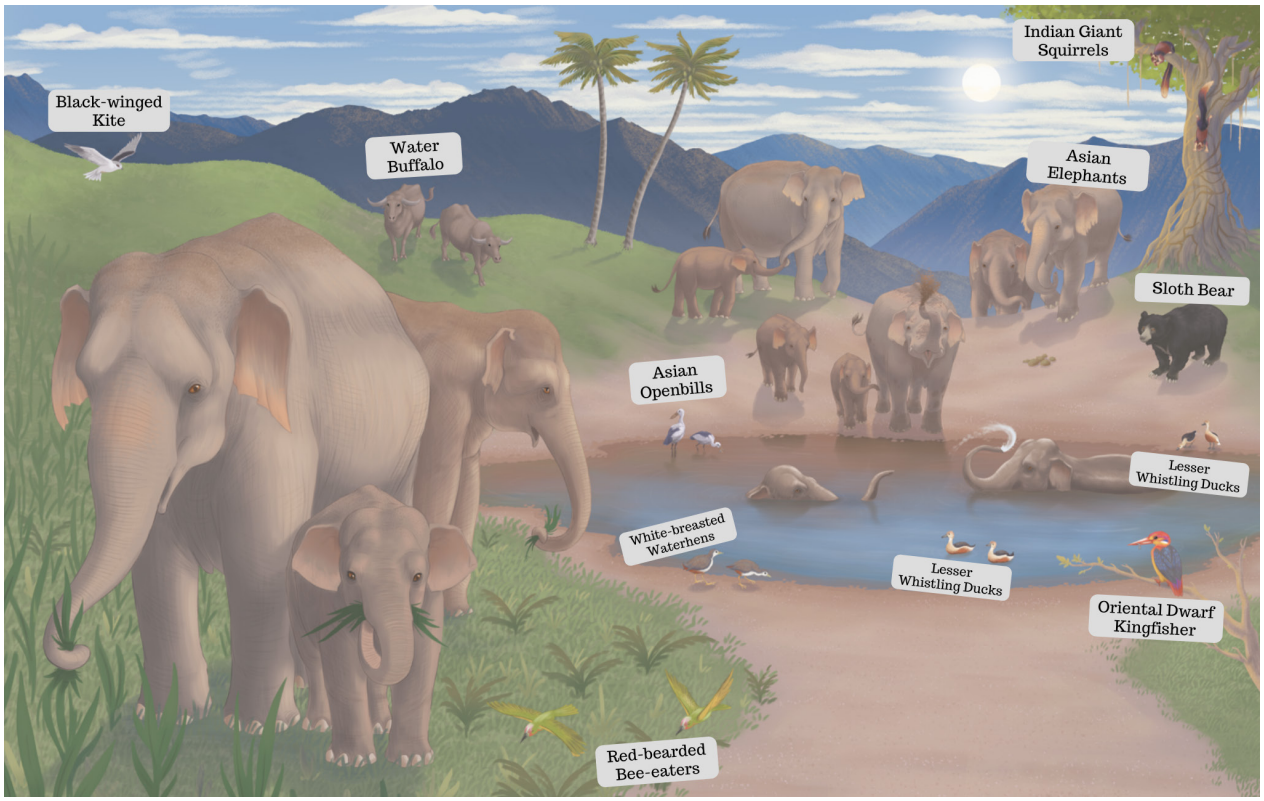
Visual Cues Research
Answers

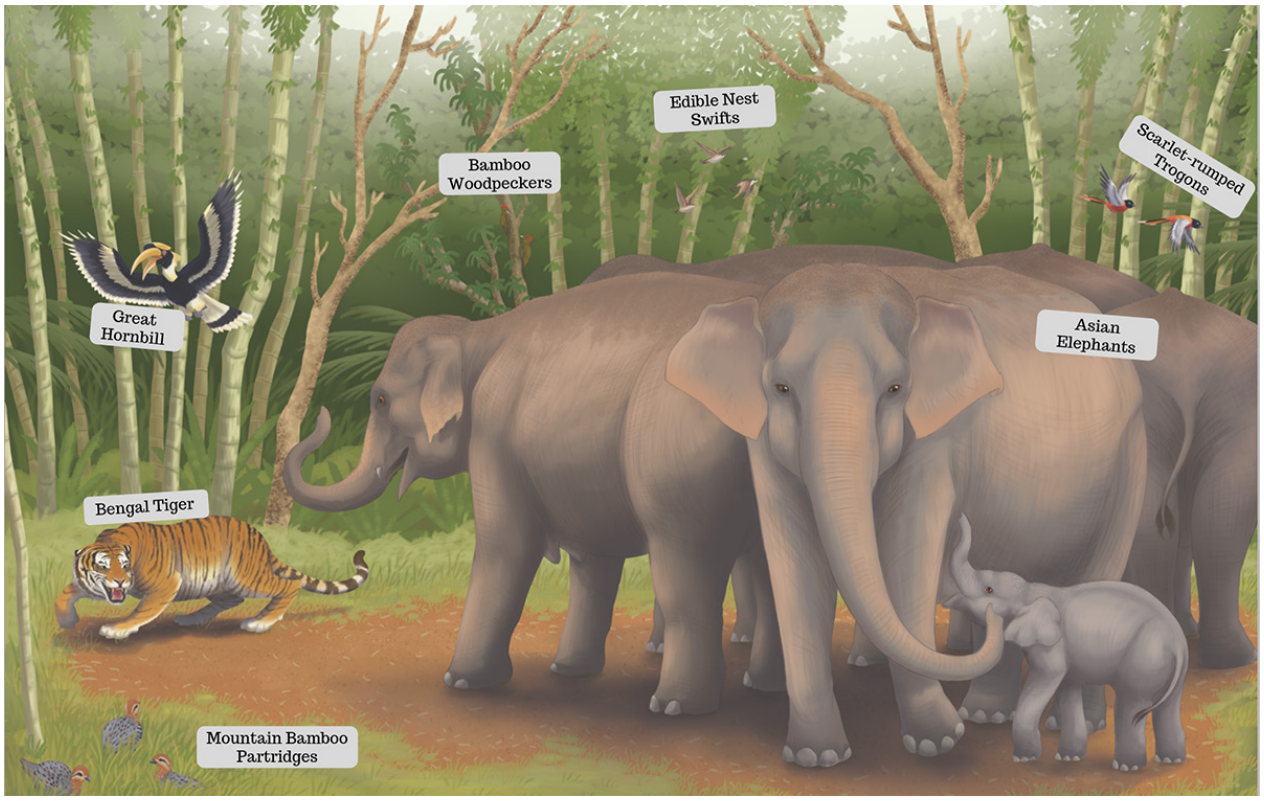
Visual Cues Research
Answers





Visual Cues Research
Answers





Section 2: Introduction to Life Cycles

In ***This Is How I Grow***, each animal baby tells the reader about the beginning of their life cycle, but the story doesn't follow them into adulthood. This section contains the basic life cycle story, from birth to death, for each of the animals in the book.

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Grades
3–6

Subject
Life cycles, development, growth, aging, milestones, gestation, weaning, mammal reproduction, passage of time, elapsed time

Skills
Active reading, inference, research, graphing, comparison

Materials
- *This Is How I Grow*
- Life Cycles Worksheet (page 51)
- Animal Research Reputable Resources List (page 70)
- Life Cycle Stories (pages 53–67)

Next Generation Science Standards
- LS1B: Growth and Development of Organisms
- *K-LS1-1:* From Molecules to Organisms: Structures and Processes
- *K-LS1-2:* From Molecules to Organisms: Structures and Processes
- *1-LS1-2:* From Molecules to Organisms: Structures and Processes
- *3-LS1-1:* From molecules to Organisms: Structures and Processes

Activity: Life Cycles

Background

The story of an animal's journey through life is called its ***life cycle***. Every plant and animal goes through a life cycle. This covers everything from the time an animal starts to develop inside its mother's womb until the time it dies, and includes reproduction. All animals grow differently, but most mammals go through eight different stages.

Please see the next page for descriptions of the different stages in animal life cycles.

Activity

1. Review the concept of life cycles as a class. Make sure students understand the important milestones present in a mammal's life cycle as outlined on the next page of this guide.

2. Assign each student one animal from the book, or have them each choose one. Distribute the **Life Cycles Worksheet** (page 51) and a copy of the book to each student.

3. Based on the information in the book, have students fill out the **Life Cycles Worksheet** for their animal. Information they can't find in the book they can find by referencing the **Life Cycle Stories** (pages 53-67). Students may also do further research using the resource list in *This Is How I Grow* (page 42 in the book) or pass out the **Animal Research Reputable Resources List** of this Teacher's Guide (page 70).

More on back...

Life Cycle Stages

The following are the eight life cycle stages generally seen in mammals:

1. *Gestation:* This is the time it takes for a mammal to grow inside of its mother. Different mammal species have different gestation lengths. This usually depends on the size of the animal and the kind of mammal it is. *For more information, see the **How Were You Born? Activity** (page 15).*

2. First stands up: Being able to stand and walk on their own for the first time is a big deal. It's their first "step" toward independence.

3. Opens eyes*: Some animals are born with their eyes open, taking in the world around them. Others are born with their eyes sealed shut. These animal babies rely on their other senses (smell, sound, touch, and taste) for their first few days or weeks of life.

4. Begins *weaning*: Weaning is the process of switching from eating only mother's milk to eating the foods each mammal will rely on as an adult. This process begins when a baby samples its first non-breastmilk food.

5. Completes weaning: Weaning ends when an animal gets all of its nutritional needs without breastmilk. For many animals, completing weaning marks the end of childhood and the beginning of adulthood.

6. Leaves family group*: Some mammals stay with their family group for their entire adult lives. Scientists call them ***social mammals***. Other animals leave their family group once they have the skills they need to survive on their own. These are known as ***solitary mammals***. For social animals, leaving the family group usually coincides with the end of childhood. *For more information, see the **Who Do You Live With? Activity** (page17).*

7. Has first offspring: ***Reproduction***—having babies—is an essential part of any life cycle. To ensure the continuation of a species, animals must reproduce. Reproduction is a life cycle stage that occurs during adulthood.

8. Dies: The end of any life cycle is death. Animals that are predators are more likely to die of natural causes than prey animals. Typically this involves loss of hearing and sight, lack of energy, weakness, and illness. Animals that are prey are more likely to die in an attack. As prey animals age, they have a harder time running from their predators.

*The starred milestones only apply to some mammal species. Why do you think some animals go through these stages while others don't?

A(n) _____ 's Life Cycle

(Animal name)

A life cycle is made up of all the stages that a living thing naturally goes through between its birth and its death.

The major milestones in a mammal's life cycle are outlined below.

Use this worksheet to complete the mammal life cycle research project for *This Is How I Grow*.

1. Gestation length: _____

_____

2. First stands up: _____

_____

3. Opens eyes: _____

_____

4. Begins weaning: _____

_____

5. Completes weaning: _____

_____

6. Leaves family group: _____

_____

7. Has first offspring: _____

_____

8. Dies: _____

_____

Expand the Activity: Time Lines

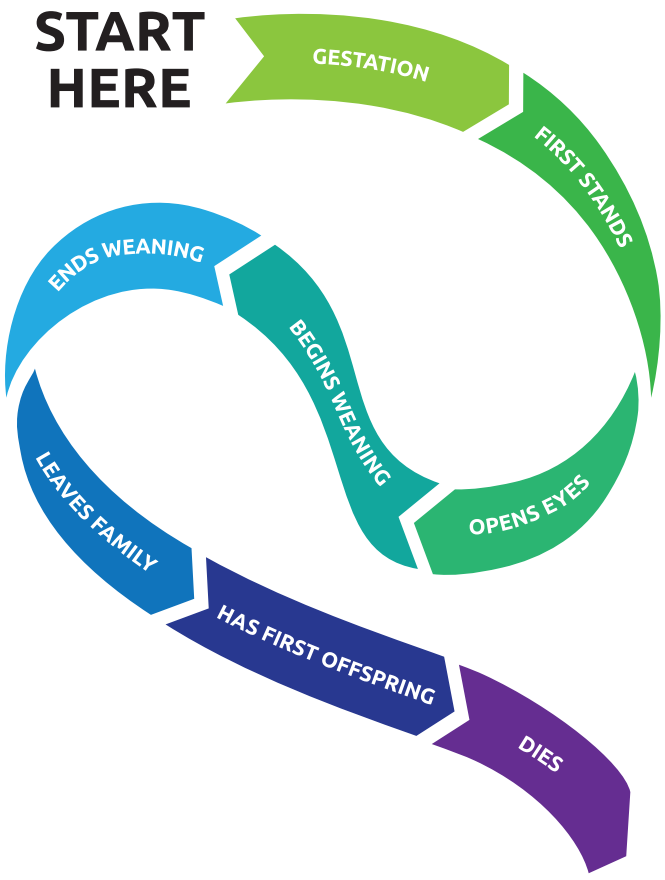
Time lines are graphic representations of events in time in their chronological order. They show the order in which events happen, as well as the interval of time between these events.

Have each student make a time line of their animal's life. At one end of the time line is the animal's birth, at the other is its death. In filling out their **Life Cycles Worksheet**, the students have already identified the major events for the time line, as well as the time each one occurs.

