AMERICAN MUSEUM OF NATURAL HISTORY

LIZARDS & SNAKES: ALIVE!

EDUCATOR'S GUIDE

www.amnh.org/lizards

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KEY CONCEPTS

Squamates—legged and legless lizards, including snakes—are among the most successful vertebrates on Earth. Found everywhere but the coldest and highest places on the planet, 8,000 species make squamates more diverse than mammals. **Remarkable adaptations in behavior, shape, movement, and feeding contribute to the success of this huge and ancient group.**

BEHAVIOR

An animal's ability to **sense and respond to its environment** is crucial for survival. Some squamates, like iguanas, rely heavily on **vision** to locate food, and use their pliable tongues to grab it. Other squamates, like snakes, evolved effective **chemoreception** and use their smooth hard tongues to transfer molecular clues from the environment to sensory organs in the roof of their mouths. This allows them to detect and track prey (even in complete darkness), which they then seize with their teeth.

Squamates, like all other animals, **communicate** with members of their own species and other organisms. Except for the distinctive vocalizations of geckos, most squamates are silent, yet they get their message across. For example, like walking billboards, chameleons change the color patterns along their flanks to talk to each other. There are as many "languages" as there are species!

Whether being hunted as prey or threatened for territory, animals have ways to protect themselves. Squamates may **react to danger** by biting, fleeing, inflating their bodies, or gaping (exposing colored tongues and throats). Some play dead, squirt blood from their eyes, or use venom to keep danger at a distance. In extreme danger, some squamates may sacrifice parts of their bodies—a tail, or even large pieces of skin—to distract and escape from predators.

STRUCTURE & FUNCTION

Species within a group can have **diverse forms and sizes**. Squamates range in size from the Dwarf Gecko, which can stand on a dime, to the extinct *Mosasaurus*, which grew to 17 meters (56 feet) long. Some squamates have four limbs while many have no limbs at all; some have only back legs, others only front legs; and many intermediate conditions exist. These diverse body plans enable them to **move on the ground, in water, and even in the air**. For example, geckos have toe pads with nano-hairs that allow them to cling to and move across many surfaces; sea snakes rely on paddle-like tails to traverse oceans; and some squamates have wing-like structures that enable them to glide.

Crypsis is a phenomenon in which an organism's appearance allows it to blend well into its environment. Chameleons, for example, employ crypsis when they rock like a shaking leaf to blend in with vegetation. Some squamates are **mimics**, like the harmless Campbell's Milk Snake, which resembles a highly venomous Coral Snake. Many brown and gray forest-dwellers are well **camouflaged** when they sit motionless on the trunks and limbs of trees.

Over 450 species of snakes (yet only two species of lizards) are considered to be dangerously venomous. Snake **venom** is a poisonous "soup" of enzymes with harmful effects—including nervous system failure and tissue damage—that subdue prey. The venom also begins to break down the prey from the inside before the snake starts to eat it. Venom is delivered through a wide array of teeth. For example, vipers employ hypodermic needle-style fangs that fold inside the mouth when not in use.

HABITATS, ECOSYSTEMS & ENERGY

Adaptations in form enable animals to live in a variety of environments. Squamate habitats range from deserts to rain forests, treetops to underground burrows, and coral reefs to the open ocean.

Most squamates are **ectothermic**: they use external heat sources to maintain a relatively constant body temperature. Because this conserves energy, some squamates can go for long periods (more than a year in some cases) between feedings. For snakes, that typically means eating something really big. And they do this with no hands! Flexible skulls, elastic jaw ligaments, and remarkable digestive function make this possible.

EVOLUTION

Over the course of biological evolution, **species adapt and change over time**. All organisms differ among themselves (variation) and pass traits on to their offspring (inheritance). Over many generations, those better-adapted organisms may give rise to new species (selection).

All of the almost 8,000 living squamates can trace their lineage back to one common ancestor that lived at least 200 million years ago. Since that time, many squamate groups have gone extinct and new groups have evolved. Dozens of squamate groups have undergone **limb reduction and loss**. Limblessness is an excellent adaptation to life underground, where much food is found and predators are few. Losing limbs may have allowed squamates to take advantage of resources unavailable to limbed vertebrates.

Scientists discover new squamate species all the time, and the more we learn, the more **new questions** about squamate diversity arise. For example, how many lineages of squamates have lost limbs? How many times has venom evolved? How can answers to questions like these help us protect these amazing animals?

