# Amphibian and Reptile Conservation Teaching and Learning Module

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Funding provided by the Department of Ecology and Evolutionary Biology at the University of Tennessee - Knoxville

Dear Educator,

We are pleased to present you with an Amphibian and Reptile Conservation (ARC) teaching and learning module. ARC aims to engage Kindergartner to 4th grade students in biology while promoting student learning of the Tennessee state science standards and fostering positive attitudes toward amphibians and reptiles. We have chosen amphibians and reptiles for this teaching module because these animals have been successfully used in formal and informal education settings to promote student learning and interested in science. Many students are intrigued by the slimy and slithery nature of these organisms; however, they have also heard expressions such as: "Toads give you warts," or "The only good snake is a dead snake." Therefore, we hope these lessons enable teachers to address student misconceptions and apprehensions regarding these unique organisms.

Given that education reform strives to incorporate authentic science experiences, ARC is designed to promote student learning by encouraging them to think, and act, like a scientist. ARC is designed to provide students with background information early on, and then progression to inquiry driven lessons focused on conservation challenges and diversity loss. We intend this module to be a guide. Teachers are welcome to use the lessons in any order they wish, use just portions of lessons, and may modify the lessons as they wish. Furthermore, educators may share these lessons with other school districts and teachers; however, please do not receive monetary gain for lessons in ARC. ARC has been created and disseminated by Drs. K. Denise Kendall, Kristin Rearden, and Matthew L. Niemiller. Funding for ARC has been graciously provided by the Department of Ecology and Evolutionary Biology at the University of Tennessee Knoxville. An electronic version of ARC, as well as images of amphibians and reptiles, can be found on Dr. Niemiller's website http://www.herpetology.us/ARC/ Additional amphibian and reptile teaching lessons will also be posted on this website as they become available.

Sincerely,

K. Denise Kendall, Ph.D.
Kristin Rearden, Ph.D.
Matthew L. Niemiller, Ph.D.

## Table of Contents

## Lesson Alignment with Tennessee State Science Standards

### Kindergarten

GLE0007.Inq.1 Observe the world of familiar objects using the senses and tools.
GLE0007.Inq.2 Ask questions, make logical predictions, plan investigations, and represent data.

GLE0007.Inq.3 Explain the data from an investigation

GLE0007.3.1 Recognize that living things require water, food, and air.

GLE0007.4.1 Observe how plants and animals change as they grow.

GLE0007.10.1 Identify the sun as the source of heat and light.

| | How big? | Chemical Spill | A toad is a frog? | Cycle of life | Why do turtles sunbathe? |
|---|---|---|---|---|---|
| GLE000.7.Inq.1 | *X* | *X* | *X* | | *X* |
| GLE000.7.Inq.2 | *X* | *X* | *X* | | *X* |
| GLE0007.Inq.3 | *X* | *X* | *X* | | *X* |
| GLE0007.3.1 | | | *X* | | |
| GLE0007.4.1 | | | | *X* | |
| GLE0007.10.1 | | | | | *X* |

First Grade

GLE0107.Inq.1 Observe the world of familiar objects using the senses and tools.
GLE0107.Inq.2 Ask questions, make logical predictions, plan investigations, and represent data.
GLE0107.Inq.3 Explain the data from an investigation.
GLE0107.3.1 Recognize that plants and animals are living things that grow and change over time.
GLE0107.4.1 Observe and illustrate the life cycle of animals.
GLE0107.5.2 Recognize that some organisms which formerly lived are no longer found on earth.

| | How big? | Chemical Spill | A toad is a frog? | Cycle of life | Why do turtles sunbathe? |
|---|---|---|---|---|---|
| GLE0107.Inq.1 | *X* | *X* | *X* | | *X* |
| GLE0107.Inq.2 | *X* | *X* | *X* | | *X* |
| GLE0107.Inq.3 | *X* | *X* | *X* | | *X* |
| GLE0107.3.1 | | | | *X* | |
| GLE0107.4.1 | | | | *X* | |
| GLE0107.5.2 | *X* | | | | |

Second Grade

GLE0207.Inq.1 Observe the world of familiar objects using the senses and tools.