To put these events on a time line, they will have to know the time elapsed between each event. To calculate this, they may need to identify the smallest common unit of time. For example: If an animal opens its eyes after 2 weeks, and begins weaning after 2 months, in order to show relative time, the student will have to visualize 2 months as a factor of weeks.

Here are general conversions students will need:

1 week = 7 days
1 month = 4 weeks (= 28 days)
1 year = 12 months (= 48 weeks = 336 days)



Note that the passage of time isn't quite as simple as this. Not all months are made of 4 weeks (28 days). In fact, most months are 30 or 31 days long, a little longer than 4 weeks. There are 52 weeks, or 365 days, in a year. For the purposes of this activity, approximate numbers are fine.

Classification:

Domain: *Eukarya*
Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Mammalia*
Order: *Chiroptera*
Family: *Molossidae*
Genus: *Tadarida*
Species: *T. brasiliensis*

Related Activities:

- Baby Bat Cups (page 95)
- Echolocation in Action (page 97)

Brazilian Free-tailed Bat

Tadarida brasiliensis

Brazilian free-tailed bats are among the most abundant mammals in the Americas. They form colonies larger than those of any other bat; larger, in fact, than any other group of warm-blooded animal in the world. They get their name from their tails, which extend freely beyond their back legs.

Birth

Female Brazilian free-tailed bats roost together yearly in large maternity colonies of millions of pregnant mothers.

After growing inside of their mothers for 11 weeks, bat pups are born blind and nearly hairless. Bats give birth upside-down, hanging from the roof of the cave. The umbilical cord makes sure the newborn pup stays attached to its mother. A few minutes after being born, the pup tucks itself under its mother's wing and nurses for the first time. The mother licks and sniffs her pup as it eats, learning its scent.

After the baby bat's first meal, its mother flies it to a higher part of the cave to hang upside down with thousands of other pups. This area is known as the "nursery."

Childhood

Brazilian free-tailed bat pups stay in the nursery for several weeks. Their moms come back twice each day to feed them. The nursery is full of thousands of bats, so mothers use scent and sound to locate their own pup.

As the babies grow, they begin to play together. They practice flying between the walls of the cave. When they are five or six weeks old, pups are strong enough to fly outside of the cave. They leave at night with the adults and fly through the forest, catching and eating bugs.

Adulthood

By the time they are eight weeks old, Brazilian free-tailed bats don't need to drink mother's milk any more. Instead, they eat thousands of bugs every night. Bats use echolocation to navigate in the dark and locate their prey. They can fly as fast as 60 mph.

Now, they have reached their adult size of 3–4 inches, with a wingspan of 11 inches. They weigh less than half an ounce. Female bats weigh a little bit more than males. This helps them stay healthy while they gestate and nurse a baby.

Female Brazilian free-tailed bats have their first offspring when they are about a year old.

In the wild, Brazilian free-tailed bats live an average of eight years.

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Red Squirrel

Sciurus vulgaris

Classification:

Domain: *Eukarya*
Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Mammalia*
Order: *Rodentia*
Family: *Sciuridae*
Genus: *Sciurus*
Species: *S. vulgaris*

Related Activities:

- Nuts About Squirrels (page 103)

Red squirrels are smaller than other tree squirrels. They have reddish fur, a white underbelly, and white rings around the eyes. Their appearance changes with the seasons: during winter, their ears are slightly tufted; in summer they have a black line along the side of their bodies.

Birth

Baby red squirrels grow inside of their mother for only 39 days. They are born in litters of one to eight blind, bald, and hairless kits (also called kittens or pups). At birth, each kit weighs between 10 and 15 grams, but by nursing every two hours they gain nearly 2 grams each day. Their eyes remain closed for their first 30 days of life. They will chirp like birds to communicate with their mother.

Childhood

Around the same time they open their eyes, kits also begin to stand and walk on all four legs. Once they are strong enough to stand, they don't nurse as often.

By now they are covered in fur and ready to leave the nest. They follow their mother outside where she shows them how to jump from tree branches. When they are about six weeks old, the kits begin to try the same nuts and berries that their mom eats. They continue to nurse occasionally until they are eight to ten weeks old.

Red squirrels must harvest food in August and September so they have enough to eat during the winter. On average, they eat about 1 lb. of food each week, storing the rest of what they forage in middens. Middens are collections of food, mostly pine cones, that are hidden underground, under piles of branches, or in hollow logs. Red squirrels must fill them up and remember where they're hidden so they can return later. Kits learn how to do this from watching their mothers.

Adulthood

Red squirrels reach their full body size when they are about four months old. Fully grown, they weigh between 400 and 800 grams (14 oz.–1 lb 12 oz.) and measure 13.5–17 inches from the top of their head to the tip of their tail.

Around the time they reach this size, red squirrel kits are ready to leave their mother and siblings. Each red squirrel has its own home territory, though it may overlap with that of others. They build their nests, forage, and keep their middens in this area.

Red squirrels typically keep to themselves, but meet seasonally to mate. Females typically have their first litter when they are two years old.

Winters are harsh and squirrels have many predators. More than 75% of juveniles die during their first winter. Those who survive will live to be an average of three years old, though some make it to ten.

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Red Kangaroo

Macropus rufus

Classification:

Domain: *Eukarya*
Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Mammalia*
Order: *Diprotodontia*
Family: *Macropodidae*
Genus: *Macropus*
Species: *M. rufus*

Related Activities:

• Hop to It (page 113)

Red kangaroos are marsupials who carry their young in a front pouch. They are the world's largest marsupial. Rather than walking, they use their large, flat feet to hop. Fun fact: the family name "Macropodidae" is from the Latin word meaning "large foot."

Birth

Red kangaroos grow inside of their mothers for only 30 days. They are born blind, hairless, and smaller than a cherry. This newborn, called a neonate, climbs up its mother's fur until it reaches her pouch. Inside the pouch are the mother's four nipples. The neonate clamps its mouth around one of them and starts to nurse. As milk flows, the nipple swells inside the neonate's mouth, holding the newborn firmly in place. For about two months, the neonate stays attached to the nipple, eating and growing rapidly.

Childhood

Baby red kangaroos are called joeys. After 120 days of nursing and growing inside of the pouch, the joey is large enough to emerge. At first, it will just stick its head out of the pouch until it feels safe enough to fully step outside. The joey will spend more and more time outside of the mother's pouch until it is around 235 days old, when it will leave the pouch for good.

Once outside of the pouch, the joey will continue to nurse for several more months. By sticking its head inside of the mother's pouch, it will suckle from the same teat it was attached to as a neonate. Over this time, the joey also begins to eat the vegetation that its mother grazes on. By the time the joey is one year old, it will not need to nurse anymore.

Red kangaroos do not have many predators, but joeys are much more vulnerable than adults. Eagles and other raptors will target young kangaroos, so mothers must remain alert.

Adulthood

Red kangaroos are not particularly social, but live together in small groups of mothers and their female offspring. Females grow to be about 3 feet long and 40-88 lbs. Males form their own small groups. Adult males are about 5 feet long and weigh 125-200 lbs.

Each group of two to four members is called a mob. These groups may be clustered together, but do not have much interaction. Kangaroo mobs spend most of their day resting in the shade.

Female red kangaroos have their first young around two and a half years of age, after which time, they are nearly permanently pregnant. They are often responsible for three generations of offspring at once, with one joey living outside the pouch but not yet weaned, one neonate inside the pouch continuously nursing, and one fertilized egg growing inside the uterus.

In the wild, red kangaroos live to be an average of 23 years old.

Advanced Species Information on back...

Kangaroos: Major Marsupials

Australia is home to the majority of the world's marsupials. Those belonging to the genus *Macropus* are generally considered to be kangaroos. These are the largest of the big-footed, hopping marsupials. However, there are several other large-footed, hopping marsupials (like wallabies and wallaroos) that are only closely related to kangaroos. Wallabies are the smallest, and wallaroos are an intermediate size.

In the genus *Macropus* there are four kangaroo species:

- Red kangaroo (*Macropus rufus*)
- Antilopine kangaroo (*Macropus antilopinus*)
- Eastern gray kangaroo (*Macropus giganteus*)
- Western gray kangaroo (*Macropus fuliginosus*)

Western gray kangaroo

Eastern gray kangaroo

Antilopine kangaroo

Red kangaroo

Red kangaroos are the largest of all kangaroos, and are mostly found in the interior of Australia on large, open plains.

You may have noticed that, even though they're named "red kangaroos," not all of the kangaroos pictured in the book are actually red. This species gets its name from the reddish-brown fur that all males have. However, not all female red kangaroos have red fur. Many of them are a bluish-gray. These female red kangaroos are sometimes called "blue fliers."

Cougar

Puma concolor

Classification:

Domain: *Eukarya*
Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Mammalia*
Order: *Carnivora*
Family: *Felidae*
Genus: *Puma*
Species: *P. concolor*

Related Activities:

• Cougar Tongue (page 93)

Cougars are carnivorous cats that can be found in many habitats. They are the largest cats in America, though they weigh less than the more muscular jaguar. Cougars have many other names, including mountain lion, puma, mountain cat, catamount, and panther.

Birth

Cougar cubs grow inside of their mother for about 90 days. When she is ready to give birth, a cougar mom makes a den in a cave or clearing of bushes by covering the ground with leaves, grass, and other foliage.

Cougars have one to six cubs in a litter. Newborn cubs weigh only 1 lb. and are born with their eyes and ear canals closed. They can hardly move, but they start nursing almost immediately. Their fur is spotted, to camouflage them from predators, including wolves, bears, or adult male cougars.

Ten days after birth, cubs open their eyes. At the same time, their ears open and their first teeth appear.

Childhood

Cubs stay inside of the den where they were born for several weeks. Their mother leaves occasionally to hunt and eat her own food. Sometimes, she will bring back strips of meat for her cubs to try.

When they are eight weeks old, cougar cubs follow their mother out of the den for the first time. She leads them to one of her kills. Cougars eat deer, as well as smaller animals like coyotes, raccoons, and porcupines. Following their mother to a kill is time for both feeding and play. Cubs practice stalking, wrestling, and attacking their prey.

As they grow stronger and more skilled, cubs will separate from their mothers for days a time to hunt on their own. These intervals grow longer and longer.

Adulthood

When they are about one year old, cougar cubs leave their mother and siblings for good. They find their own home territory where they will live, hunt, and eventually raise their own cubs. By now, their spots have faded and their fur is a solid reddish brown, sand, or gray color.

Adult male cougars are nearly 8 feet long from nose to tail and weigh between 115-220 lbs. Female cougars are about 6.5 feet long and weigh between 65-140 lbs. They move freely around their home territory, stalking and hunting prey at dawn, dusk, and during the night.

Female cougars have their first young when they are about two years old, and will have a litter every one to three years after that. In the wild, cougars live to be approximately 8-13 years old.

Advanced Species Information on back...

Cougars: The Cat of Many Names

Puma concolor are the only known living species in the genus *Puma*. The genus name might sound familiar, because it's one of the many names by which these large cats are known.

Though there is only one cougar species, there are a small number of recognized ***subspecies***.

The book *Mammal Species of the World*, published in 2005, is one of the leading reference texts in the field of ***mammalogy***. This book recognizes five subspecies:

- *Puma concolor concolor* (South American cougar)
- *Puma concolor couguar* (eastern cougar or eastern puma)
- *Puma concolor puma* (located in southern South America, primarily in Chile and Argentina)
- *Puma concolor costaricensis* (Costa Rican cougar)
- *Puma concolor anthonyi*
- *Puma concolor cabrerae* (Argentine cougar)

More recently, the International Union for Conservation of Nature's Cat Classification Taskforce defined only two valid subspecies:

- *Puma concolor concolor* (located primarily in South America)
- *Puma concolor couguar* (located primarily in Central and North America)

Blue Whale

Balaenoptera musculus

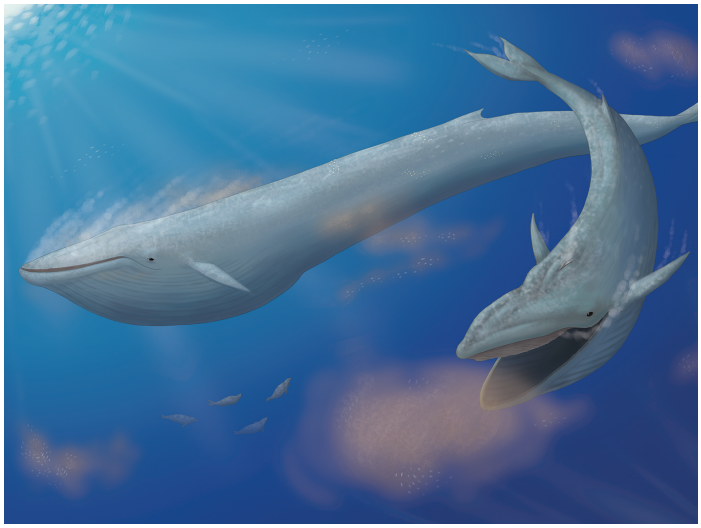
Classification:

Domain: *Eukarya*
Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Mammalia*
Order: *Artiodactyla*
Family: *Balaenopteridae*
Genus: *Balaenoptera*
Species: *B. musculus*

Related Activities:

- Whale Blubber (page 87)
- Baleen Scene (page 89)
- How Big Is a Whale? (page 91)

Blue whales are the largest mammal known to have ever existed. They are also among the loudest animals on the planet, emitting sounds that can be heard up to 1,000 miles away. They live in nearly every ocean on Earth and migrate yearly between warm and cold climates.