What's a Squamate?

What do iguanas, chameleons, monitor lizards, geckos, vipers, and cobras have in common? They're all squamates (*skwah*-mates). **Squamata**, which means "scaly" in Latin, is the name scientists use for **the group that includes legged and legless lizards, including snakes.**

Squamates are vertebrates, animals with a backbone. Unlike mammals and birds, which generate their own body heat, most squamates are ectothermic—they use external heat sources to maintain a relatively constant body temperature. All squamates have scales (though other kinds of animals do too) and they periodically shed their skin. Every squamate—each male and female—has paired, or two of the same, reproductive organs.

Fossil evidence shows that squamates existed at least 200 million years ago, when dinosaurs began to flourish. These early lizards were probably small, diurnal, ground-dwelling predators with spiky ridges down their backs. Over time, as squamates adapted to live in many different environments, they evolved extremely diverse characteristics. For example:

GREEN BASILISK LIZARD

Some squamates fly, some parachute, some walk upside down on ceilings, and some, like Green Basilisk Lizards, can even sprint across water.

Some squamates, like Veiled Chameleons, have lightning-fast tongues that can be fired with pinpoint accuracy to grab prey.

VEILED CHAMELEON

RED SPITTING COBRA

Some squamates have highly toxic venom that can subdue prey in seconds, and some, like Red Spitting Cobras, can spray venom into a predator's eyes.

Some squamates may eat several times a day, while others, like Burmese Pythons, can get by with one large meal a year—when they can swallow whole an animal as large as a deer!

BURMESE PYTHON

Come Prepared

Review this guide and additional online resources to help plan your visit ahead of time. Give students directions and supplies before you arrive, since it can be hard to do so once at the Museum.

The exhibition and the activities in this guide are correlated to the **National Science Education Standards** listed below. On our website you'll find correlations to the New York City Performance Standards and the NYC DoE Draft Middle School Scope and Sequence.

All online resources, including a glossary, reference lists, and standards, are available at www.amnh.org/resources/lizards. Information about school visits is available at www.amnh.org/education/schools.

Grades K–4

Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Standard C: Life Science
- Characteristics of organisms
- Life cycles of organisms
- Organisms and environments

Grades 5–8

Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Standard C: Life Science
- Structure and function
- Reproduction and heredity
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Standard F: Science in Personal and Social Perspectives
- Populations, resources, and environments

Grades 9–12

Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Standard C: Life Science
- Biological evolution
- Interdependence of organisms
- Matter, energy, and organization in living systems
- Behavior of organisms

Prior to your visit, you can download and distribute copies of **Be an Exhibition Explorer** and a Family Guide. Students can use the Be an Exhibition Explorer field journals to record their observations and research. The **Family Guide** provides a kid-friendly guided tour through the exhibition.

TEACHING IN THE EXHIBITION

Explore the Key Concepts with these possible paths through the exhibition. Use the map to locate the animals and places indicated in *italics*. You may wish to divide your class into small teams. Each team can investigate one question and record its findings to share back in the classroom. Note that animals in captivity do not always behave like ones in the wild, so students won't be able to see all of their characteristic behaviors. This makes the supporting exhibition text and images a great resource.

BEHAVIOR

How Do Squamates Sense Their Environment?

Ask students to observe four animals: *Collared Lizard, Eastern Water Dragon, Green Tree Monitor,* and *Eastern Green Mamba*. At each case, ask students to count and record the number of tongue flicks over a one-minute period. Ask students to explain why some squamates flick their tongues more than others. How is this characteristic related to how different squamates sense their environment or to their feeding behavior?

POSSIBLE INFERENCES: These animals belong to two behavioral groups. The members of one group, which includes the Collared Lizard and Eastern Water Dragon, use their vision to detect prey and their tongues to grab food. The other group, which includes the Green Tree Monitor and Eastern Green Mamba, relies on chemoreception. They use their tongues to collect information about the environment and their teeth to capture prey. That's why they generally flick their tongues more often than the vision group.


GREEN TREE MONITOR

How Do Squamates Communicate?

Ask students to visit three animals: *Cuban Knight Anole, Frilled Lizard,* and *Veiled Chameleon*. How do these squamates communicate with members of their own species and other animals?

POSSIBLE INFERENCES: Cuban Knight Anoles use head bobs, color changes, and the display of colorful throat "fans." Frilled Lizards move their frills up and down and sometimes expand them fully. Veiled Chameleons use changing color patterns along their flanks.