GLE0207.Inq.2 Ask questions, make logical predictions, plan investigations, and represent data.

GLE0207.Inq.3 Explain the data from an investigation.

GLE0207.2.1 Investigate the habitats of different kinds of local plants and animals.

GLE0207.2.2 Investigate living things found in different places.

GLE0207.3.1 Recognize that animals eat plants or other animals for food.

GLE0207.4.1 Compare the life cycles of various organisms.

GLE0207.4.2 Realize that parents pass along physical characteristics to their offspring.

GLE0207.5.1 Investigate the relationship between an animal's characteristics and the features of the environment where it lives.

GLE0207.10.1 Explain why the sun is the primary source of the earth's energy.

| | How big? | Chemical Spill | A toad is a frog? | Cycle of life | Why do turtles sunbathe? |
|---|---|---|---|---|---|
| GLE0207.Inq.1 | *X* | *X* | *X* | | *X* |
| GLE0207.Inq.2 | *X* | *X* | *X* | | *X* |
| GLE0207.Inq.3 | *X* | *X* | *X* | | *X* |
| GLE0207.2.1 | | | *X* | | |
| GLE0207.2.2 | | | *X* | | |
| GLE0207.3.1 | | | *X* | | |
| GLE0207.4.1 | | | | *X* | |
| GLE0207.4.2 | | | | *X* | |
| GLE0207.5.1 | | | *X* | *X* | *X* |
| GLE0207.10.1 | | | | | *X* |

Third Grade

GLE0307.Inq.1 Explore different scientific phenomena by asking questions, making logical predictions, planning investigations, and recording data.
GLE0307.Inq.2 Select and use appropriate tools and simple equipment and conduct an investigation.
GLE0307.Inq.3 Organize data into appropriate tables, graphs, drawings, or diagrams.
GLE0307.Inq.4 Identify and interpret simple patterns of evidence to communicate findings of multiple investigations.
GLE0307.Inq.5 Recognize that people may interpret the same results in different ways.
GLE0307.Inq.6 Compare the results of an investigations with what scientists already accept about this question.
GLE0307.T/E.1 Describe how tools, technology, and inventions help to answer questions and sole problems.
GLE0307.T/E.3 Identify appropriate materials, tools, and machines that can extend or enhance the ability to solve a specified problem.
GLE.0307.2.2 Explain how organisms with similar needs compete with one another for resources.
GLE0307.3.1 Describe how animals use food to obtain energy and materials for growth and repair.
GLE0307.4.1 Identify the different life stages through which plants and animals pass.
GLE0307.5.1 Explore the relationship between an organism's characteristics and its ability to survive in a particular environment.
GLE0307.5.2 Classify organisms as thriving, threatened, endangered, or extinct.

| | How big? | Chemical Spill | A toad is a frog? | Cycle of life | Why do turtles sunbathe? |
|---|---|---|---|---|---|
| GLE0307.Inq.1 | *X* | *X* | *X* | | *X* |
| GLE0307.Inq.2 | *X* | *X* | *X* | | *X* |
| GLE0307.Inq.3 | *X* | *X* | *X* | | *X* |
| GLE0307.Inq.4 | *X* | *X* | *X* | | *X* |
| GLE0307.Inq.5 | | *X* | *X* | | *X* |
| GLE0307.Inq.6 | | *X* | *X* | | *X* |
| GLE0307.T/E.1 | *X* | *X* | | | *X* |
| GLE0307.T/E.3 | *X* | *X* | | | *X* |
| GLE0307.2.2 | | | *X* | | |
| GLE0307.3.1 | | | | *X* | *X* |
| GLE0307.4.1 | | | | *X* | |
| GLE0307.5.1 | | | *X* | *X* | *X* |
| GLE0307.5.2 | *X* | *X* | | | |

Fourth Grade

GLE0407.Inq.1 Explore different scientific phenomena by asking questions, making logical predictions, planning investigations, and recording data.
GLE0407.Inq.2 Select and use appropriate tools and simple experiment to conduct an investigation.
GLE0407.Inq.3 Organize data into appropriate tables, graphs, drawings, or diagrams.