Birth

Blue whale calves grow inside of their mothers for about a year. At birth, they weigh 5,950 lbs. (the same as a fully-grown hippo!) and are 23 feet long. Born in warm, tropical waters, the first thing the calf must do is swim to the surface to take a breath.

For the first six months of its life, a blue whale calf only drinks its mother's milk. It drinks 100-150 gallons of this milk each day, gaining up to 200 lbs. in a 24 hour period—that's 8 lbs. per hour!

Calves nurse as they swim alongside their mothers. The mother's body makes a current as she swims, which pulls the calf along, keeping the pair close together. They swim slowly through the ocean as part of their yearly migration.

Childhood

By the time a whale calf is six months old, the mother and child pair will have reached the cold, polar waters where they spend their summer. The calf will have doubled in length and, thanks to the high fat content of its mother's milk, it will also have grown a thick layer of blubber. This fat will keep the calf warm.

They have traveled all this way to find their feeding grounds. The krill that blue whales eat only live in polar waters. The mother blue whale shows her calf how to use the baleen in its mouth to catch and eat the tiny creatures. By the time it is eight months old, the whale calf will not need mother's milk anymore.

After weaning, the mother and calf will stay together for another one to one-and-a-half years, until the mother becomes pregnant again.

Adulthood

After a blue whale leaves its mother, it spends the next two to eight years migrating, hunting, and growing, until it is ready to have a calf of its own. It will follow the same migration route that it traveled with its mother. Most female blue whales become pregnant for the first time in their tenth year.

Adult blue whales weigh between 50 and 150 tons. Adult males are between 66 and 82 feet long, while females are slightly larger—between 69 and 86 feet from nose to tail.

Blue whales can live for at least 80 years in the wild. However, because their lifespan is so long, and because human records don't go back that far, the maximum lifespan of a blue whale is not yet known.

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Polar Bear

Ursus maritimus

Classification:

Domain: *Eukarya*
Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Mammalia*
Order: *Carnivora*
Family: *Ursidae*
Genus: *Ursus*
Species: *U. maritimus*

Related Activities:

- Polar Brrr Adaptations (page 109)

Polar bears are the only marine mammal with powerful limbs that let them run on land. These bears have very large feet and are best known for being covered from head-to-toe in white-ish fur.

Birth

Before giving birth, mother polar bears build a "maternity den" in a snow drift or in the frozen ground. This is where the cubs are born. Usually, polar bears have twins, but there can be up to four cubs in a litter. The cubs weigh less than 2 lbs. and can't see anything when they are born, but they immediately find a nipple and start to nurse. Newborn cubs don't have much fur, but the den traps body heat and keeps them warm.

Childhood

After about three months, the family emerges from their den. This is the first time that the cubs will experience the outside world, but by now they weigh 22–33 lbs., thanks to their mother's fatty milk, and are covered in thick white fur. For a few days, the cubs stumble around in the snow, learning how to walk. Eventually, they follow their mother many miles to the edge of the sea ice. Here, she eats her first meal since entering the den.

The cubs learn to hunt by imitating their mother. This is a long process, because it takes strength and skill to hunt and eat a seal. Over this time, the cubs nurse less frequently and eat more meat and fat.

By the time the cubs are two and a half years old, their mother either chases the juveniles away or abandons them. Now they must hunt to survive. The siblings typically stick together for a few months, perfecting their skills. If they have not yet gained enough experience and body size to successfully hunt seals, they will scavenge leftovers from other bears' kills. When they are strong enough, the siblings go their separate ways.

Adulthood

Adult polar bears are between 6 and 10 feet long. Fully-grown males weigh 770–1,550 lbs., and adult females weigh 330–550 lbs. They must eat about one seal meal a week.

These bears are stealthy hunters with a well-developed sense of smell—they can detect seals nearly 1 mile away and under 3 feet of snow. They wait by holes in the sea ice until a seal approaches. Swiping a powerful paw into the water, they pull the seal out, smashing its head onto the ice. Polar bear cubs eat all parts of the seal, but adults mostly only eat the fatty parts.

Female polar bears have their first litter when they are four or five years old, but males don't father children until the age of six.

In the wild, healthy polar bears can live to be 20–30 years old.

Advanced Species Information on back...

Bears: "We're Bear-ly Even Related"

There is only one species of polar bear: *Ursus maritimus*. However, there are seven other bear species (eight in total). The species are:

- North American black bears
- Asiatic black bears (sometimes known as "moon bears")
- Brown bears (known as "grizzlies")
- Sun bears
- Sloth bears
- Giant pandas
- Andean bears (known as "spectacled bears")

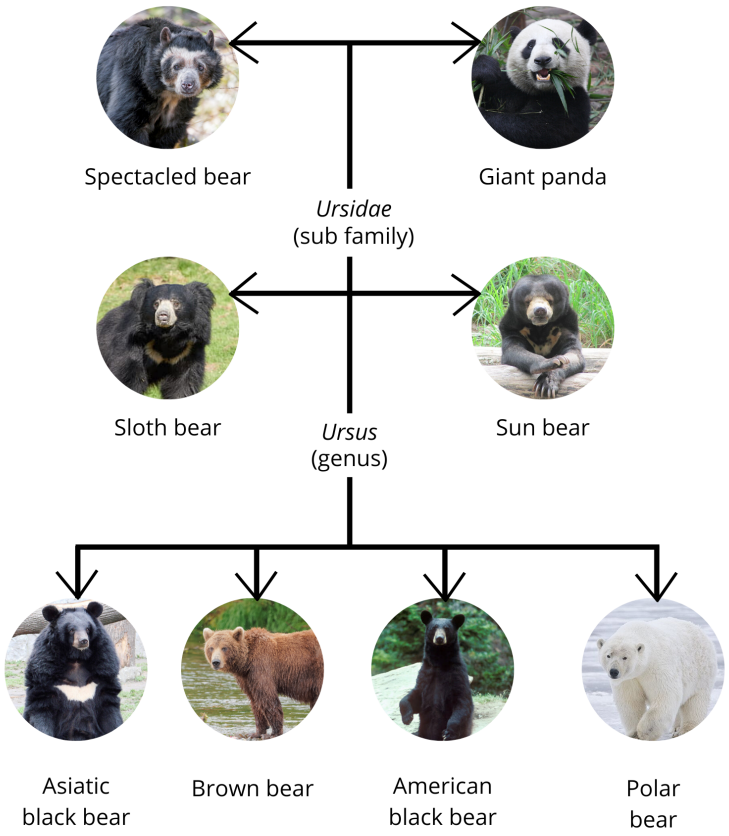
Did you know that polar bears may be related to brown bears? Scientists think they diverged about 200,000 years ago. The two can—and sometimes do—still cross-breed to produce fertile offspring.

How could this have happened? It's probably due to their proximity in the wild. Brown bears are found along the coasts of Alaska, Canada, and Russia (as well as in the mountains of the United States and Europe). Polar bears spend most of their time in the Arctic Circle, which includes northernmost North America (Canada and Alaska) and Russia. Where their ranges overlap, the two have the opportunity to breed.

Scientists also believe that climate change is creating more opportunities for cross-breeding. Check out this *Washington Post* article on the subject to learn more:

"Love in the time of climate change: Grizzlies and polar bears are now mating" written by Adam Popescu (***https://wapo.st/2SZOkyF***)

Ursidae family tree



Masai Giraffe

Giraffa camelopardalis tippelskirchii

Classification:

Domain: *Eukarya*
Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Mammalia*
Order: *Artiodactyla*
Family: *Giraffidae*
Genus: *Giraffa*
Species: *G. camelopardalis tippelskirchii*

Related Activities:

• Adaptable Necks (page 101)

Masai giraffes are the world's tallest land mammal. There are three primary distinguishing characteristics of the giraffe: their long neck and legs, the soft horn-like projections on their heads (called ossicones), and their distinctive webbed coat patterns.

Birth

When a mother Masai giraffe is ready to give birth, she leaves her herd and finds a secluded spot. She gives birth standing up, and the calf falls to the ground, snapping the umbilical cord on the way down. Within an hour, the calf wobbles to its feet, reaches up, and begins to nurse. Within a couple of hours, the newborn can walk and even run.

Mothers and newborns spend their first week together away from the rest of the herd, licking and nuzzling one another to learn each other's scent. Calves grow an inch each day during this first week.

Childhood

When the mother brings her calf back to the herd, the one-week-old joins a group of other calves which are guarded by one adult female while the other mothers leave to forage. This group is known as a calving pool or nursery group. Together, the calves play and explore, developing important physical and social skills.

By the time they are two months old, calves are ready to start eating vegetation. Their mother shows them how to use their tongue to pull leaves off of tall branches. Young Masai giraffes continue to nurse occasionally until they are six to nine months old, though they may continue for up to 22 months.

At six months old, young giraffes are fairly independent from their mothers, though they will remain nearby for several more months, often until the mother becomes pregnant again. Male Masai giraffes grow faster than females and are typically more aggressive.

Adulthood

Aggressive males leave their mother's herd and form or join all-male "bachelor herds." Females tend to stay in their mother's herd for life. These non-territorial herds average six members, but can number up to 44. Herds travel together in search of food, keeping away from predators like lions.

Masai giraffes reach nearly their full height by the time they are four years old, but continue to gain weight until they are seven or eight. Females usually have their first offspring when they are four years old.

Adult Masai giraffes are between 14 and 18 feet tall. Females weigh between 1,500 and 2,600 lbs., while males can weigh up to 4,250 lbs.

Given their massive size and strong legs (which they use for running and kicking), adult giraffes do not have many predators. They can live for up to 25 years in the wild.

Advanced Species Information on back...

Giraffes: Spot the Species

Masai giraffes are just one of several giraffe species. However, scientists do not agree on how many species of giraffe there actually are. In 2001, a two-species ***taxonomy*** was proposed, but by 2007 most scientists agreed there were more than just two giraffe species. The question is, are there four, six, or eight?

Four-species Taxonomy

The four-species taxonomy is the most recent construction, proposed in 2016. Researchers claim that these four species have not exchanged genetic information for 1-2 million years. This taxonomy is the least established.

Four species:*
- Northern giraffe (*G. camelopardalis*)
- Southern giraffe (*G. giraffa*)
- Reticulated giraffe (*G. reticulate*)
- Masai giraffe (*G. tippelskirchii*)

Six-species Taxonomy

The six-species taxonomy was proposed in 2007 and is based on genetic differences in nuclear and mitochondrial DNA. These species are reproductively isolated and rarely interbreed.

Six species:
- West African giraffe
- Rothschild giraffe
- Reticulated giraffe
- Masai giraffe
- Angolan giraffe
- South African giraffe

Eight-species Taxonomy

The eight-species taxonomy was proposed in 2011 based on the ***morphology*** of giraffes and the application of the ***phylogenetic species concept***. The suggested eight species are known by their Latin names.

Eight species:
- *G. angolensis*
- *G. antiquorum*
- *G. camelopardalis*
- *G. giraffa*
- *G. peralta*
- *G. reticulate*
- *G. thornicrofti*
- *G. tippelskirchii*

*In 2017, the Giraffe Conservation Foundation published a poster that beautifully breaks down some of the species in the four-species taxonomy. Best of all, it uses pictures of each species' spot pattern to distinguish between them.

You can visit ***https://bit.ly/2SKMQd3*** to download the poster for your classroom.

Classification:

Domain: *Eukarya*
Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Mammalia*
Order: *Proboscidea*
Family: *Elephantidae*
Genus: *Elephans*
Species: *E. maximus*

Related Activities:

- Elephant Feet (page 79)
- Elephant Teeth (page 81)
- Water for Elephants (page 83)

Asian Elephant

Elephas maximus

Elephants are the largest living land animal. Asian elephants are slightly smaller than their African cousins, and males are typically larger than females. They have short, straight tusks, thick gray skin, poor vision, and an excellent sense of smell.

Birth

Elephants have the longest gestation of any mammal. They stay inside their mother's womb for 22 months before they are born! The calf is fully developed by the 19th month, but it stays in the womb an extra few months to grow tall enough to breastfeed as soon as it is born. The calf weighs 150-350 lbs. at birth and hits the ground with a big thump! It wobbles to its feet as fast as it can, reaches up with its mouth, and begins to nurse.

Childhood

Within days, the Asian elephant calf learns how to walk. It travels with its family as the herd walks in search of food and water. The calf stays close to its mom, nursing whenever it is hungry. Sometimes, it will eat its mother's dung, which contains nutrients and important bacteria that will help the calf digest other food once it weans. Other females in the herd help the new mom look after her young.

Around the time the calf is six months old it learns how to use its trunk. An elephant's trunk functions like a hand—the young Asian elephant can use it to spray other elephants with water, cover itself with mud to keep cool, and pull up leaves and grass to try. By five years of age, the calf will no longer rely on its mother's milk for survival. Around this time, its mother will give birth to another calf, and will turn her attention to taking care of the new baby.

Adulthood

Adult Asian elephants weigh 6,000 to 12,000 lbs., meaning elephant calves have a lot of growing to do. Elephants graze on roots, grasses, fruit, and bark for 14–19 hours each day, and adults can eat up to 300 lbs. of food in that time.