FRILLED LIZARD

CHUCKWALLA

How Do Squamates Protect Themselves?

Ask students to visit five animals: *Chuckwalla, Tropical Girdled Lizard, Blue-tongued Skink, Red Spitting Cobra,* and *Campbell's Milk Snake*. How do these squamates avoid being eaten by predators?

POSSIBLE INFERENCES: Chuckwallas hide by wedging themselves in rock crevices. Tropical Girdled Lizards have heavy-duty body armor for protection. Blue-tongued Skinks open their mouths wide, hiss, and stick out their big blue tongues to scare predators away. Red Spitting Cobras may spit venom from several feet away to disable enemies and gain time to escape. Campbell's Milk Snakes are mimics, resembling highly venomous Coral Snakes.

STRUCTURE & FUNCTION

MADAGASCAN GIANT DAY GECKO

How Does Body Shape Relate to Locomotion?

Ask students to visit three animals: *Green Basilisk Lizard, geckos*, and *Burmese Python*. Then direct them to watch the *locomotion video*. What connections can students make between body shape and locomotion?

POSSIBLE INFERENCES: Green Basilisk Lizards have strong hind legs and long toes fringed with scales that enable them to sprint across water. Geckos have toe pads with nano-hairs that allow them to cling to and move across many surfaces, even glass. Burmese Pythons use their rib and trunk muscles to move side to side, which is also known as lateral undulation.

HABITATS, ECOSYSTEMS & ENERGY

How and Where Do Squamates Live?

Ask students to observe two animals: *Gabon Viper* and *Eastern Green Mamba*. What can they infer about the relationship between body form and where in the habitat these squamates live? Do their colors offer any clues? What hunting strategies might they employ?

POSSIBLE INFERENCES: Gabon Vipers are ground-dwellers—they have short, massive bodies and sit and wait for prey. Eastern Green Mambas are slender, fast-moving snakes that forage in the treetops, where their vivid green and black colors are good camouflage.

EVOLUTION

What Is Life Like Without Limbs?

Ask students to visit three animals: *Emerald Tree Boa, Amazonian Tree Boa*, and *Burmese Python*. Then direct them to examine the nearby fossil and interactive display titled *Life Without Limbs*. How have snakes evolved specialized characteristics to live without limbs? How do they move, capture prey, and feed?

POSSIBLE INFERENCES: Snakes have evolved several different types of locomotion that use their hundreds of ribs and trunk muscles. They thrive in treetops, underground burrows, loose sandy deserts, and the open ocean. Snakes use their highly mobile lower jaw to draw food into the mouth. The skull has evolved to be so flexible that snakes can swallow large prey, allowing them to eat bigger meals less often and reducing the amount of energy spent seeking food. Venom-delivery systems, infrared vision, and constriction also help snakes capture and eat their prey.

Explore the Exhibition with a Field Journal

A journal is an important tool that scientists use to record their field observations and lab data. They record information in a variety of ways: as illustrations, data tables, or written descriptions.

In this exhibition, students can keep their own field journals to record what they observe about live animals. They can use a composition book, a clipboard, or copies of **Be an Exhibition Explorer**, available at **www.amnh.org/resources/lizards**. Back in the classroom, the recorded data will be a great springboard for further discussion and/or research.

Below are three strategies for using field journals in the exhibition. Please note that animals in captivity do not always behave like ones in the wild, so students won't be able to see all of their characteristic behavior.

1. What Do Squamates Look Like?

Ask students to observe one or more squamates in detail and record their morphological observations, such as color, body size, body type, and limb shape, and to note environmental conditions. How do students think these traits are adapted to the places in which the animals live? Journal entries can conclude with questions derived from students' observations. The class can explore these questions further in a follow-up activity.

2. What Is the Relationship Between Structure and Function?

Ask students to record morphological observations of one or more squamates, and to read the supporting exhibition text. What connections between structure and function can students extrapolate from this data? For example, chameleons have toes that are fused into two pads, enabling them to grip branches, even very thin ones.

3. How Many Different Species Are There?

One question scientists ask in the field is how many species are present in a particular location. Have students pick an enclosure that contains several animals (e.g. geckos) and hypothesize how many different species are inside. Ask them to draw each species' color and patterns, record its location (up on a tree? on the ground?), and document its behavior (moving around? staying still?). Then ask students to use their notes to estimate the number of species.

