



MAMMALS

HANDBOOK





What do tiny bats and gigantic whales have in common?

They are both mammals, just like us.

Mammals are a type of vertebrate. Run your fingers up the center of your back. Do you feel the thin column of bones there? Those are your vertebrae, small bones stacked to form the spine which holds your torso up. All mammals have a spinal column, but that's not what makes them mammals. Fish, amphibians, reptiles, and birds are vertebrates, too. But they are not mammals. Mammals have hair and they nourish their offspring with milk. Most mammals give birth to live babies, not eggs. Mammals have strong jaws with specialized teeth. And most mammals are warm-blooded, meaning that they keep their body temperature relatively constant even when it becomes warmer or colder outside.



IN THE APP

In *Mammals* by Tinybop, you can study and compare several mammals. Play with each animal. Tap it, feed it, and consider what you do and do not have in common with it.



Study the animal's appearance.

An animal's appearance can tell us about its **behaviors** (how it lives) and its **habitat** (where it lives). For instance, you can tell whether an animal lives somewhere warm or cold; eats meat, plants, or both; flies, jumps, hops, runs, and more.



Tap the mammal's muscular system.

Mammals rely on two types of muscles. Smooth muscles keep their hearts beating, lungs breathing, and stomachs digesting. Skeletal muscles, which you can see in the app, move mammals' skeletons and help them walk, run, and jump.



Tap the mammal's respiratory or circulatory system.

Animals, like us, inhale the oxygen needed for energy and growth and exhale the carbon dioxide produced as waste. This process, called breathing, is the work of a mammal's respiratory system. Breathing is essential to a mammal's survival. With the help of a muscle called the diaphragm, air enters through the mammal's nose or mouth, travels down the trachea, through the bronchi and an intricate network of airways, and finally, into the lungs.

The circulatory systems helps spread oxygen from the lungs to the rest of a mammal's body. The heart is at the center of the circulatory system. The heart pumps blood through a network of blood vessels throughout the body to deliver oxygen and nutrients and remove carbon dioxide, a waste product. A human heart beats 60 to 100 times per minute when resting, and up to 200 times per minute when sprinting. A bat's heart can pump up to 1,100 beats per minute while flying.



Tap the nervous system.

Drag items toward the mammal.

The nervous system includes the brain, spinal cord, nerves, neurons, and sensory organs: the ears, nose, eyes, tongue, skin, and whiskers. The brain contains many cells called neurons. Through neurons, the brain processes messages from the skin, eyes, ears, nose, whiskers, and tongue about how things feel, look, sound, smell, and taste. This is how an animal knows that another animal is nearby and determines whether it is a threat, a friend, or a meal.



Feed the mammal.

A mammal can be an herbivore that eats plants, a carnivore that eats other animals, or an omnivore that eats both plants and other animals.

Everything an animal eats and drinks takes the same trip through the digestive system. The digestive system starts in the mouth: as an animal chews, muscles and spit begin to break down food. Thin incisors cut bites of food. Flat, broad molars grind up leafy food, while sharp canines tear apart meat or crunch through insect shells.

As food travels through the esophagus, stomach, and intestines, it breaks down into nutrients. Some herbivores, like sloths and kangaroos, have multi-chambered stomachs which help them break down tough leaves and other plant matter. Animal proteins, the food that carnivores like bats and tigers like, are easier to digest. Carnivores tend to have simpler stomachs and shorter intestines.

The nutrients that aren't absorbed by a mammal are turned into waste and discarded as poop.



Tap the kangaroo or elephant's bladder.

Tap the elephant's uterus or the kangaroo's mammary glands.

The urogenital system includes the urinary system, which makes animals pee, and reproductive organs, which help animals make babies.

The kangaroo, tiger, elephant, bat, and sloth are female. The kangaroo has a young baby. Like all other mammals, the kangaroo produces milk and feeds that milk to her baby. The elephant is pregnant with an elephant calf. Elephant calves, and most other mammals, develop inside their mothers in an organ called the uterus. Mammal mothers give birth to young that already have all of their body parts formed.



Tap the skeleton.

Bones provide a framework for mammal bodies, protect important organs, and support movements. Most mammals have similar sets of bones in their body. While the shape of your hand is very different from the shape of a bat's wings, both you and a bat have a set of bones called phalanges. In your hand, the phalanges support your fingers. In the bat's wing, phalanges support the membrane stretching across it.

DISCUSSION QUESTIONS

Study each animal's interior and exterior. Do you think each animal is a carnivore, herbivore, or omnivore? Why?

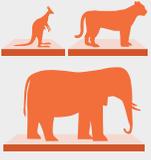
Compare each animal's body parts to your own.

Which part on each animal is most like your hand? Your feet?

Pick two animals and compare them. How do their appearances differ? Their insides? Why might these differences exist?