GLE0407.Inq.4 Identify and interpret simple patterns of evidence to communicate the findings of multiple investigations.

GLE0407.Inq.5 Recognize that people may interpret the same results in different ways.

GLE0407.Inq.6 Compare the results of an investigation with what scientists already accept about this question.

GLE0407.T/E.1 Describe how tools, technology, and inventions help to answer questions and solve problems.

GLE0407.T/E.3 Identify appropriate materials, tools, and machines that can extend or enhance the ability to solve a specified problem.

GLE0407.3.2 Investigate different ways that organisms meet their energy needs.

GLE0407.4.2 Differentiate between complete and incomplete metamorphosis.

GLE0407.5.1 Analyze physical and behavioral adaptations that enable organisms to survive in their environment.

GLE0407.9.1 Collect data to illustrate that the physical properties of matter can be described with tools that measure weight, mass, length, and volume.

| | How big? | Chemical Spill | A toad is a frog? | Cycle of life | Why do turtles sunbathe? |
|---|---|---|---|---|---|
| GLE0407.Inq.1 | *X* | *X* | *X* | | *X* |
| GLE0407.Inq.2 | *X* | *X* | *X* | | *X* |
| GLE0407.Inq.3 | *X* | *X* | *X* | | *X* |
| GLE0407.Inq.4 | *X* | *X* | *X* | | *X* |
| GLE0407.Inq.5 | | *X* | *X* | | *X* |
| GLE0407.Inq.6 | | *X* | *X* | | *X* |
| GLE0407.T/E.1 | *X* | *X* | | | *X* |
| GLE0407.T/E.3 | *X* | *X* | | | *X* |
| GLE0407.3.2 | | | | | *X* |
| GLE0407.4.2 | | | | *X* | |
| GLE0407.5.1 | | | *X* | *X* | *X* |
| GLE0407.9.1 | *X* | *X* | | | |

## Background for Teachers

The study of amphibians and reptiles is called herpetology and is derived from the Greek words *herpeton* meaning "creeping animal" and *–logia* meaning "knowledge." This includes the 6,400 species of amphibians and 9,300 species of reptiles worldwide. Amphibians and reptiles do not comprise a nature group of organisms, but have been studied together historically because of some biological similarities, including being tetrapod (having four limbs) vertebrates that exhibit ectothermy (regulating their body temperature from their surrounding environment). Amphibians and reptiles are collectively referred to as herpetofauna or "herps."

### Amphibians

Amphibians are ectothermic vertebrates that inhabit many terrestrial and aquatic habitats around the world. There are around 6,400 species of amphibians and amphibian fossils date back to the Devonian Period 370 million years ago. In addition to being ectothermic, amphibians are characterized by having four limbs without true nails or claws, glandular skin lacking scales that is semipermeable, a three-chambered heart, eggs that lack several surrounding membranes, and a generalized biphasic life cycle. In fact, the word amphibian is derived from Greek words that mean "double life" in reference to the two primary life stages of most amphibians, an aquatic larval stage and a terrestrial or semi-terrestrial adult stage. There are three orders of amphibians, including frogs, salamanders, and caecilians. Caecilians are long, limbless amphibians that are both worm-like and snake-like in appearance. Their skin has a number of transverse folds and they have rudimentary eyes. Caecilians vary in length from 3 inches to almost five feet in length and generally are found in underground burrows in tropical regions in Africa, Asia and Central and South America. Almost all amphibians are entirely carnivorous as adults. Amphibian skin is glandular and contains mucous glands to help retain moisture as well as poison glands; however, the poison produced varies widely in toxicity. Some species are benign or only mildly distasteful to predators, while the poison of others can cause severe impairment or even death, such as the poison dart frogs.