BACK IN THE CLASSROOM

These activities will help your students explore and extend their understanding of squamates.

ELEMENTARY & MIDDLE SCHOOL

- **Ask students to share what they learned from the exhibition.** Discuss the diversity of squamate behavior, structure and function, and habitat. Ask them what squamate behavior or adaptation surprised them the most and why. What other animals have similar adaptations or demonstrate similar behavior?
- **Ask students to compare the ways in which humans and squamates sense the environment** (e.g. detection of food). What senses do we share with squamates? Which senses are more highly developed in squamates? Which squamate sensory systems are unique?
- **Ask students to research the diversity of squamates in their area.** They can contact local nature centers or other experts. Students can also visit websites such as NYS Amphibian and Reptile Project (www.dec.state.ny.us/website/dfwmr/wildlife/herp), NJ Online Field Guide (www.njfishandwildlife.com/ensp/fieldguide_herps.htm), and CT Wildlife (dep.state.ct.us/burnatr/wildlife). Where do different species live? How do they fit into the food chain and local ecosystem? How do they survive seasonal changes? Are any squamates endangered, and if so, why?
- **Visit the Science Explorations: Uncover Lizards and Snakes website** (teacher.scholastic.com/activities/explorations). Here students can create their own squamates exhibit. They can also investigate the similarities and differences between squamates and other animals.
- **Visit the Tree of Life Cladogram** on the Museum's OLogy website (ology.amnh.org/biodiversity/treeoflife). Squamates are considered to be mostly ectothermic, scaly vertebrates. What other animal groups have one or more of these characteristics?


HENKEL'S LEAF-TAILED GECKO

MIDDLE & HIGH SCHOOL

- **Ask students to share what they learned from the exhibition.** Discuss the diversity of squamate behavior, structure and function, and habitat. Ask them what squamate behavior or adaptation surprised them the most and why. What other animals have similar adaptations or demonstrate similar behavior?
- **Ask students to share what they've learned about limbless squamates.** Discuss how they move, hunt, and feed. Then have students investigate locomotion in another animal group (e.g. birds). How do limb form and function vary among species within the same group (e.g. penguin, ostrich, hawk)?
- **Ask students to design a wildlife habitat for a squamate of their choice.** What requirements are necessary for the animal's survival? Suggest students consider factors such as food supply, temperature, climate, and humidity.
- **Visit the Science Explorations: Uncover Lizards and Snakes website** (teacher.scholastic.com/activities/explorations). Here students can create their own squamates exhibit. They can also investigate the similarities and differences between squamates and other animals.
- **Visit the Museum's Spectrum of Life interactive** (www.amnh.org/exhibitions/hall_tour/spectrum). Explore the representatives of each vertebrate group. Which groups include members that show loss or reduction of appendages (e.g. limbs and fins)? How is appendage loss related to how they function?
- **Visit the Museum's Darwin exhibition website** and explore the section called A Trip Around the World: Black on Black (www.amnh.org/exhibitions/darwin/trip/unique.php). When naturalist Charles Darwin visited the Galápagos, he encountered land and marine iguanas. Ask students to research what Darwin observed about their appearance and behavior. What connections did he make between their form and habitat?

CREDITS

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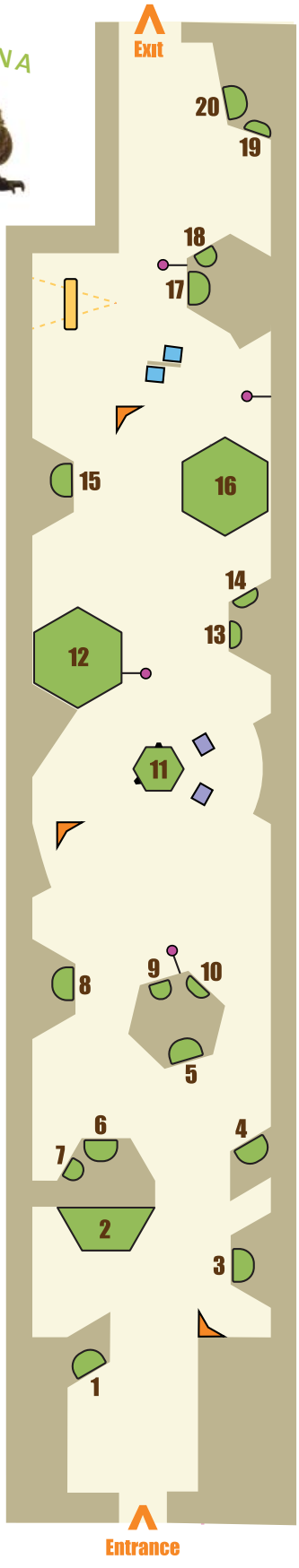
COLLARED LIZARD