Consider how each animal lives.

For more about a mammal's muscular, cardiovascular, digestive, nervous, urogenital, and skeletal systems, see [The Human Body app and handbook](#).



Look Closer

There are over 5,000 mammal species. They live all over the world, in the land, air, and sea. Some live in places that are very hot, others in places that are very cold. A mammal can be **nocturnal** (active during the night) or **diurnal** (active during the day). It can be a predator (hunts other animals) or **prey** (is hunted), eat meat, or prefer plants.



VISION

Drag an animal into the circle below the goggles to see the world through the animal's eyes.

Animals have receptors in their eyes that allow them to see. The amount and type of receptors an animal has influences how and what it sees.

If an animal has lots of receptors, its vision is crisp and clear. If it has fewer receptors than we do, its vision appears less crisp and clear than ours.

There are two types of receptors: rods and cones. Rods see light and shape. Cones see color. Nocturnal animals have more rods, which work well in dim light. Diurnal animals have more cones, which do not work well at night. Humans have three types of cones; each type can see a separate range of colors. Some animals only have two types of cones and see fewer colors. Animals with no cones in their eyes cannot see color at all.



DISCUSSION QUESTIONS

Which mammals do you think are more active at night?

Which are more active during the day? Why do you think so?



FUR

Drag a mammal into the circle to examine its hair.

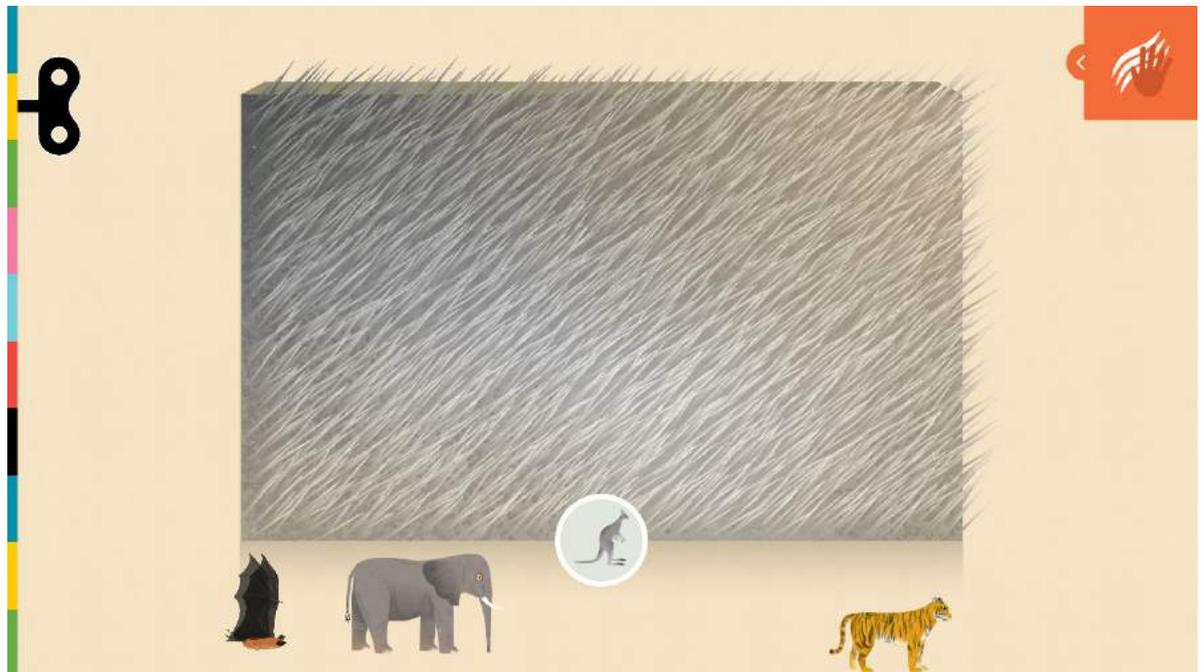
All mammals, even whales, have hair at some point in their lives. Dense fur can keep a mammal warm or protect its skin from sunburn. Stripes or spots conceal a mammal from other animals, or send signals to other animals. An arctic fox's white coat in the winter helps it blend into snow; a skunk's stripes warn predators not to bother it.

Sometimes hair can support an ecosystem beneficial to an animal. Green algae lives in the sloth's dense fur and helps the sloth camouflage (blend) into treetops. Or, hair can sometimes be a powerful defense, like the porcupine's hard, pointy spines.

Hair can also be a sense organ. Whiskers are stiff, thick hairs attached to nerve endings. They sense touch, just like our fingers do.

DISCUSSION QUESTIONS

Look at the hair of each mammal. What does the color, pattern, thickness, and length tell you about where it lives?