There are more than 5,500 species of frogs worldwide belonging to the order Anura and found on all continents but Antarctica. The greatest diversity is found in tropical regions. Frogs are generally robust with four limbs, protruding eyes and lack a tail. The hind limbs typically are folded underneath the body at rest. The hind limbs allow many species of frogs to quickly jump away from predators. In fact, one species, the Australian Rocket Frog, can leap over 6 feet, which is more than 50 times its body length! The typical frog is semiaquatic with webbed hind feet for swimming. However, many species are adapted to a variety of other habitats. Some live exclusively in trees and have adhesive toe pads for climbing. Others, like the African Dwarf Frog, have fully webbed feet and live entirely in water. Several ground-dwelling species regularly burrow and have feet adapted for such activities, including toads. Toads are actually frogs but are characterized by having more robust bodies with short hind limbs, warty and dry skin, and large poison glands behind the eyes. They are adapted to drier habitats. Frogs vary widely in color. Some are aposematically (brightly) colored with highly visible reds, oranges and yellows, while others are colored and patterned such that they are camouflaged in their environments to avoid detection by predators. The smallest frog from Papua New Guinea measure just 0.3 inches while the largest, the Goliath Frog, can reach a foot in body length.

Frogs have a biphasic life cycle (which means that they have two main life stages): adults and tadpoles. Most frog species lay their eggs in water that develop over a period of a few days to a few weeks. The eggs hatch into an aquatic life stage called a tadpole. Tadpoles, occasionally called polliwogs, have oval-shaped bodies with flattened tails. Tadpoles lack eyelids and have cartilaginous skeletons. They also possess gills on each side of the head that are external but then become internal as a gill pouch develops and covers them. Most tadpoles are herbivorous and have jaws and mouthparts adapted for feeding on algae and other plant matter. However, some species are carnivorous as tadpoles, some even cannibalistic. At the end of the tadpole stage, a frog then undergoes metamorphosis transitioning into the adult form. Major changes in body structure occur including the development of lungs, the disappearance of gills, full development of the limbs, absorption of the tail, repositioning of the eyes, development of the adult jaws, ossification (formation of bones) of the skeleton, among other changes. One metamorphosis is complete, froglets and toadlets leave water to disperse over land and to grow into adults.

Most species simply lay their eggs in water and offer no parental care. Some species can lay tens of thousands of eggs in one breeding season. However, up to 20% of frog species are known to care for their eggs and young in some way. This can include guarding their eggs in water or even laying eggs and guarding them on land. In the latter case, adults then transport newly hatched tadpoles to water.

Frogs have an external ear drum, the tympanum, on each side of the head for hearing. Vocal communication is very important for many species. During the breeding season, males produce sounds by moving air over their vocal cords and into vocal sacs to attract females. These calls are specific to individual species and can be conducted through both air and water. Females of many species often use suitable mates based on specific call characteristics. Males also recognize the calls of other males when establishing and maintaining territories. Some species are explosive breeders and only call and reproduce during a very specific time of the year, such as desert toads that breed during a rare heavy rainfall event. Species living in less variable and harsh environments may breed anytime throughout the year.

Salamanders are far less diverse than frogs, with only about 600 species worldwide in the order Caudata. Much of this diversity is centered in the Southern Appalachians of North America with over 100 species. There are 58 species of salamanders in Tennessee alone. Salamanders resemble lizards in appearance (four limbs and a tail) but differ in that they lack scales and toenails, and have moist skin. However, some species, like the Siren, have only have front limbs, while others, like the Amphiuma, have rudimentary limbs and are fish-like in appearance, resembling eels. The moist skin is typically smooth but some species (the newts) have velvety or even warty skin. Salamanders must keep their skin moist, as many species readily breathe through their skin (also known as cutaneous respiration). In fact, an entire family of salamanders (the Plethodontidae) lack lungs and breathe entirely through the skin! Salamanders vary widely in coloration. Some are drab and blend into their environments, while others are brightly colored, typically with orange, red, or yellow pigment, and exhibiting variously patterns of spots, bars, stripes, and blotches. Salamanders range in size from just over an inch as adults to the 6 foot Chinese Giant Salamander, which can weigh up to 140 lbs! Salamanders are found almost exclusively in the Northern Hemisphere in North America, Europe and Asia, but also are found in South America and northern Africa. They occupy a variety of habitats from temperate forests to prairies to swamps and rivers. Several species are known exclusively from the highest elevations of the Appalachian Mountains. A few species even live only in caves and have degenerate eyes and reduced pigmentation.