Considering how big they get, elephants grow quickly. However, males grow faster than females. When a male Asian elephant (bull) is about eight years old, he becomes competitive and increasingly independent. By the time he is 13, he will have left his family group for good. These bulls form their own all-male bachelor herd. When they are about 30 years old, males will father their first child.

Female Asian elephants (cows) stay with their mother's herd for life. As they grow, they help look after the other calves in the herd and guide the group to water. When they are in their mid-teens, cows will have their first child.

In the wild, Asian elephants live to be 60–70 years old.

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Grades
3–6

Subject
Life cycles, language arts

Skills
Research, composition

Materials
- *This Is How I Grow*
- Animal Research Worksheet (page 71)
- Animal Vignette Worksheet (page 72)
- Animal Research Reputable Resources List (page 70)
- Computer with Internet access

Next Generation Science Standards
- *K-LS1-1:* From Molecules to Organisms: Structures and Processes
- *1-LS1-2:* From Molecules to Organisms: Structures and Processes
- *3-LS1-1:* From molecules to Organisms: Structures and Processes

Common Core English Language Arts
- *CCSS.ELA-LITERACY.CCRA.W.2:* Text Types and Purposes
- *CCSS.ELA-LITERACY.CCRA.W.7:* Research to Build and Present Knowledge

Activity: Animal Research

Background

This book tells the stories of 8 different mammals, but there are over eight million known animal species on Earth. In this activity, students will research an animal of their choosing, and write a vignette about that animal's childhood like those in *This Is How I Grow*.

A ***vignette*** is a short description that gives an impression of a person, thing, or event. It's kind of like a picture you paint with words.

Activity

1. Read *This Is How I Grow* together. Discuss the information that's presented about each animal and the style of each animal story. Ask the following questions:
   What is consistent between each animal story? *(Hint: each animal talks about their birth, breastfeeding, weaning, and acquisition of basic skills.)*
   How is the information presented? *(Hint: it's told from the animal baby's point of view. This is called first person.)*

2. Assign each student an animal not included in the book, or allow them to choose their own. Distribute the **Animal Research Reputable Resources Worksheet** (page 70). Help students find appropriate resources for their research. Visit a library or direct them to other reputable online sources if you wish.

3. Once research is complete, distribute the **Animal Vignette Worksheet** (page 72). Using their completed **Animal Research Worksheet** (page 71), students will convert the animal information into a vignette like those in *This Is How I Grow*.

Worksheets on the next few pages...

• Defenders of Wildlife, a conservation organization saving wildlife by protecting and restoring species and their habitats (***Defenders.org/Animal-FactSheets***)

• American Society of Mammalogists, a society of scientists devoted to studying mammals and publishers of the *Journal of Mammalogy* (***Mammalogy.org***)

• Animal Diversity Web, a database of animal natural history, distribution, classification, and conservation biology from the University of Michigan (***AnimalDiversity.org***)

• The Encyclopedia Britannica, the world's oldest general knowledge English-language encyclopedia (***Britannica.com***)

• The International Union for Conservation of Nature's Red List of Threatened Species, a comprehensive compilation of information on the global conservation status of animal, fungi, and plant species (***IUCNRedList.org***)

• National Geographic (also National Geographic Kids), a global nonprofit dedicated to helping understand the world and generating solutions for a more sustainable future (***NationalGeographic.com/Animals*** or ***Kids.NationalGeographic.com/Animals***)

• Nature Works, an online resource developed by New Hampshire PBS in collaboration with the Squam Lakes Natural Science Center (***NHPTV.org***)

• San Diego Zoo (also San Diego Zoo for Kids), a conservation organization committed to saving species around the world (***Zoo.SanDiegoZoo.org*** or ***Kids.SanDiegoZoo.org/Animals***)

• Smithsonian National Zoo and Conservation Biology Institute, a conservation zoo and research facility in Washington, DC (***NationalZoo.si.edu/Animals/List***)

• The Smithsonian National Museum of Natural History, an organization devoted to understanding the natural world and our place in it (***NaturalHistory.si.edu***)

• Western Wildlife Outreach, a science-based community education project specializing in large carnivores of the Western United States (***WesternWildlife.org***)

• The World Wildlife Foundation, the leading agency working to protect nature and the future of our planet (***WorldWildlife.org***)

Animal Research
Worksheet

Animal name: _____

What do they look like? _____

_____

_____

What do they eat? _____

_____

_____

Are they **omnivores**, **herbivores**, **carnivores**, or **insectivores**? (circle one)

Are they **social** or **solitary**? (circle one)

Life Cycle

How long is their gestation?

When do they open their eyes?

When do they stand up?

When do they sample their first food?

When do they stop breastfeeding?

When do they leave their family?

Animal Vignette Worksheet

Animal name: _____

Draw a picture of your animal.

"I grow up _____

_____

_____"

Birth fact: "_____

_____

_____"

Food fact: "_____

_____

_____"

Second food fact: "_____

_____

_____"

"When I'm _____ old and able to _____

_____, I will be all grown up."

Grades
3–6

Subject
Life cycles, development, growth, weaning, milestones, passage of time, elapsed time

Skills
Interviewing, research, graphing

Materials
- Autobiography Worksheet (page 75)

Next Generation Science Standards
- *LS1B:* Growth and Development of Organisms
- *K-LS1-1:* From Molecules to Organisms: Structures and Processes
- *3-LS1-1:* From molecules to Organisms: Structures and Processes

Common Core Mathematics
Expand the Activity:
- *CCSS.MATH.CONTENT. 1.MD.C.4:* Represent and interpret data
- *CCSS.MATH.CONTENT. 3.MD.B.3:* Represent and interpret data
- *CCSS.MATH.CONTENT. 2.MD.D.9-10:* Represent and interpret data

Activity: Autobiography

Background

Did you know that humans are a type of mammal? Our species is called *Homo Sapien*. As animals, humans also have a life cycle. Just like the animals in this book, you were born, you opened your eyes, you were nursed in some form or another, you weaned, and you learned to walk. Just like these animals, you will eventually leave your family home, and many of you will have children of your own.

In this activity, you will interview a family member or guardian to identify your own personal life cycle milestones. You will tell your own story, like each of the animals in *This Is How I Grow*. This personal story is called an ***autobiography***. An autobiography is a life story written or told by the person whose life story is being told.

Activity

1. Review the above background as a class, as well as the background from the **Life Cycles Activity** (page 49). *This activity is best done after completing the **Life Cycles Activity**.*

2. Send each student home with an **Autobiography Worksheet** (page 75). Instruct students to interview their parent or guardian about the student's own life, filling out the worksheet with their personal milestones.

3. Using their completed worksheets, have them write their own personal biography in ten sentences or less, mimicking the style of the personal vignettes in *This Is How I Grow*.

Additional Information

A human's social structure is much more complex than that of other animals. We have invented many things that help us survive and thrive in ways that other animals don't. For example, sometimes gestation is cut short when a mother goes into labor early and a baby is born premature, or before they have finished developing. For most animals, this baby would die without the support of the mother's womb. Humans, however, have invented ways to keep premature babies alive. There is a place in hospitals called the NICU that keeps these babies safe and helps them grow. Another human invention is formula. Formula is a man-made liquid that many families feed their babies instead of breastfeeding. Formula has many of the same nutrients that breastmilk does. For the purposes of this activity, it is fine to consider ending formula feeding as "stop nursing" on the **Autobiography Worksheet** (page 75).

More on back...

Expand the Activity: Time Lines

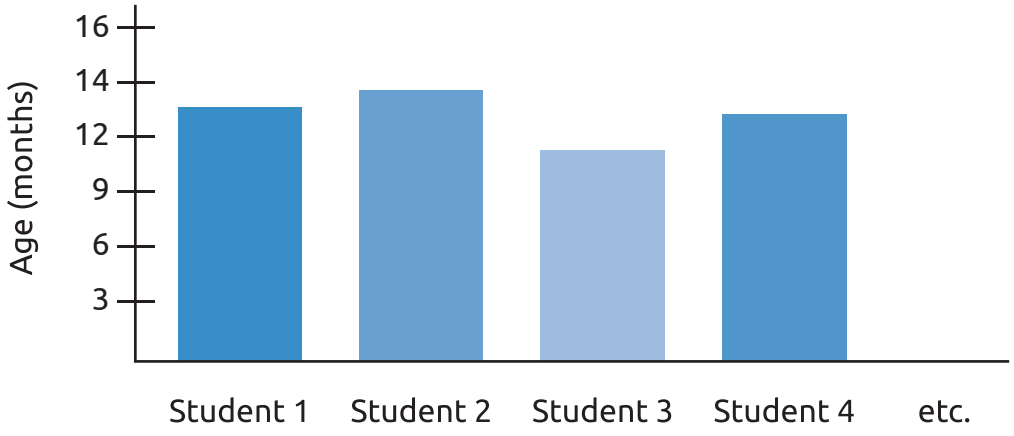
Have students use their completed **Autobiography Worksheet** to make a time line of their life so far. Compare this with the animal time line completed in the first part of this activity. Ask them questions like:

What similarities and differences do you see between your time line and your animal's?
What do you think these differences mean?

Expand the Activity: Graph the Class

A ***graph*** is a drawing that shows mathematical information using lines, shapes, and colors. You can use a graph to compare different kinds of information.

Once all students have completed their personal autobiography, use graphs to compare everyone's information. Use a ***bar graph*** like the following to visualize what age each student in the class took their first step:



You can also use the data the class has compiled in different ways. Calculate the *mean, median,* and/or *mode* age each student took their first step, weaned, or ate their first solid food.

Mean: The average of a set of numbers, calculated by adding all numbers in the data set and then dividing by the number of values in the set.

Median: The middle value in a set of numbers when the data is ordered from least to greatest value.

Mode: The number that occurs most often in a data set.

Ask your students what they can learn from examining this data and what this information says about normal human development.

Autobiography Worksheet

This worksheet will help you learn about your own life!
Fill it out with the help of a parent or guardian.

How long was your gestation? _____

_____

When were you born? _____

_____

When did you eat your first non-milk food? _____

_____

When did you stop nursing (drinking breastmilk or formula)? _____

_____

When did you stand up for the first time? _____

_____

When did you learn to walk? _____

_____

Are there any other life events that you learned about in *This Is How I Grow* that apply to your life?

_____

_____

_____

_____

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Section 3: Hands-on Activities

Each of the animals in *This Is How I Grow* is fascinating, unique, and complex. We've included as much information as we can, but there's so much more to learn! The hands-on activities in this section allow students to explore, learn, and understand the intricacy of the natural world.

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Grades
K–5

Subject
Habitats, adaptations, weight distribution, anatomy, physical structures

Materials
- Thick sponges
- Rubber bands
- Flat surface

Next Generation Science Standards
- *1-LS1-1:* From Molecules to Organisms: Structures and Processes
- *1-PS4-1:* Waves and Their Applications in Technologies for Information Transfer
- *3-LS3-2:* Heredity: Inheritance and Variation of Traits
- *4-LS1-1:* From Molecules to Organisms: Structures and Processes

Activity: Elephant Feet

Background

Elephants have the largest feet of any land mammal on the planet. A male Asian elephant can weigh up to 6 tons! You might think that carrying so much weight around would be hard on the joins. You might also think that moving through the jungle would be a thunderously loud endeavor. However, you would be wrong on both accounts…

Activity

1. Give each student a moistened sponge with a rubber band around it. Have them put the sponge on their hand, using the rubber hand to keep it in place.

2. Using the other hand, with no protective padding, have the students gently hit a flat surface like their desk. Hear how much sound it makes and feel how much impact is made.

3. Then, using the padded hand, gently hit the same flat surface. Notice that there is almost complete silence. Ask the students how that hand feels compared to the unpadded one. They will notice that there is comparatively very little impact.

4. Discuss: Soft, padded feet help elephants move over rocks, absorb the pressure from their weight, and allow even a herd of elephants to move almost silently through the jungle—barely leaving footprints!

Expand the Activity

Elephants are the largest land animals, yet their size and weight do not mean that they have a noisy walk or even leave footprints. Ask your students how they would design a human shoe to walk silently and not leave a footprint.

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Grades
K–5

Subject
Anatomy

Materials
- Bricks
- Sandpaper

Next Generation Science Standards
- *3-LS3-2:* Heredity: Inheritance and Variation of Traits

Activity: Elephant Teeth

Background

The majority of mammals are ***herbivores***, eating grasses, leaves, and plants. These foods are mostly fiber and water, and are low in nutrients. In order to get the nutrients they need to survive, herbivores have to eat for up to 20 hours a day. Even then, some resort to vomiting up food and re-eating it, or re-eating their waste to extract any nutrients they missed the first time!

Eating can be very hard on the teeth. Herbivores—like Asian elephants who spend 16 hours eating each day—grind their teeth to break down their food. How do you think this affects their teeth and their health?

Activity

1. Review the above background as a class.

2. Distribute a brick and a piece of sand paper to each student.

3. Using the sandpaper, have each student rub the brick for a minute. Ask them what they see.

4. Discuss: As you rub the sandpaper on the brick, you will see dust in the air. This is what happens to the Asian elephants' teeth with every meal! Can you imagine what would happen to the brick if you rubbed sandpaper on it for 16 hours every day? After ten years of constant grinding and wearing away, elephants will grind their teeth until there is nothing left. Fortunately, in elephants this triggers a new set of teeth to come in. Their full set of teeth will grow back six times, but after the sixth set, no more will grow.