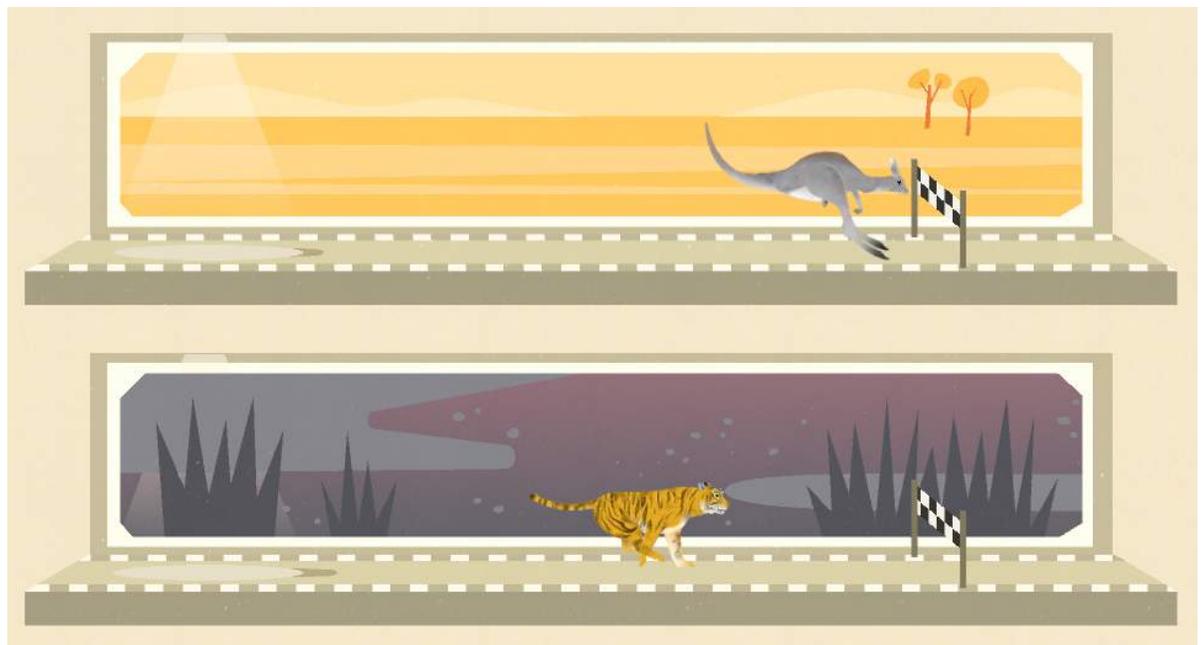
LOCOMOTION

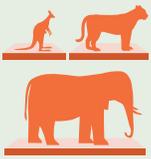
Drag two animals onto the race tracks.

Some animals can run very quickly. Some animals can run for a very long time. And some animals do not move very quickly or very much at all. Both a tiger and a kangaroo can move faster than 35 miles per hour. The tiger moves quickly to capture prey. The kangaroo moves quickly to avoid predators. But not all prey animals need to be able to move quickly to defend themselves. Instead of trying to outrun its predators, a sloth hides by blending into treetops.

DISCUSSION QUESTIONS

Many animals can run faster than humans, but few could run for as long as humans. How might it have benefited humans to run for a longer time than other animals?





Meet Each Species



TIGER, PANTHERA TIGRIS

Tigers are the largest cat species in the world. They are apex predators, meaning that once they are adults, no other animal hunts them. While a house cat might occasionally tackle

SIZE:
4 ¼ to 9 ¼ feet long,
220 to 660 pounds

DIET:
Pigs, deer, monkeys, frogs, moose,
cows, horses, buffaloes, goats

HABITAT:
Areas with grass or shrubs to hide in,
water, and available prey

RANGE:
South and East Asia



CONSERVATION STATUS:
Endangered

LIFESPAN:
8 to 10 years in the wild,
16 to 18 years in captivity

a mouse or bird, a tiger can capture large prey like wild pigs and deer.

They are powerful, effective hunters, but tigers are still at risk. They are solitary animals. And each requires a large territory to be able to capture enough prey to survive on. All five surviving subspecies of tiger are endangered because of hunting and human expansion into their territory.

Tigers are strong predators. When a tiger hears potential prey, it walks toward it through the tall grass its prey eats. Each tiger's unique pattern of stripes helps it blend into the grass. The tiger's broad paws stifle the sound of its footsteps so that it can approach silently. When the tiger nears its prey, it sprints toward

the prey and swipes it with its heavy paws. Retractable claws, usually kept tucked in the tiger's paw to maintain sharpness, extend from its paws and help the tiger hold tightly onto its prey.

Tigers often kill by biting its prey's neck. A tiger's upper canine teeth can be as long as 2.5 inches. Canine teeth can also tear apart food. Tigers have curved hooks on their rough tongues that help them scrape meat from their kill. Food moves quickly through the tiger's relatively simple digestive system.