Salamanders also have a biphasic (two phase) life cycle, but there is much variation of this basic life cycle. The life cycle begins with many species laying their eggs in water that hatch into aquatic larvae that possess large external gills just behind the eyes. Larvae are equivalent to the tadpole stage of frogs. Larvae spend a variably amount of time growing then undergo metamorphosis, turning into the adult form. However, there are several variations to this life cycle. Some species never fully undergo metamorphosis and reach sexual maturity while in the larval stage, a condition known as neoteny. Neoteny is more common in species that live in harsh, terrestrial habitats, such as arid regions or in caves. However, some species lay their eggs on land that hatch into fully developed, miniature adults. These species bypass the larval stage while still in the egg. This reproductive strategy allows these species to be completely divorced from large amounts of water to lay their eggs. Instead, they rely on moist microhabitats to lay their eggs in drier regions. The females of a few species even retain eggs inside their bodies until hatching. Unlike frogs, salamanders do not vocalize or produce calls to attract mates. Instead, many species rely on chemical pheromones to communicate.

Salamanders have multiple strategies for defense. In addition to poison glands, salamanders can readily drop their tail as a defense mechanism. The tail will wiggle for a short period of time, hopefully distracting the predator long enough for the salamander to get away. Salamanders will regenerate this tail within just a few weeks. In fact, salamanders are remarkable in that they can even regenerate entire limbs that are lost.

**Reptiles**

Modern reptiles belong to the vertebrate class Reptilia, and include crocodilians, snakes, lizards, turtles, and tuataras. Birds are now also considered reptiles but we do not treat them here, rather focusing on traditional reptile groups. All reptiles have scales and an amniotic egg. They are an ancient group of vertebrates that date back to the Carboniferous period 320 to 350 million years ago. The evolution of the amniotic egg—a nutrient-rich, membranous egg with a protective shell covering—allowed the ancestors of reptiles (and mammals) to lay eggs away from water. This adaptation has allowed reptiles a plethora of habitats, including many in which amphibians are quite rare (i.e., deserts), and diversify into many different groups, from long-extinct relatives like the dinosaurs of the Mesozoic Era to the lizards and snakes found in our backyards today.

Currently, reptiles are divided into two groups: the Archosauria and the Lepidosauria. The archosaurs include turtles, crocodilians, birds, dinosaurs, and pterosaurs. Birds and crocodilians are each other's closest living relatives and, along with the turtles, are the surviving members of Archosauria after the extinction of dinosaurs 65 million years ago. The lepidosaurs include the snakes, lizards, amphisbaenians (worm lizards), and tuataras in the order Squamata. Tuataras are a unique group of lizard-like reptiles that includes just two endangered species restricted to islands off northern New Zealand. Reptiles worldwide consist of over 9,500 species that occupy both terrestrial and aquatic habitats on nearly every continent (except Antarctica) and in all of the world's oceans. They range in size from the world's smallest amniote, the Jaragua Dwarf Gecko from the Dominican Republic that measures just 0.6 inches, to the Indo-Pacific Crocodile of the South Pacific that reaches lengths of 23 feet and weighs 2,200 lbs!

Lizards and snakes comprise the most diverse group of reptiles with around 9,000 species. They belong to the order Squamata, which is derived from the Latin word *squama* meaning "scale." It is this characteristic that allows lizards to be distinguished from similarly shaped amphibians (i.e., salamanders). Scales are made of hardened keratin (the same protein that makes your fingernails rigid) and act like protective armor against minor scrapes and helps reduce water

loss, particularly in very dry habitats. However, scales also have a variety of other purposes, from communication to aiding in locomotion. The Reticulated Python is the longest snake reaching lengths up to 32 feet. However, the Green Anaconda is largest snake in terms of mass. Adults can reach 28 feet and can weight more than 550 pounds! Most lizards are less than a foot in length although some species can grow quite large. The Komodo Dragon is the largest lizard on the planet reaching up to 10 feet and weighing up to 150 lbs.