What do you think will happen when the elephants no longer have teeth?
How are teeth connected to survival?

Expand the Activity

Consider the following questions:

How many sets of teeth do humans have?
What do you do to take care of your teeth?
Based on this activity, what do you think a giraffe's teeth are like? What about cougar's teeth?

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Grades
2–6

Subject
Water systems, aquifers, adaptations, ecosystems

Materials
For aquifer:
- Clear plastic cups
- Sand
- Gravel
- Water

For elephant:
- Plastic forks with the 2 middle tines removed
- Bendable plastic straws
- Construction paper
- Tape

Next Generation Science Standards
- *K-LS1-1:* From Molecules to Organisms: Structures and Processes
- *K-ESS2-2:* Earth's Systems
- *2-ESS2-3:* Earth's Systems
- *3-LS3-2:* Heredity: Inheritance and Variation of Traits
- *3-LS4-2:* Biological Evolution: Unity and Diversity
- *3-LS4-4:* Biological Evolution: Unity and Diversity
- *4-LS1-1:* From Molecules to Organisms: Structures and Processes

Activity: Water for Elephants

Background

Every animal needs water to survive. In dire circumstances, humans can live without food for more than three weeks (Gandhi survived 21 days of starvation), but we can only survive about 100 hours (four days) without water.

Some animals live in habitats where water is hard to find, and those animals have developed adaptations that let them store water in their body or get hydration from a different source. Giraffes can go up to three weeks without drinking anything! But they still need to eat, and the leaves and vegetation that make up most of their diet have a high water content. Kangaroo rats, tiny rodents that live in very hot, dry climates, make water inside their bodies from the seeds they eat.

Other animals, including Asian elephants, have adapted a different way to get the water they need. In this activity, you will learn all about how elephants take advantage of ***groundwater*** to hydrate themselves and other creatures in their habitat.

First things first: what is *groundwater*? It's just what it sounds like: water that comes from the ground. It is found in the natural cracks and spaces between soil, sand, and rock, called ***aquifers***. Groundwater is stored in and flows through these aquifers. Let's build our own model…

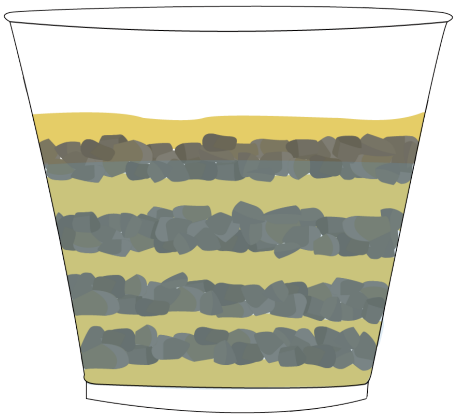
To fully understand groundwater, students should know that it is just one part of the water cycle.

Visit *TinyURL.com/GW-Cycle* for instructions from the Groundwater Foundation on making a miniature terrarium that demonstrates the phases of the water cycle. For a simpler project, try making water cycle bangles with instructions at *TinyURL.com/Water-Bangle*.

More on back...

Activity

1. Review the above background as a class.



Part 1: How Aquifers Work

2. Distribute aquifer materials to each student. You may prefer to have groups of students work together or simply observe you as a class. Each student or group of students needs two cups.

3. Layer sand and gravel in the clear plastic cups, alternating between the two substances until they are about 3/4ths of the way full. This is your aquifer.

4. Slowly pour water into the first cup, stopping when the water comes up about 1 cm above the top layer of sand/gravel. As they pour, have students observe. See how the water makes its way through the small openings between the rock as it goes down.

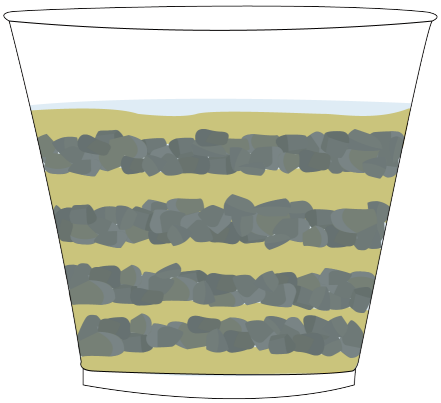
5. Explain: This is like a watering hole. The aquifer below the little lake is full, pushing any extra water above ground for animals to drink.

6. Think: What happens if the animals drink all the water in the watering hole, and there's no rain to fill it back up?

7. Slowly pour water into the second cup, this time being careful to stop about half an inch BELOW the top of the aquifer.

8. Explain: This is what a watering hole is like during drier times of the year.

9. Ask: What would you do if this was your only source of water? Students may suggest digging, but ask them how. We use our hands for digging, but most animals that use the watering hole don't have hands, let alone shovels.



Part 2: The Elephant in the Room

10. Distribute elephant materials to each student. Each student (or group of students) needs one plastic fork (with middle tines broken off) and one bendable straw.

11. Place plastic fork on the table or desk, with tines curved up.

12. Place straw along the handle of the fork, with the bendable part between the two remaining fork tines. Tape fork and straw together. The straw represents an Asian elephant's trunk, the remaining fork tines represent the elephant's tusks.

13. Cut ears out of construction paper and tape them to the elephant's head. Draw a face if you would like.

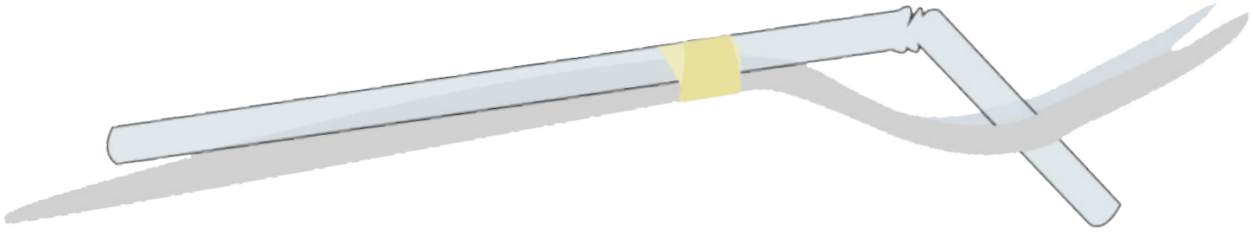
14. Using their elephant construction, have students try to access the ground water in the cups. They should find that the tine tusks are good for digging. As they dig, moving gravel and sand aside with their tusks, they should find that water accumulates in the hole they make.

15. If the water doesn't come fully to the surface, your elephant can suck water up out of the ground with their trunk. Insert the tip of the straw into the hole until it is hanging into the water. Then, cover the other end of the straw with your finger, forming a tight seal. Now you can pull the elephant's trunk out and water will come with it.

Part 3: Discussion

This is how elephants get water during dry seasons! Digging with their tusks helps them survive. However, elephants aren't the only ones who benefit from this adaptation. Once they have drunk their fill, other animals in their habitat take their turns. What would happen to the other animals in the elephant's habitat if elephants lost their tusks?

Elephant tusks are pretty amazing. Unfortunately, they are made of a material called *ivory,* which humans find very valuable. People called *poachers* hunt and kill elephants to take their tusks and sell them. This means the elephant population is in danger of extinction. According to *Tusk*, a nonprofit organization that focuses on conservation of Africa's wildlife, the African elephant population has fallen by over 30% in the last seven years (as of 2019). Incredibly, elephants are evolving in response to this problem. More and more elephants are born and develop without tusks. While this is a useful adaptation for dealing with poachers, think about what this means for these elephants' access to water. **You can read more about this at *TinyURL.com/NG-Tusks*.**



More on back...

Expand the Activity: Aquifers for All

Groundwater isn't just important for Asian elephants and the animals in their environment. Humans have developed ways to access groundwater for drinking and irrigation. It comes to the surface naturally through a spring, or can be extracted by drilling a well into an aquifer.

In the United States, groundwater supplies drinking water for 51% of the total population (and an even higher percentage of rural communities—99%!). 64% of groundwater is used in farming to water crops (irrigation). It also helps refill lakes, rivers, and wetlands.

The same way that aquifers fill from rain water and snow melting through layers of soil, other things can get mixed into the groundwater. Landfills, septic tanks, leaky underground gas tanks, and fertilizers and pesticides can pollute groundwater, making it unsafe to drink.

Visit *TinyURL.com/Save-Groundwater* to learn what you can do to protect your groundwater.

Grades
K–5

Subject
Nutrient density, habitats, anatomy, energy systems, kinetic energy, heat

Materials
- Bowl of ice water
- Tub of Crisco (varies by class size)
- Paper towels

Next Generation Science Standards
- *3-LS3-2:* Heredity: Inheritance and Variation of Traits

Activity: Whale Blubber

Background

The blue whale has the longest known migration of any mammal. They spend summers in the waters near Alaska, eating 900–24,000 lbs. of krill each day. When they begin their journey to Mexico in the fall, the mothers weigh 30 tons, are coated in a 5–10 inch layer of blubber, and will not eat. These mothers will swim 24 hours a day, travel 10,000 miles, gestate a 2,000 pound baby, and produce 6 tons of breastmilk—all with NO food! Even if they wanted to eat, there wouldn't be any food available, because the krill they feed on are only found in Alaska.

For 270 days each year they live off of the energy stored in their blubber. Fat is a concentrated food source for these whales. This fat layer not only provides nourishment for the whale, but also helps keep them warm during the long journey.

This activity uses solid fat to show the insulation properties of whale blubber.

Activity

1. Apply a thick coat of Crisco around one pointer finger of each student, leaving the other pointer finger clean.

2. Have students dip both pointer fingers into ice water and keep them there for one minute.

3. After removing their fingers from the water, ask the students how their fingers feel and if they feel different from one another. The Crisco finger represents the blubber on a whale. The Crisco keeps the participant's finger warm, just like the blubber keeps the whale insulated.

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Grades
1–5

Subject
Physical structures, habitats, nutrient density, food chains, anatomy, feeding behavior

Materials
- Container for water
- Sand
- Beads
- Combs

Next Generation Science Standards
- *4-LS1-1:* From Molecules to Organisms: Structures and Processes

Activity: Baleen Scene

Background

Whales are the largest mammals alive today, and the largest known to have ever existed. Blue whales are the largest species of whale, larger than the largest land animal (African Elephant) and the largest shark. There are two types of whale -- baleen and toothed. The key difference between them is the way they feed and what they have inside their mouth. Toothed whales, like sperm whales, killer whales, and dolphins, represent almost 90% of all types of whale, and are accomplished hunters. They eat fish, sharks, seals, sea turtles, octopuses, squid, and sea birds.

Baleen whales are generally huge and are filter-feeding specialists, straining enormous volumes of seawater through the baleen plates which sieve and retain little sea creatures in huge quantities. They feed on plankton and krill, a small shrimp-like crustacean (crustaceans are animals like crab and lobster, that have three body segments and are covered with an exoskeleton).

Baleen is made of keratin, the same material human fingernails and hair is made of, and forms a kind of spaghetti strainer in the whale's mouth. The whale scoops up a mouthful from the bottom of the sea, the sand and water strain out through the baleen, and only the krill are left. Blue whales eat 900–2,400 pounds of these tiny krill every day to support their 30-ton bodies.

Activity

1. Create a demonstration for students or have them create their own simulations, to better understand how baleen capture food for the whale. In this activity, the combs represent the baleen and the beads represent the krill.

2. To prepare, put a layer of sand in the bottom of your container. Fill with water about an inch above the sand line. Place some beads in the sand. The beads represent the krill.

3. Using a selection of different combs, try to scoop up some of the beeds. Be sure to go under the sand and sieve out the sand in order the "capture" the beads.

4. Observe what happens. Which combs allowed you to get the most beads? Look at photos of baleen to see how much it does or doesn't look like a comb. What else could you have used in your simulation besides combs and beads? Ask the kids if they would like to eat all their food this way.

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Grades
K–5

Subject
Measurement, relative size, phenotype

Materials
- Tape measure
- Chalk
- Large outdoor blacktop

Common Core Mathematics
- *CCSS.MATH.CONTENT.K.MD.A.1:* Describe and compare measurable attributes
- *CCSS.MATH.CONTENT.1.MD.A.2:* Measure lengths indirectly and by iterating length units

Activity: How Big Is a Whale?

Background

Blue whales are the largest animal known to have ever existed. They're bigger than any existing land animal, any other whale, and even the dinosaurs!

Why do you think this is? Part of the reason is that whales live under water, and water helps buoy against the effects of gravity. This means that a whale's body doesn't have to support as much weight as it would if it lived on land.

Blue whale calves are born about 23 feet long, and grow to be almost 100 feet long as adults. 23 feet is a HUGE baby, but blue whales have A LOT more growing to do. Luckily, their mother's milk is extremely fatty and nutrient-dense, which helps them grow quickly. In its first few weeks of life, a blue whale calf will drink 100-150 gallons of milk every day. With this rich diet, they can put on as much as 200 lbs. every day—that's 8 lbs. every hour!

It can be hard to understand how massive something this size truly is. This activity will allow students to visualize the size of a blue whale.

Activity

1. Ask students how big they think a blue whale is. Why do they think that? Record their predictions on the board.

2. After students have made their initial predictions, tell them that blue whales are about 100 feet long and review the above background information with them.