IN THE APP



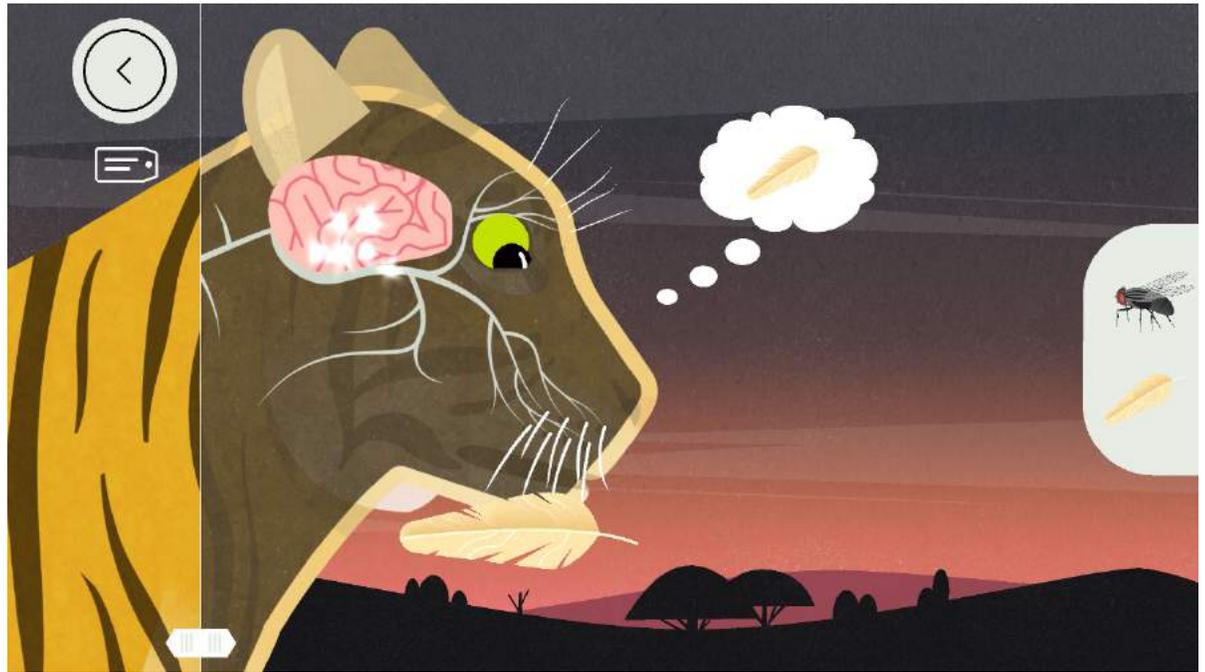
Drag a mouse towards the tiger's paw. Move the slider. What do you see?

A tiger uses its claws to hold prey and to mark its territory by scratching tree trunks. A small tendon (a cord that attaches a muscle to a bone) holds the claw inside of a tiger's paw when it is not in use. When the tendon relaxes, the tiger's claw extends.



Drag the feather and tickle the tiger's whiskers. Move the slider. What do you see?

Whiskers can help a tiger feel objects near its face and even help it tell whether it can fit through a narrow passageway.



DISCUSSION QUESTIONS

Bats and tigers are both predators, but their diets are very different. Why might a tiger not eat insects? Why might a bat not eat deer or other large prey?



LITTLE BROWN BAT, MYOTIS LUCIFUGUS

Have you ever heard squeaking sounds overhead at night? The sounds might have come from bats. Bats are the only mammals capable of flight. They play an important role in

SIZE:

2 to 4 inches long, 9 to 11 inch wingspan
(60 to 102mm long, 222 to 269mm wingspan)

.18 to .49oz (5 to 14g)

DIET:

Beetles, mosquitos, moths,
and other small insects

HABITAT:

Areas near forests or caves and water

RANGE:

North America, as far north as Alaska
and as far south as northern Florida



CONSERVATION STATUS:

Least concern

LIFESPAN:

6 to 7 years in the wild;
30 years in captivity

ecosystems. **Fructivorous** bats

eat fruit and disperse seeds in their poop.

Insectivorous bats like the little brown bat, eat up to 600 mosquitoes per hour. Bats are nocturnal, but they cannot see better at night than humans can. Instead, bats use echolocation to help them find prey. Bats send out sounds, wait for them to bounce off of their prey, and use the echo to find the prey.

Little brown bats have three areas to sleep and rest. These areas are called **roosts**. During the day, little brown bat roosts are in buildings, trees, or in piles of wood or rocks. They have a separate, similar roosts to use during cold nights. During the winter, little brown bats hibernate in warm, humid spaces like caves or abandoned mines. Bats are very common in North America. However, bats are at risk. White nose syndrome, named after the white fungus that grows on infected bats' faces, kills them while they hibernate. Scientists are researching causes and cures for white nose syndrome.