AMERICAN MUSEUM OF NATURAL HISTORY

MAP OF THE EXHIBITION



Live Animal Habitat
Gecko Zoom Camera
Snake Interactive
Fossil and Interactive Display
Sound Button
Locomotion Video Viewing Area

1. **Green Basilisk** (*Basiliscus plumifrons*)
2. **Rhinoceros Iguana** (*Cyclura cornuta*)
3. **Collared Lizard** (*Crotaphytus collaris*)
4. **Eastern Water Dragon** (*Physignathus lesueurii*)
5. **Frilled Lizard** (*Chlamydosaurus kingii*)
6. **Chuckwalla** (*Sauromalus ater*)
   Western Fence Lizard (*Sceloporus occidentalis*)
7. **Cuban Knight Anole** (*Anolis equestris*)
8. **Veiled Chameleon** (*Chamaeleo calyptratus*)
9. **Crested Gecko** (*Rhacodactylus ciliatus*)
10. **Tropical Girdled Lizard** (*Cordylus tropidosternum*)
11. **Madagascan Giant Day Gecko** (*Phelsuma madagascariensis*)
    Common Leaf-tailed Gecko (*Uroplatus fimbriatus*)
    Lined Leaf-tailed Gecko (*Uroplatus lineatus*)
    Henkel's Leaf-tailed Gecko (*Uroplatus henkeli*)
12. **Water Monitor** (*Varanus salvator*)
13. **Blue-tongue Skink** (*Tiliqua scincoides*)
14. **Gila Monster** (*Heloderma suspectum*)
15. **Green Tree Monitor** (*Varanus prasinus*)
16. **Burmese Python** (*Python molurus*)
17. **Gabon Viper** (*Bitis gabonica*)
    Eastern Green Mamba (*Dendroaspis angusticeps*)
18. **Amazonian Tree Boa** (*Corallus hortulanus*)
    Emerald Tree Boa (*Corallus caninus*)
19. **Campbell's Milk Snake** (*Lampropeltis triangulum campbelli*)
20. **Red Spitting Cobra** (*Naja pallida*)

CONNECTIONS TO OTHER MUSEUM HALLS

A journey through the Museum is a great way to explore the diversity of squamates—legged and legless lizards, including snakes. Found everywhere on Earth but the coldest and highest places, this successful group is represented in many halls.

HALL OF REPTILES AND AMPHIBIANS

Continue your investigation of squamates in this amazing hall. The animals are arranged by themes such as anatomy, defense, locomotion, distribution, reproduction, and feeding. Explore the great range of these animals' physical forms, from the tiniest lizard to the 25-foot-long Reticulated Python, and the widely diverse ways in which they move, protect themselves, chase prey, and reproduce. Exhibits include the Australian Frilled Lizard raising its frill of skin to exaggerate its size to a predator, and the Komodo Dragon stretching its jaws across the belly of a wild boar.

HALL OF VERTEBRATE ORIGINS

Squamates lived at least 200 million years ago, when dinosaurs began to flourish. Since that time many squamate groups have gone extinct, and many new groups have evolved. Look for the fossil of *Tylosaurus*, an extinct marine-dwelling mosasaur that is over 10 meters (33 feet) long. You'll also find over a dozen fossil casts and skeletons of other ancient and modern squamates set in two glass cases nearby (specimens 11–29).

HALL OF BIODIVERSITY

Look for lizards and snakes on the Spectrum of Life wall. Using the *How Is Life Classified?* interactive, investigate the characteristics and distribution of each squamate. You can also watch a video of squamates in the wild. Then visit the Dzanga-Sangha Rain Forest diorama. What squamates can you find in the forest? Look through the Reptiles and Amphibians section of each flipbook to read about the lizards and snakes that live there.

HALL OF OCEAN LIFE

Find the sea snake on the vertebrate Tree of Life wall and use the interactive to learn more about this animal, including where it lives and who its close relatives are. Then look for another sea snake in the Coral Reef diorama and explore the ecosystem in which it lives.