Lizards and snakes (along with turtles) are ectotherms meaning that they obtain and regulate their body heat from their environment. This feature limits where they can live, as they need warmer temperatures for at least part of the year to regulate their body functions. Consequently, lizards and snakes are more diverse and numerous in warmer habitats. In colder regions, many species hibernate underground, often in large numbers in the case of some snakes, to avoid cold temperatures. All snakes lack limbs, while most lizards have four limbs and a tail. However, some lizards have lost their limbs and resemble snakes. These reptiles, often called legless lizards, can be distinguished from snakes by possessing external ears and moveable eyelids that are lacking in snakes. In addition, many species of lizards can purposefully break off their tail when attacked or threatened by a predator. This adaptation, known as tail autotomy, is not exhibited by snakes.

Snakes have a number of other interesting features and adaptations. They have long, narrow bodies with a greater number of vertebrae than most other vertebrates. Rather than having the paired internal organs, like the lungs and kidneys, arranged side by side, they are arrange linearly (kidneys) or only have one developed, in the case of lungs. However, members of the boa family have two developed lungs. The jaws of snakes are extremely flexible and adapted for eating large prey. Because they lack limbs, snakes must eat their prey whole. Consequently, they have several adaptations for feeding. In addition to a very flexible jaw, snakes have recurved teeth to capture and secure prey and use powerful body muscles to help push their food toward the stomach. In addition, snakes have stretchable skin to help accommodate large prey. Some snakes simply grasp and pin their prey, while others use constriction to suffocate their prey before eating. Others, like rattlesnakes and cobras, inject venom into their prey produced in venom glands in the head and injected in either grooved or hollow fangs. The venom of some species is extremely toxic, even to humans. For example, the venom of Belcher's Sea Snake is so deadly that just a few milligrams is enough to kill over 1,000 human beings!

Turtles are not nearly as diverse as snakes and lizards. There are only about 320 species worldwide, with the greatest diversity in Southeast Asia and the Southeastern United States. Turtles are unique among reptiles in that they have an extremely modified skeleton that includes an external shell that surrounds both the shoulder and hip girdles. The shell is composed of ribs and bony plates that are covered with large scales called scutes. The upper part of the shell is called the carapace, while the lower part is called the plastron. This shell provides excellent protection from predators. Many turtles have a hinged plastron and very flexible necks that allows them to tuck their head, tail and limbs into their shell. Some species, like the Box Turtle can completely seal their shells. Many species of turtles are aquatic or semiaquatic. Some, like the sea turtles, are completely aquatic and only females come onto land to lay eggs. Turtles are also ectotherms and are restricted to activity during warmer periods. However, Painted Turtles are capable of remaining active even in near-freezing temperatures and can even tolerate being frozen only to emerge in the spring suffering no ill effects! Most aquatic turtles bask either out of the water on logs or in shallow water to thermoregulate. Some turtle species are completely terrestrial and live in very dry conditions. Rather than having webbed feet, like their aquatic

cousins, tortoises have stumpy feet adapted for walking on land. Turtles have considerable life spans and some species of tortoises can outlive human beings. In fact, the one tortoise in captivity lived to the age of 188!

There are only 24 species of crocodilians worldwide, many of which are highly endangered. They are the closest living relatives of birds and the ancestors of modern crocodilians date back 200 million years in the fossil record. There are two species of crocodilians native to the United States, the American Alligator and the American Crocodile. Crocodilians are large, aquatic reptiles with a thick skin that contains hardened bony plates called osteoderms for protection. They are powerful predators that typically ambush their prey from the water's edge. Crocodilians are capable of taking down large animals, such as deer, with their powerful jaws and large, gripping teeth. Unlike most other reptiles, crocodilians exhibit complex mating behaviors, such as vocal communication and parental care. Males of most species establish territories during the mating season.