Bats are unique mammals because they can fly. Bat wings evolved from body parts similar to our hands and arms. The patagium, a thin and leathery membrane, stretches between each finger, beneath the arm bones, and across the bat's legs.

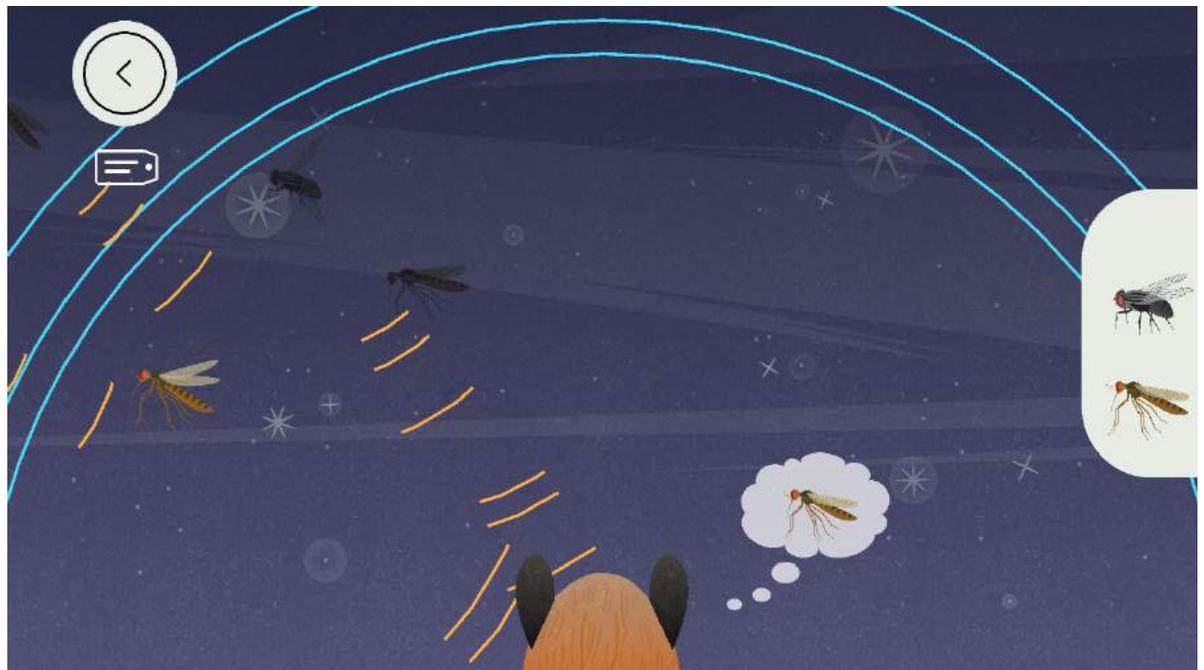
Flight allows bats to catch and eat a lot of insects. But flying also requires lots of energy. A bat's heart and lungs are much larger than other animals of a similar size to support the work of flying. And a tough membranes between bats' feet and tail helps them collect more bugs.

Bats spend much of their time sleeping upside down. Thick fur insulates bats as they hibernate. Tendons in a bat's feet clamp their claws tightly shut as they roost upside down.

IN THE APP

Drag flies toward the bat.

How bats find bugs to eat in the dark is amazing. Little brown bats squeak as they fly through the dark night. Their sounds bounce off of nearby bugs. Bats hear these echoes and use them to determine where bugs are.





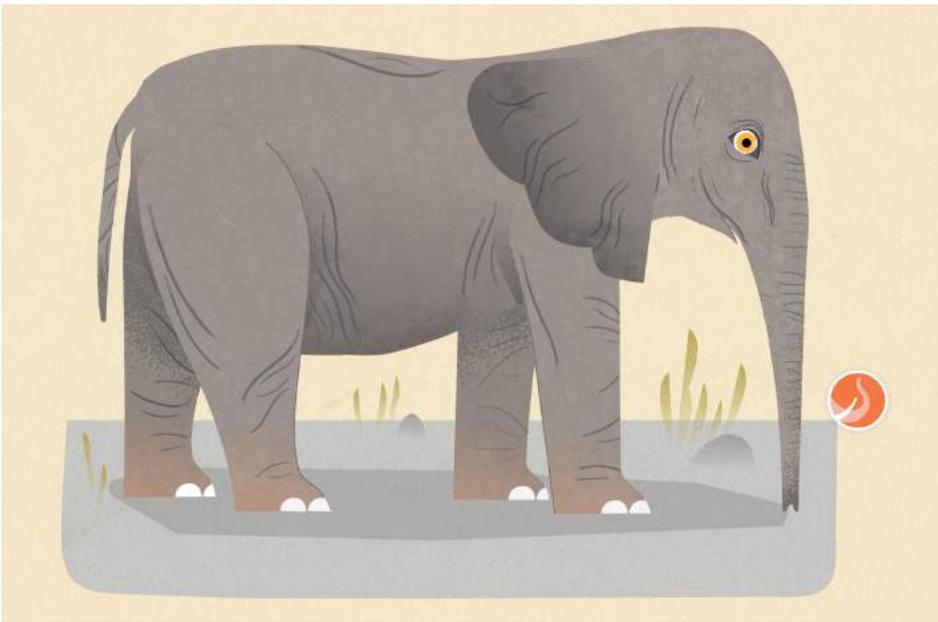
Drag food particles around inside the bat.