3. Then ask, how many students do they think it would take to make a chain as long as a blue whale (lying head-to-foot or holding hands)? Write predictions on the board.

4. Optional: use a tape measure to calculate the height of one student, or measure multiple students and calculate an average. With these measurements, students can make a more educated guess.

More on back...

5. Next, take the students outside. You will need a large blacktop, parking lot, or stretch of sidewalk. Using the tape measure, measure 100 feet, and mark either end with chalk.

6. Have students stand with their arms stretched out, touching fingertip to fingertip, to measure how many students can fit lengthwise inside a blue whale. Alternately, have students lie on the ground head to toe. *Note: a person's arm span is approximately the same as their height, so either option should net similar results.*

7. Record how many students it takes to be as long as a blue whale. Discuss: how does this compare to your predictions?

Expand the Activity: Relative Size

Look up sizes of other kinds of whales. Mark out their length alongside your blue whale chalk line. Ask the students how they compare.

Look up the sizes of the other animals in *This Is How I Grow*. Mark their length alongside your blue whale chalk line. Compare them to the whale and to each other.

Blue whales live off of krill. Look up the size of a single krill. Compare that to your chalk measurement. Discuss how blue whales survive when their food is so tiny.

Grades
K–5

Subject
Habitats, feeding behavior, adaptations

Materials
- Crayons (dark colors work best)
- Sandpaper
- Cougar Tongue Elk Coloring Page (on back)

Next Generation Science Standards
- *3-LS3-2:* Heredity: Inheritance and Variation of Traits
- *4-LS1-1:* From Molecules to Organisms: Structures and Processes

Activity: Cougar Tongue

Background

As you learned in *This Is How I Grow*, cougars are carnivores that eat elk, deer, rabbits, and many other creatures in their habitat. Hunting is hard work with a low success rate and a lot of risk. When an animal is felled, it is essential for the hunter to gain all the nutrients possible from the animal. Cougars have an adaptation in their tongues that allows them to leave no waste behind. Their tongues are like sandpaper, and efficiently scrape all the flesh off the bones, making sure they can get every bit of meat.

Activity

1. Distribute a **Cougar Tongue Elk Coloring Page** (page 94), dark colored crayon, and piece of sandpaper to each student.

2. Have students color in a section of the elk.

3. Then, have them take a piece of sandpaper and rub it on the section they colored.

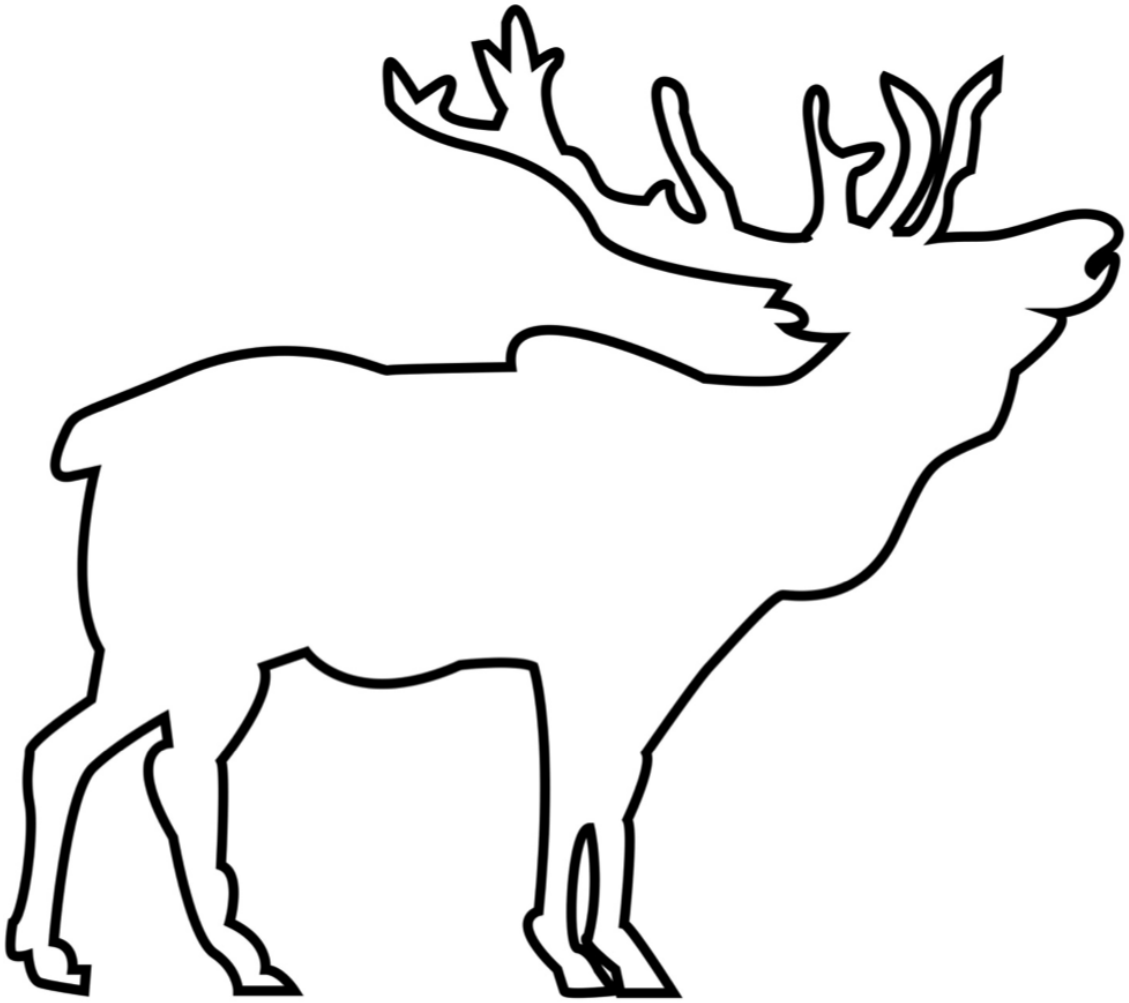
4. Tell them to look at the sandpaper. What do they see? The crayon should have lifted off the paper and attached itself to the sandpaper.

5. Explain: this is how a cougar's tongue works. The scratchy tongue picks up remaining scraps of flesh and pulls it off the bone.

Elk Coloring Page on back...

Cougar Tongue
Elk Coloring Page

Using crayons, color the elk below.



Cats are known as the only true carnivores, because they feed solely on meat. Many carnivores occasionally supplement their diet with plant matter, but not cats! You may see a cat eating grass, but they cannot digest plant material; instead, the grass helps them bring back up any fur they may have swallowed while grooming themselves.

It's not too surprising, then, that cats are the only mammals with a scratchy tongue. It is specifically adapted for scraping flesh off of bone, which is essential for animals that can only eat meat. They need to get as much nutrition from an animal as possible, because they can't supplement with other kinds of food.

Grades
1–5

Subject
Sensory perception, infant identification, habitats, life cycles, parental care, adaptations

Materials
- Opaque cups
- A material to cover the cups (ex. tape, aluminum foil, or lids)
- Various items that produce distinct sounds (ex. popcorn kernels, rice, noodles, beans, etc)
- Various materials with distinct scents (ex. cinnamon, coffee, curry powder, mint, etc)
- Black and red markers

Next Generation Science Standards
- *4-LS1-2:* From Molecules to Organisms: Structures and Processes

Activity: Baby Bat Cups

Background

As any mom will tell you, it's difficult to do much when you have a newborn—showering, sleeping, and eating all become more complicated when you're responsible for a helpless baby. Mammal moms have a number of strategies for feeding themselves while they take care of their young:

- Some mammal moms keep their babies with them while they feed.

- Other mammal moms, like polar bears, don't eat anything while their cubs are young, because the cubs can't walk and it's not safe to leave them alone.

- Some mammal moms are social carnivores, like in a pride of lions, and share duties. In these herds, some females will care for the young while others do the hunting for the community. This is similar to how human families do things!

- Many mammal moms hide their young while they go looking for food. Bats are among this group. Hiding your young seems simple enough—but is it?

At dawn, with their bellies full, Brazilian free-tailed bat moms return to the nursery cave to feed their young. What's the catch? There are three million baby bats in the nursery! The cave is dark (there's no natural light), cold, and the bats are huddled tightly together to stay warm. How does a mom locate her own baby? By memorizing its smell and the sound of the pup's voice! Let's try it…

More on back...

Activity

1. Prepare 5–20 pairs of cups (depending on the age and ability of your students) as follows. Preparing them can seem unduly complicated the first time, but once you get the hang of it, it gets easier.

   i. Cover all the cups with tape, tin foil, or a lid. Using a pin, open paper clip, or other sharp object, poke holes in the top of all the cups so you can smell through them.

   ii. Using a marker, draw a red circle on the tops of half the cups, and a black circle on the tops of the other half.

   iii. On the bottom of each red cup, write a number, starting with 1 and continuing through all the red cups.

   iv. On the bottom of each black cup, write a number, starting with 41 and continuing through all the black cups.

   v. Put the cups in pairs by number (black #1 with red #41, black #2 with red #42, etc). If this number code seems to be to obvious for your students, you can make your own code and key.

   vi. Both cups in each pair need to have the same combination of sound and scent added. You may use the same scent for more than one pair of cups, as long as each of those pairs has a different sound. Only members of a pair (one red cup and its matching black cup) should have the same combination of sound and smell. For example, put popcorn kernels in four different pairs of cups. Put mint in the first pair of popcorn cups, cinnamon in the second pair, curry in the third pair, and lavender in the fourth.

   vii. Place all red cups together in one area. Place all black cups together in a different area.

2. Ask each student to select one cup, shake and smell it, note the number on the bottom, then place it back on the table.

3. Then, have them walk to the other set of cups and try to find the one with the identical scent and sound.

4. You can verify their matches based on the numeric code on the bottoms of the cups (1 with 41, 2 with 42, 3 with 43, etc).

5. Discuss: This is how bat mothers find their babies. It may have been difficult for us, but bats have a much easier time. Why? Every living thing is adapted for its environment. Humans rely primarily on our sight and touch to gain information about their surroundings. Bats rely primarily on their hearing and sense of smell. This exercise is difficult for humans because our sense of hearing and smell are not well developed. The senses you use are the ones that are most necessary for survival in our environment.

Grades
2–4

Subject
Classifications, habitats, anatomy, adaptations, sensory perception

Materials
- Blindfold
- Echolocation in Action Worksheet (page 99)
- Large inflatable or rubber bouncy ball (for extension)

Next Generation Science Standards
- *4-LS1-1:* From Molecules to Organisms: Structures and Processes
- *4-LS1-2:* From Molecules to Organisms: Structures and Processes

Activity: Echolocation in Action

Background

Every animal is adapted to its environment. We've already explored some examples of these adaptations. Can you think of any? *(Hint: elephant tusks, whale blowhole)*

Brazilian free-tailed bats live in dark, underground caves, and do most of their hunting at night. This means they can't rely on their eyesight to figure out what's around them. Instead, they use their hearing in a special way. They use something called ***echolocation***, the process of using sound waves to find where objects are located.

Bats make noises from their throat, just like humans. Those noises travel through the air in a wave of sound. If the sound hits an object—like a mosquito, moth, or other food source—the sound wave bounces back, like an echo.

In this activity, students will play the part of a bat and practice using their other senses to locate objects around them.

Activity

1. Divide students into groups of three. One student will be the bat, one will be the moth, and one will be an observer. Each group needs a blindfold and three copies of the **Echolocation in Action Worksheet** (page 99).

2. Make sure students have plenty of room to move around. Have the groups move to different parts of your space. This activity is best done in a gym, other large room, or outside.

3. Have the "bat" student put on their blindfold, and stand still or sit in a chair. The "moth" student should move around the "bat" student in each group, making sure to stay a few feet away at all times. Instruct the "moth" to clap at various points as they circle around the "bat."

4. Each time the "moth" claps, the "bat" should point in the direction where they think the "moth" is.

More on back...

5. Using the **Echolocation in Action Worksheet,** the observer will record each clap—where the "moth" was, where the "bat" guessed it was, and whether the "bat" was right or wrong.

6. Each "bat" should try ten times before the group members switch. Every student should get a turn being the bat, moth, and observer. By the end, each student will have a completed **Echolocation in Action Worksheet.**

7. Discuss:
   Which location did the bats guess correctly most often?
   Which location did they guess wrong most often?
   Why do you think some locations were easier or harder to guess than others?

Expand the Activity: Bouncing Ball Echolocation

To mimic the experience of using echolocation more closely, students can use a blindfold and a large inflatable or rubber bouncy ball. One student at a time should take turns being the bat in this activity.

Blindfold the bat, and stand them about 10 feet from a wall, facing the wall. Give them the ball. The bat's goal is to figure out where the wall is, and get close enough to touch it, without running into the wall.

To do this, the blindfolded bat should throw the ball at the wall, keeping their hands in front of them prepared to catch the ball when it bounces back (if the ball doesn't bounce back into the bat's hands, fetch the ball and hand it back to them). If the bat thinks the ball is more than a step away, they should take a step closer to the wall. Continue throwing the ball against the wall and catching the "echo" until they find the wall.