All crocodilians and turtles as well as most lizards and snakes are oviparous, meaning they lay eggs. Eggs of lizards and snakes are typically small with a leathery shell and generally laid underneath some sort of cover. Some species, such as skinks, actually guard the eggs by coiling around them, while other lizards and snakes will lay their eggs and leave them unguarded. Females of some lizards and snakes retain their eggs, which then hatch inside their bodies. The hatchlings, called neonates, are then birthed.

**Amphibian and Reptile Conservation**

The list of amphibians and reptiles nearing the brink of extinction continues to grow each year, while many other species are experiencing population declines. Amphibians in particular have received considerable attention due to massive global population declines and species extinctions, especially in Central and South America, Australia, and the western United States. This rapid loss of amphibian diversity is both upsetting and alarming, as amphibians are often thought of as bioindicators of environmental health. That is to say they are like the canaries in the coal mine whose distress might indicate serious environmental problems.

Amphibians are facing many threats around the world and here in the United States. Perhaps the greatest threats to amphibians are habitat loss and pollution. The loss or modification of forests, wetlands and other amphibian habitats into agriculture fields, housing developments or for timbering has greatly impacted many species. Many species are killed each year on roads, as they travel to and from breeding wetlands. Because they have semipermeable skin, pollution can greatly harm developing eggs, larvae and even adults. The use of pesticides and herbicides has been linked to some amphibian declines and deformities. Diseases, such as the fungal pathogen chytrid and the virus Ranavirus, have played major roles in the decline of many amphibian populations and species. In particular, chytrid is linked to tremendous dieoffs of Central American frogs where conditions are ideal for the fungus to grow. Chytrid is now found nearly worldwide. The introduction of invasive species into native habitats of amphibians has decimated some species. For example, introduction of game fishes such as Rainbow Trout and Largemouth Bass are implicated in the decline of some frogs in the Western United States. Many amphibians, particular frogs, are highly regarded in the pet trade. In addition to decimating local populations from over-collection, some non-native species have escaped and established populations here in the United States with unfortunate consequences. For example, the Cuban Treefrog has become established in Florida and is a voracious predator of native frogs.

Reptiles face many of the same threats as amphibians, such as habitat loss and disturbance, pollution, and novel diseases. Introduced species are a major problem for many native reptile populations, particularly on islands. The introduction of domestic animals, such as cats, rats, goats, dogs, and pigs, have been detrimental to many species, even resulting in the extinction of some island lizards and snakes. Cats are especially destructive as they instinctively kill wildlife. Many people have a strong fear of reptiles, particularly snakes. Consequently, they assume that any snake is venomous or dangerous and maliciously any serpent on site, when, in fact, most snakes are harmless and extremely beneficially to a healthy ecosystem. Other species are hunted for sport, food, or the pet trade. In the Southeastern United States, "rattlesnake roundups" still occur where hundreds to thousands of rattlesnakes are captured and slaughtered leading to drastic declines in local populations. Turtles are trapped for both food and the pet trade. This is an immense threat to turtles in Southeast Asia, which have suffered dramatic declines for overharvesting for food, some to the brink of extinction. Climate change might adversely affect both amphibians and reptiles in the future.

The global loss of amphibians and reptiles demands our attention and warrants remediation. We encourage those interested in learning more about amphibian and reptile declines or to assist in conservation efforts to contact the local, regional and national organizations listed at the end of this book in the resources section.


Cope's Gray Treefrog
Tiger Salamander
Five-Lined Skink
Scarletsnake
Eastern Box Turtle
American Alligator

## How Big?

**Objective**

Students will compare the wide range of body sizes exhibited by amphibians and reptiles, both living and extinct, and make inferences about the effect of size on survival.