Little brown bats' primary food is insects. But bats can't digest the shiny shells, made of a substance called chitin, that surround insects. Undigested bits of chitin make it all the way through a bat's digestive system, leaving sparkly bits in the bat's poop.

DISCUSSION QUESTIONS

As you look at the bat's skeleton, compare the bones in its wing to those in your hand. Which bone on the bat's wing do you think is the most similar to your thumb? Your pinky?

Why do you think bats sleep upside down?



AFRICAN ELEPHANT, LOXODONTA AFRICANA

Weighing as much as six tons, elephants are the heaviest animals currently walking the Earth. To maintain their weight, elephants spend up to two-thirds of their time eating. One elephant

SIZE:
7,900 to 13,200 pounds;
3,600 to 6,000kg)

DIET:
Plants, especially high up ones, including leaves, shoots, fruit, woody plants, roots, twigs

HABITAT:
Deserts, forests, savannas, and marshes

RANGE:
Africa, south of the Sahara Desert

can eat over 300 pounds of leaves, fruit, branches, and other vegetation in a day. A muscular trunk, the combination of a nose and upper lip, help the elephant get food.



CONSERVATION STATUS:

Vulnerable

LIFESPAN:

70 years in the wild, 80 years in captivity

African Elephants are social animals. When friendly elephants meet, they hug each other with their trunks. They wander in large herds of up to 200 elephants, crossing deserts, grasslands, and even water to find food. Threats to elephants include human expansion into elephant territories and hunters who illegally sell elephants' ivory tusks and hair.

An elephant's **habitat** is very hot. Elephants cannot sweat like people do to keep themselves cool. When they become too hot, elephants use other ways to cool down. They flap their large, thin ears like fans.

Elephant's trunk and tusks are their most important tools. Elephants use their trunks to move heavy tree trunks, spray water on themselves to cool down, and to greet other elephants. When elephants swim, they

lift their trunk above water and use it as a snorkel. The elephant's tusks are a longer version of a type of tooth called the incisor. Tusks help elephants dig for water and food. Elephants also use their tusks to defend themselves and to clear walking paths.

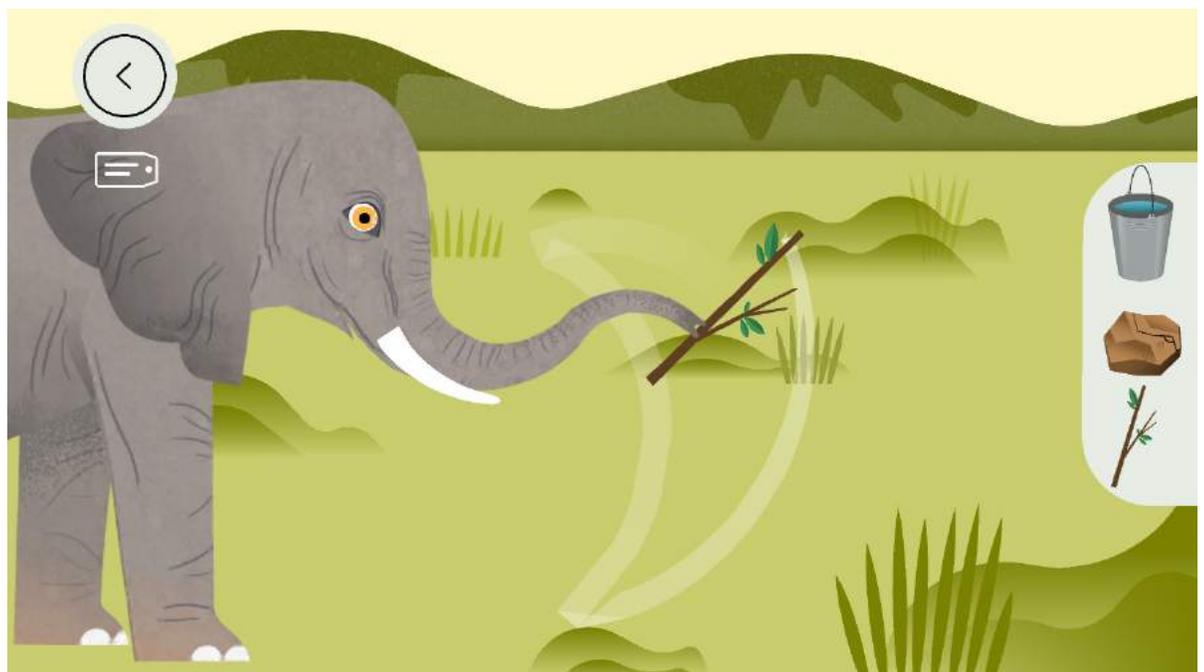
Elephant's teeth are also pretty important since they spend so much time eating. Large, flat molars grind the elephant's food. As one tooth wears down, another moves forward to replace it. Elephants can grow six sets of teeth during their 50-70 year lifespan. (Humans only have two!).