Echolocation in Action
Worksheet

Bat Name _____ Observer Name _____
(Blindfolded student)

Moth Location (front, back, left, right)	**Bat's Guess**	**Right or Wrong?** (circle one)
		R W
		R W
		R W
		R W
		R W
		R W
		R W
		R W
		R W
		R W

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Activity: Adaptable Necks

Grades
1–4

Subject
Classification, habitats, anatomy, adaptations, physical structures

Materials
- Pipe cleaners (approximately 10 inches long; each student will need 3)
- Beads (0.25 inches; each student will need 25)
- Smaller wooden spools (0.4 inches; each student will need 7)
- Larger wooden spools (0.75 inches; each student will need 7)

Next Generation Science Standards
- *3-LS3-2:* Heredity: Inheritance and Variation of Traits
- *4-LS1-1:* From Molecules to Organisms: Structures and Processes

Background

Masai giraffes are tall, and their necks are looooooong. Because of this, you might think they have more neck bones than other mammals, but that is not the case.

While birds, amphibians, and reptiles have a large variation in the number of vertebrae in the neck, in mammals it is fixed at seven. The long neck of the swan is composed of 22 to 25 cervical vertebrae, while ducks' necks have 16. In contrast, the long necks of giraffes have seven cervical vertebrae, the same number as humans, bats, dogs, and whales. With just two exceptions (the manatee and the sloth), this number is constant for all mammals.

If a giraffe and a bat have the same number of vertebrae, how are they so different? How would the size of the vertebrae help an animal survive? Let's see…

Activity

1. Review the above background as a class.

2. Have students tie a knot at one end of a pipe cleaner. String 25 beads on it. This is similar to a swan's neck.

3. Have them tie a knot in another pipe cleaner. String seven small spools on it. This is similar to a horse's neck.

4. Finally, have them tie a knot in a third pipe cleaner. String seven larger spools on it. This is similar to a giraffe's neck.

5. Compare the necks for stiffness and flexibility. Determine which is stiffest and which is most flexible.

6. Discuss: Both Masai giraffes and swans have very long necks, but a giraffe's neck is stiff, and swan's is flexible. ***Why do you think this is?*** Giraffes have only seven neck bones, but each bone is up to a foot long. This makes a giraffe's neck stiff, which is useful for reaching their food at the tops of trees. A swan has 23–25 much smaller neck bones, which provides flexibility. This is useful, because swans fish for their food under water. They must be able to bend down and make quick, precise movements.

Expand the Activity

Have students think about how this compares to a human neck. Each of our vertebrae are about 1 inch long, while a Masai giraffe vertebra is about a foot long.

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Grades
1–4

Subject
Habitats, nutrient density, symbiotic relationships, feeding behaviors, energy flow in organisms

Materials
- Nuts About Squirrels Pine Cone Cutouts (page 105)
- Nuts About Squirrels Acorn Cutouts (page 107)
- Outdoor area where students can dig (school garden, wooded area, or wood chip covered playground are all good options)

Next Generation Science Standards
- *K-LS1-1:* From Molecules to Organisms: Structures and Processes
- *K-ESS3-1:* Earth and Human Activity

Activity: Nuts About Squirrels

Background

Although squirrels forage for plants, mushrooms, insects, and sometimes even eggs and baby birds, tree nuts are by far their biggest and most nutritious food source. Trees only produce nuts once a year—usually in the fall—which means that squirrels have to find a way to store this precious food source to last the rest of the year.

This activity allows students to explore what skills squirrels need to keep themselves fed.

Activity

1. Prepare your **Nuts About Squirrels Pine Cone Cutouts** (page 105). Print six pine cones for each student. Write each student's name on the back of their pine cone cutouts.

2. Review above background as a class.

3. Distribute pine cones to each student and go outside.

4. Have students hide their pine cones under leaves, dirt, wood chips, etc.

5. Take a break: recess, another class, or overnight. Longer breaks are suggested for older students.

6. Bring the class back together in the area you buried your pine cones. Give students five minutes to locate their pine cones.

7. Ask the following questions:
   Was it easy to remember where you hid your pine cones?
   Were you able to find all of them?
   Could you survive as a squirrel?
   What might make it easier to find your pine cones next time?
   When looking for your pine cones, did you find other students' pine cones instead?

More on back...

Expand the Activity: Middens vs. Scatter Hoarding

Some squirrels, like the common gray squirrel, bury nuts individually in many locations. This is called scatter hoarding.

Red squirrels, on the other hand, keep their nuts, seeds, and pine cones all together in a single stash, called a "midden." Middens are hidden under logs, at the base of trees, and underground.

Give half the class **Nuts About Squirrels Pine Cone Cutouts** (page 105) and half the class **Nuts About Squirrels Acorn Cutouts** (page 107). Students with pine cones should store them all in one place (imitating a midden), and students with acorns should hide each of theirs in a different location. Then, after an interval of time (recess, another lesson, or overnight) send students hunting for their peer's hidden treats. Give students 60 seconds to hunt for as many as possible.

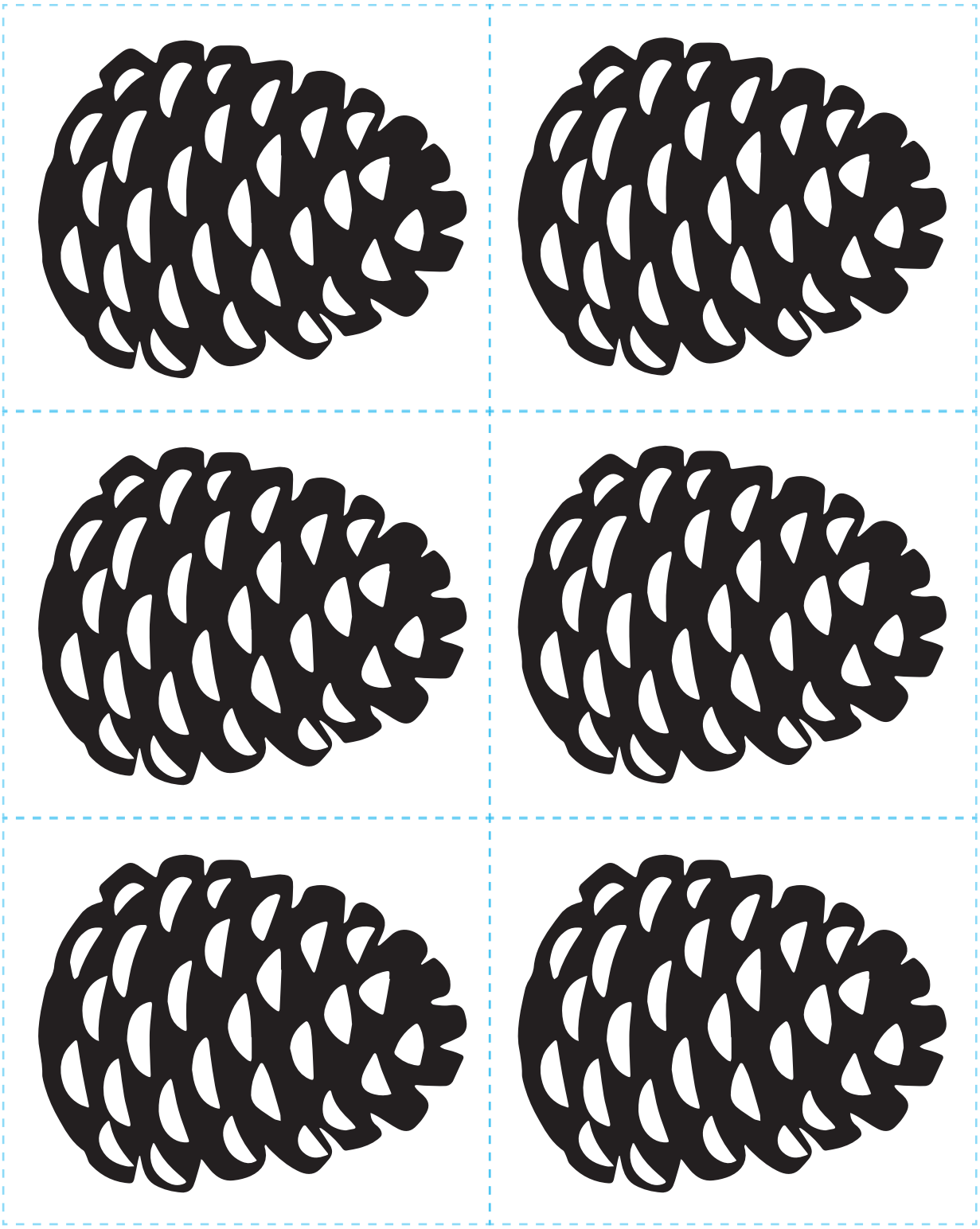
Discuss:

How many pine cones did the class find?
How many acorns? Did you find all the pine cones and acorns that you hid?
Is it easier to find food that has been scatter hoarded or that is in a midden?
What do you think are the pros and cons of using the midden method vs. scatter hoarding?
(Think: It's easier to remember where your food is if it's all in one place, but if a bear finds your midden, all your food is gone. Whereas, if a bear finds an acorn you've scatter hoarded, you still have plenty of nuts left elsewhere.)

Note: Squirrels usually don't find or finish all of the seeds and nuts they've hidden in their midden. The seeds that remain—conveniently already buried in the ground—will grow into new trees. In this way, red squirrels play an important role in the continued existence of their habitat.

Red squirrels and coniferous trees (trees that produce seed cones, like pine trees) have a mutualistic relationship: squirrels benefit from eating parts of these trees, and the trees benefit from squirrels spreading and burying their seeds. *See the **Who Do You Know? Activity** (page 17) for more on symbiotic relationships.*

Pine Cone Cutouts



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Grades
3–8

Subject
Adaptations, heat, kinetic energy, energy systems, habitats, measurement

Materials
- Ice cubes (3 per group)
- Colored paper (white, black, and red)
- Scissors
- Tape
- Newspaper
- A warm day or heat lamps
- Timers (one for each group or a large clock counting elapsed time in front of the classroom)
- Polar Brrr Adaptations Open Box Template (optional) (page 111)

Next Generation Science Standards
- *3-LS3-2:* Heredity: Inheritance and Variation of Traits
- *4-PS3-2:* Energy
- *MS-PS3-3:* Energy

Activity: Polar Brrr Adaptations

Background

Polar bears live in some of the coldest climates on Earth. The Arctic can be as cold as -58 degrees Fahrenheit during the winter!

So how do polar bears keep warm? Well, they have a number of adaptations that help insulate them from the freezing air:

- Polar bears have a thick, insulating layer of blubber that protects against cold. This blubber layer can be up to 4 inches thick. *For more information on blubber, see the* ***Whale Blubber Activity*** *(page 87).*

- They also have two dense layers of fur, up to 15 cm thick. This fur keeps their body heat trapped inside. In fact, they let out so little heat that they are nearly invisible on an infrared camera.

- Scientists have found that polar bears produce high levels of nitric oxide. Nitric oxide is a molecule that controls whether cells use their available nutrients to provide metabolic energy or to generate heat. This allows polar bears to produce heat when they need it, as long as they've eaten enough.

- Although polar bears look white, their skin is actually black. This is an essential factor when it comes to attracting and trapping heat. This activity explores how this works...

Activity

1. Prepare materials:
   i. Cut and tape colored paper into boxes or have students assemble their own using the **Polar Brrr Adaptations Open Box Template** (page 111). Boxes should be open on one side.

   ii. Make enough ice cubes for each group to have three. They should be the same size and shape for scientific integrity. You may want to make a few extras.

2. Review the above background as a class.

More on back...