IN THE APP



Drag items to the elephant's trunk.

An elephant's trunk is strong, long, and flexible. The trunk has thousands of small muscles that allow the elephant to control it. An elephant can reach its trunk into a treetop, pick a tiny piece of fruit from the tree, and put the fruit in its mouth.





Tap the fetus in the elephant's uterus. What happens?

Elephants, like most mammals, develop in their mother's uterus. An elephant growing in its mother's uterus is called an embryo. An elephant fetus gestates (grows), in its mother's uterus for 22 months before it is born. That is more than twice as long as a human baby gestates! A newborn elephant weighs about 250 pounds and it can walk within minutes of being born.

DISCUSSION QUESTIONS

How might an elephant's large size help it survive?

RED KANGAROO, MACROPUS RUFUS

Kangaroos are **marsupials**, a type of mammal with a pouch in which its babies, called **joeys**, live. This pouch, called a **marsupium**, is a safe place for joeys to nurse and take shelter from predators.



SIZE:

3 ¼ to 5 ¼ feet (1–1.6 m) body length;
30 to 47in (75–120 cm) tail
Up to 198 lbs (90 kg)

DIET:

Grasses and leaves

HABITAT:

Savanna grassland, desert,
and temperate forest

RANGE:

Australia



CONSERVATION STATUS:

Least concern

LIFESPAN:

22 years in the wild, 16.3 years
in captivity

Red kangaroos are the largest species of kangaroo. Males are red, and females are a blue-gray color. Both have large feet, up to 18 inches long. They hop on their large feet, from one feeding area to the next, reaching speeds up to 44 mph (70 kmh). Kangaroos are less graceful when moving short distances. As they graze, kangaroos scoot themselves forward using their tail as a third leg to balance themselves.

Kangaroos use their large ears to listen for predators. If they hear one, they hop to escape. Thanks to their elastic Achilles tendon, kangaroos can bounce around using very little energy. Like a spring, the Achilles tendon stores energy and becomes more powerful as kangaroos hop longer distances. The kangaroo's thick and muscular tail helps keep it stable as it moves forward. Hopping helps kangaroos escape predators, but it also allows them to travel longer distances to find food.

A kangaroo's favorite foods are grass and leaves. But they are not easy to digest. A kangaroo's three-part stomach helps it enjoy the nutrients and energy in grass and leaves.

IN THE APP



Swipe around the kangaroo's stomach.

Newborn joeys are tiny (less than 1 inch long!). Their eyes are sealed shut, they have no fur, and they only have small buds where their legs will eventually grow. But they make an incredible trip to their mother's pouch. The mother helps by licking a trail of saliva to guide the baby joey. Once inside the pouch, the joey will suckle the mother's milk until it is ready to hop around.



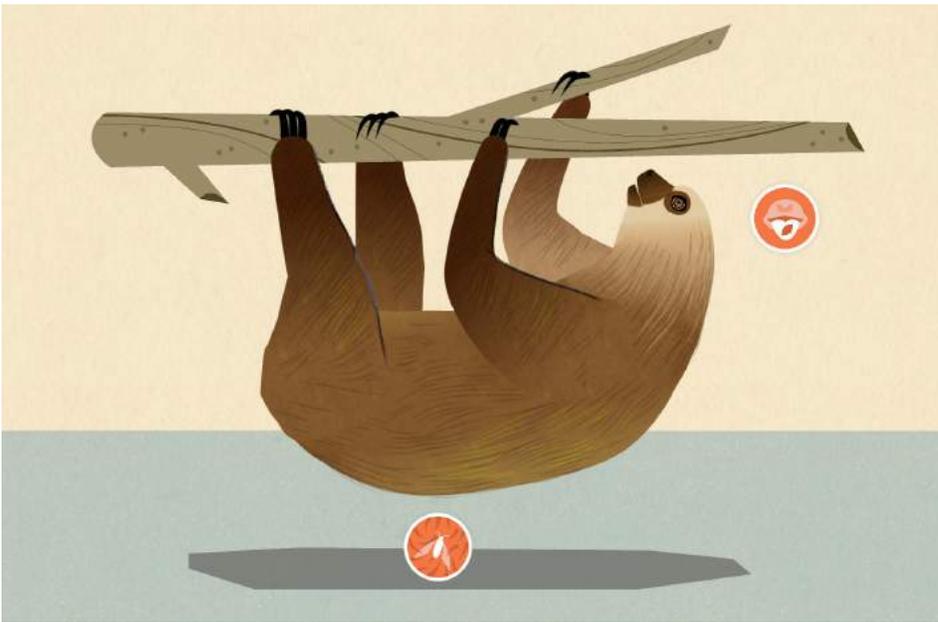
Tap the joey.