3. Divide students into groups.

4. Set up experiment stations either outside on a warm day or under heat lamps:

   • Lay down several layers of newspaper

   • Set up different colored boxes with the openings facing students so they can observe

   • Distribute timers and ice cubes

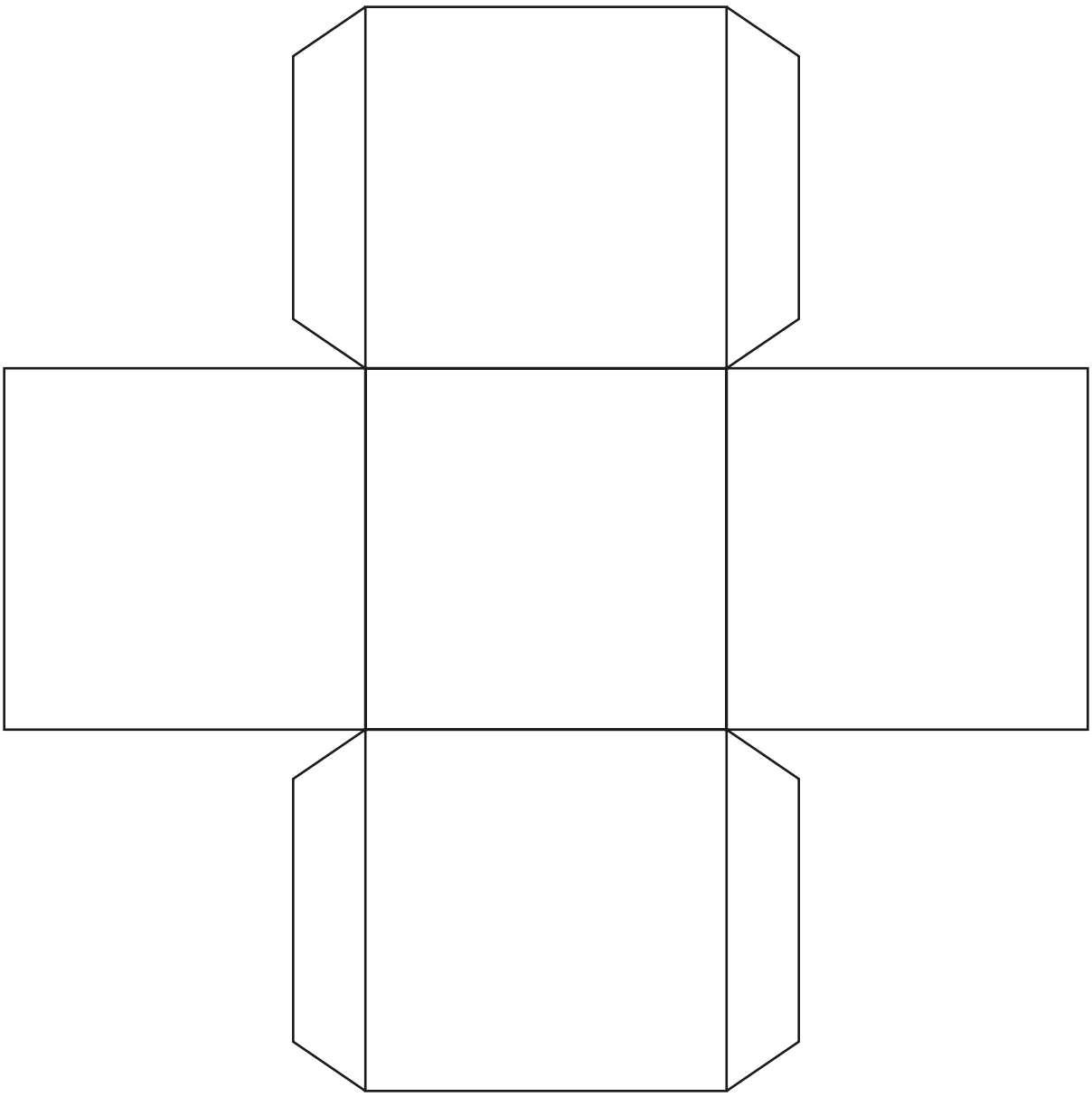
5. Have students place one ice cube in each box

6. Observe and note at what time each ice cube melts.
   Example: Black = X.XX; White = X.XX, Red = X.XX

7. Discuss as a class. Ask each group:
   Which cube melted first?
   Which cube melted last?
   What does this mean about which colors absorb more heat?
   What does this mean for polar bears?
   How could this apply for humans?

This activity was adapted from ***https://www.teachengineering.org/activities/view/colors_absorb_heat_better.***

Polar Brrr Adaptations
Open Box Template



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Activity: Hop to It

Grades
K–5

Subject
Energy (potential and kinetic), physical structures, anatomy

Materials
- Paper cups (2 per student)
- Rubber bands (2 per student)
- Scissors
- Glue stick
- Wooden skewer
- Colored pencils, crayons, or markers
- Kangaroo Template (page115)

Next Generation Science Standards
- *4-PS3-1:* Energy
- *4-PS3-2:* Energy
- *4-PS3-4:* Energy

Background

Kangaroos are special animals with a lot of unique qualities. One of their most unique characteristics is that they travel not by walking, but by hopping! Their feet are long and stiff, so they can't walk the way that we do. When they want to walk, they use their big strong tail like a third leg that pushes them forward, or they lean forward and use their arms to help propel them. However, much more commonly, they hop to get around.

Luckily, hopping is much easier for kangaroos than it is for humans. When we jump, we have to use a lot of effort from our muscles. But kangaroos have large, stretchy tendons in their hind legs that act kind of like big springs, and, as they expand and contract, they generate most of the energy that the kangaroo needs to hop.

This activity demonstrates the energy transfer that kangaroos use to hop, and gives students a functional craft to take home.

Activity

1. Review the above background as a class.

2. Hand out supplies to students and allow them to decorate their kangaroos. Cut them out along the outer line.

3. Glue the kangaroo wrap to one of the paper cups.

4. Using scissors and/or a wooden skewer, poke four holes in the wrapped paper cup at opposite points (like a cross).

5. Snip the rubber bands so they are no longer circles.

6. Feed one rubber band through opposite holes, allowing a little slack, then tie a knot in both ends. Repeat with the other rubber band and the other holes so the two bands form an X across the cup's opening.

7. Place the other cup opening-side down on the desk. Place the kangaroo on top of this cup and push down to generate energy. Let go to allow the kangaroo to jump.

This activity was adapted from ***https://www.lottamagazine.com/newsite/kids-crafts/jumping-kangaroo/.***

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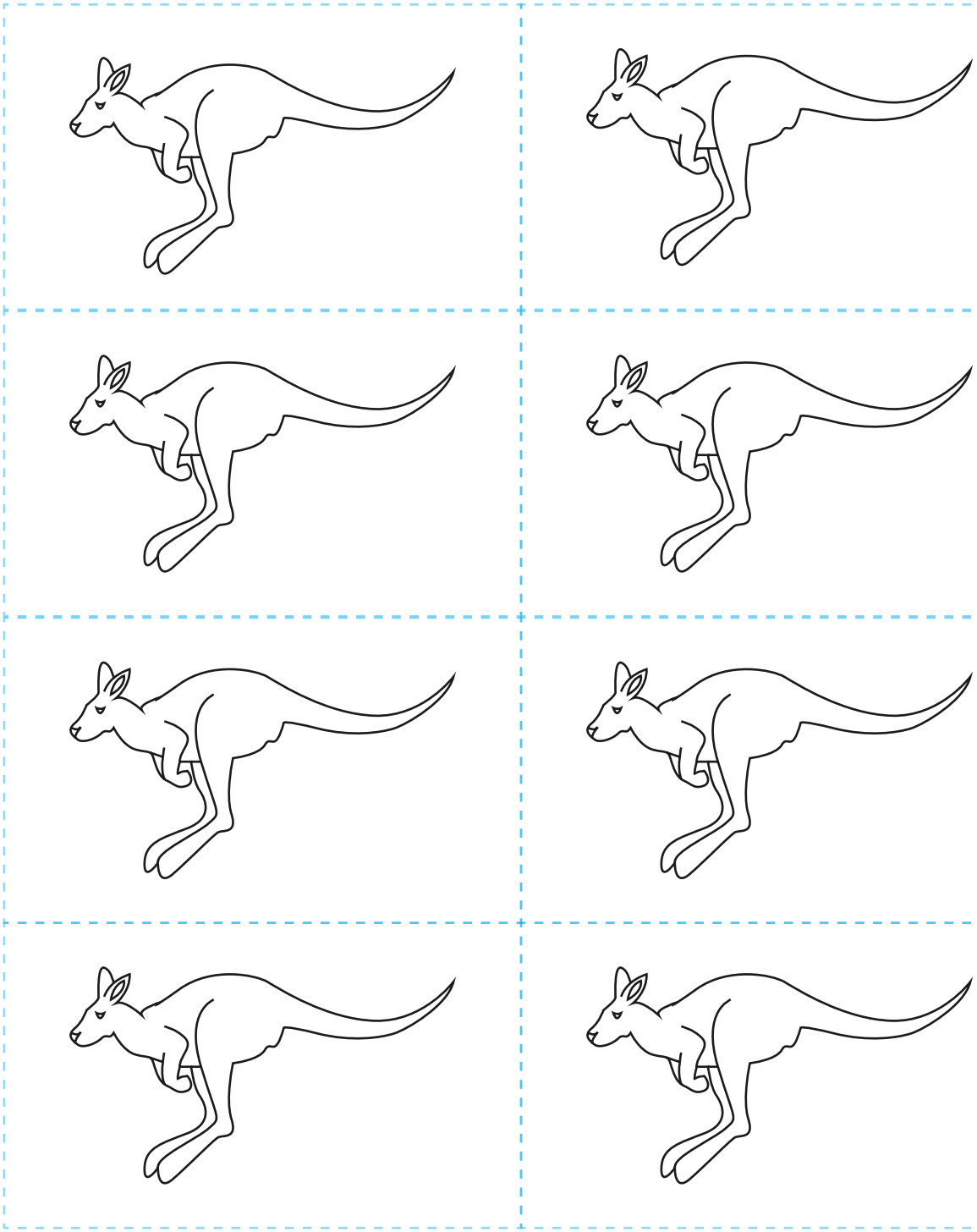
Hop to It
Kangaroo Template



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Glossary

A

Aquifers: Natural spaces between soil, sand, and rock, in which groundwater is stored.

Autobiography: The life story of an individual as written or told by the person in question.

B

Bar graph A diagram in which the numerical values of variables are represented by the height or length of lines or rectangles of equal width.

Blubber: The fat layer between the skin and muscle of whales and other cetaceans. It is used to make oil.

C

Carnivore: An animal that eats only meat.

Colostrum: The first milk a mammal mother produces after her child's birth. It is thicker than other stages of mother's milk, and contains nutrients that turbo-charge a newborn's immune system.

Commensalism: A relationship between two living creatures where one member benefits and the other is neither helped nor harmed.

Coniferous forests: Habitats full of trees that have needles instead of leaves and stay green all year.

Crustaceans: Animals with three body segments that are covered with an exoskeleton. Ex. Lobsters, crabs, shrimp.

"Contact and carry" species: Mammal species that produce milk low in fat and protein, but high in carbohydrates. Their milk is relatively low in calories, requiring mothers to stay close to their young so they can feed on demand.

D

Deciduous forests: Habitats full of trees that drop their leaves in the autumn and winter.

E

Echolocation: The process of using sound waves to find where objects are located.

F

"Feed and leave" species: Mammal species that produce milk high in fat and protein, but low in carbohydrates. Their milk is relatively high in calories, which allows mothers to leave their young alone for long intervals between feedings.

Food chain: A visual representation of how energy cycles and transfers through living organisms in a habitat. They begin with plant life and end with animal life.

G

Gestation: The period of time when a mammal is growing and developing inside of its mother.

Graph: A drawing that shows mathematical information using lines, shapes, and colors. You can use a graph to compare different kinds of information.

Groundwater: Water that is stored in and comes from the ground.

H

Habitat: The environment of an organism that is natural for their life and growth.

Herbivore: An animal that eats only plants.

Herds: Large groups of animals of one species that remain together.

Host: A living creature in a parasitic relationship with a parasite. It suffers, while the parasite benefits from the interaction.

I

Insectivore: An animal that eats only bugs and insects.

K

Keratin: Fibrous proteins that make up hair, fingernails, shells, feathers, and whale baleen.

Krill: Tiny, shrimp-like animals that live in open seas.

L

Life cycle: The story of an animal's journey through life, including all the stages that a living thing naturally goes through between birth and death.

Lipivores: Animals that eat primarily fat.

M

Mammalogy: The study of mammals.

Marsupials: Mammals who begin development inside the uterus of the mother but gestate for only a short time and are born incompletely developed. The embryo completes its development inside a pouch on the mother's belly, continuously suckling mother's milk for nourishment.

Mean: The average number in a set of numbers, calculated by adding all numbers in the data set and then dividing by the number of values in the set.

Median: The middle number in a data set when the data is ordered from least to greatest value.

Mode: The number that occurs most often in a data set.

Monotremes: Mammals who develop inside an egg. These are more rare than placentals and marsupials. Unlike the other two categories, monotremes do not give birth to live young or gestate inside the mother's uterus at all.

Morphology: The form and structure of an organism considered as a whole. Morphology is also the branch of biology dealing with the form and structure of organisms.

Mutualism: A relationship between two living creatures where both members benefit from the interaction.

O

Omnivore: An animal that eats a combination of plants and meat and/or insects.

P

Parasite: A living creature in a parasitic relationship with a host. It benefits from the relationship while the host suffers.

Parasitism: A relationship between two living creatures where only one member benefits (this member is known as the parasite) while the other one suffers (this member is known as the host).

Phylogenetic species concept: The concept of a species as an irreducible group whose members are descended from a common ancestor, and who all possess a combination of certain defining, or derived, traits.

Placentals: Mammals who carry their fetus in the uterus of the mother until a relatively late stage of development. The embryo completes its development while inside the uterus, nourished by an organ called the placenta.

R

Reproduction: The process by which a living creature creates offspring (i.e., having babies).

S

Social mammals: Mammal species that spend most of their lives with others of the same species—usually members of their own families.

Solitary mammals: Mammal species that spend most of their adult life alone.

Species: In biology the major subdivision of a genus or subgenus, regarded as the basic category of biological classification. It is composed of related individuals that resemble one another, are able to breed among themselves, but are not able to breed with members of another species.

Subspecies: A subdivision of a species, especially a geographical or ecological subdivision.

T

Taxonomy: The science dealing with the description, identification, naming, and classification of organisms.

Territory: An animal's home area. In solitary species, animals will compete for territory.

Thermoregulation: The regulation of body temperature.

Time lines: A graphic representation of events depicted in the order in which they happen(ed).

V

Vignette: A short, detailed description that gives an impression of a person, thing, or event.

W

Weaning: The process of switching from eating only mother's milk to eating the foods each mammal will rely on as an adult. This is a life cycle stage that every mammal experiences.

Subject Index