The joey eats its mother's milk. Like all mammals, kangaroo mothers feed their young with milk from their **mammary glands**, specialized sweat glands that produce milk. As a joey grows, the mother's milk changes to meet the joey's nutritional needs. A mother kangaroo can have two joeys, each a different age, in her pouch at once, and she will produce two different types of milk to match each of their needs.

DISCUSSION QUESTIONS

Most mammals' nipples are not hidden in a pouch.

What benefit might there be to the kangaroo's pouch, especially for a newborn joey?



LINNAEUS'S TWO-TOED SLOTH, CHOLOEPUS DIDACTYLUS

Sloths are slow. They might look lazy but there is a reason for their pace. Cecropia leaves are a sloth's favorite food. They are easy for sloths to eat in their treetop homes,

SIZE:

18 - 34 in (46 - 86 cm)
9 to 18 pounds (4 to 8 kg)

DIET:

Leaves, fruit, and flowers

HABITAT:

Canopy of tropical rainforest trees

RANGE:

Central America and northern
South America



CONSERVATION STATUS:

Least concern

LIFESPAN:

28 years in captivity

but they do not provide much nutrition or energy. And so the sloth has adapted to use as little energy as possible. A sloth could survive off of the energy in half of a candy bar each day. Unlike most mammals, sloths do not shiver when cold. Instead, sloth's temperature sinks when the sun sets and rises when it returns.

Sloths depend on the survival of their rainforest home. Loggers cut rainforest trees to clear way for agriculture and to collect timber to sell. As rainforests shrink, the area in which sloths can survive shrinks too.

Sloths have adapted to spend most of their lives upside down in the canopy, or tree tops, of tropical rainforests. Curved claws help sloths hang securely from tree limbs. A sloth's fur grows in the opposite direction of most mammal's fur, from its belly up to its back, so the fur lies flat when the sloth is upside down. This also helps water run off the sloth's fur easily to keep the sloth relatively dry when it rains.

Sloths' fur also helps them blend into treetops so well that it is difficult for predators to see them. Green algae (a small, simple plant which grows in patches) covers sloths' thick hair, making them look just like the branches they hang on.

Sloths have thin limbs under their fur. Compared to other animals of about the same size, sloths have about half as much muscle. Most of a sloth's muscle is red slow-twitch muscle. It helps them move slowly over a long period of time, crawling along a branch or swimming across a river.

Sloths also digest their food very slowly. While a human can digest a meal in six to eight hours; it can take a sloth a whole month to digest a meal. A sloth rarely poops. When it does, it crawls to the bottom of its tree and poops at the base. This behavior is very dangerous because a sloth cannot run fast enough to escape predators on the ground. Scientists continue to study why sloths take this risk instead of pooping from their canopy.

IN THE APP



Drag moths onto the sloth's fur.

Scientists don't all agree on the purpose of the moths and algae in a sloth's fur. One hypothesis: the moths die in the sloth's fur. The decomposing moths feed on the green algae that grows on sloths. When sloths climb down their tree to poop on the ground, they deposit moths which lay eggs in the sloth's last poop. Newborn moths eat the sloth's poop until they are ready to fly up and land on a sloth.

There is another, more simple hypothesis. The moths do not help algae grow. Instead, the sloth's dense fur holds water from the humid rainforest. Algae thrives in the dense, moist ecosystem of the sloth's fur.



Feed the sloth.

A sloth can eat even while it is upside down. It reaches for food with one hand and brings it toward its mouth. As it chews, the sloth's long tongue pushes food back into its mouth. Its tongue is covered with curved spikes that help keep all the food in the sloth's mouth.

DISCUSSION QUESTIONS

What do you think moths and algae are doing in sloth's fur?

Do you think sloths are more active at day or night? Why?

RESOURCES

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SPECIAL THANKS TO:

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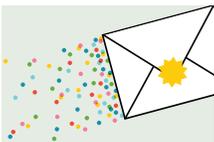
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