**State science standards**

*Kindergarten* – GLE0007.Inq.1, GLE0007.Inq.2, GLE0007.Inq.3,
*First Grade* – GLE0107.Inq.1, GLE0107.Inq.2, GLE0107.Inq.3, GLE0107.5.2
*Second Grade* – GLE0207.Inq.1, GLE0207.Inq.2, GLE0207.Inq.3,
*Third Grade* – GLE0307.Inq.1, GLE0307.Inq.2, GLE0307.Inq.3, GLE0307.Inq.4, GLE0307.T/E.1, GLE0307.T/E.3, GLE0307.5.2
*Fourth Grade* – GLE0407.Inq.1, GLE0407.Inq.2, GLE0407.Inq.3, GLE0407.Inq.4, GLE0407.T/E.1, GLE0407.T/E.3, GLE0407.9.1

**Supplies**

Measuring devices – rulers and/or unconventional measuring tools dependent on age group. For example:

- Precut long strings for younger age groups
- Tape measure
- Meter sticks
- Yard sticks
- Tiles
- Sticks
- Chalk or markers – students or flags can be used as markers

**Activity**

This is a great activity for combining mathematics and science curricula for all age groups. This activity focuses on visualizing how large amphibians and reptiles are by specifically looking at their body length. On the following page we have included a table with lengths of select species of amphibians and reptiles. However, you can extend or modify this activity using other measurements (i.e., weight or height) or by having students do their own research on species of their choice (a list of some reptiles and amphibians of Tennessee is included in the following pages). We have included some animals which are extinct, endangered, or threatened as a stepping point to offer discussion regarding the status of species.

There are many ways to conduct this activity. For instance, the instructor can be in charge and lead the class through measurements, or pairs of students can be assigned a species of which they will outline the size. We recommend using conventional measuring tools (measuring tapes and rulers) for younger grades. Unconventional measuring devices can be used for more advance grades. For example, providing students with a 10 cm tiles to use for measuring and allowing them to determine how many tiles they would need to measure a 60 cm snake through the use of division/multiplication. Chalk markings on pavement, or students marking the start and end of a species length with flags or themselves are great ways to provide visualization, certainly students can think of other ways if asked.

Discussion can be fostered throughout the activity. For instance, students can be asked to compare the sizes of two species (e.g., which is larger or what is the size difference [integrating subtraction/addition into this activity]). Advanced students can be asked to think about why some

species are quite large, while others are small. A couple of handouts have been included for this activity. The first merely asks students to draw a picture comparing the lengths of two species. Meanwhile, the second is more advanced and asks students to determine the shortest, longest, and compare differences between species by stating which species is longer/shorter. Lastly, the third is an extension of the second handout and includes subtraction and division questions.

**Journal/writing prompts**

If you were walking nearby a pond do you think all amphibians and reptiles would be large enough to be seen?

What is the best tool for measuring the length of an animal?

We measured the length of many amphibian and reptiles today, what other amphibian or reptile would you be interested in exploring how big it is?

Why do you think amphibians and reptiles come in a range of sizes?

## Size Diversity

Amphibians and reptiles are animals that come in a diversity of shapes and sizes. Why do you think amphibians and reptiles come in such a range of shapes and sizes?

Amphibians range in size from the smallest frog from Papua New Guinea measuring just 0.3 inches to the largest salamander, the Chinese Giant Salamander. Adult Chinese Giant Salamanders are 6 feet long and weigh up to 140 lbs! Meanwhile, the largest frog is the Goliath Frog, which can reach a foot in body length and the smallest salamander is just over an inch in length. The largest toad is the Cane Toad, which ranges from 4 to 6 inches and weighs about 3 pounds.

Reptiles range in size from the world's smallest amniote, from the Jaragua Dwarf Gecko in the Dominican Republic that measures just 0.6 inches, to the Indo-Pacific Crocodile of the South Pacific that reaches lengths of 23 feet and weighs 2,200 lbs! The Reticulated Python is the longest snake reaching lengths up to 32 feet. However, the Green Anaconda is largest snake in terms of mass. Adults can reach 28 feet and can weight more than 550 pounds! Most lizards are less than a foot in length although some species can grow quite large. The Komodo Dragon is the largest lizard on the planet, reaching up to 10 feet and weighing up to 150 lbs. The largest turtle in the world is the Leatherback Sea Turtle, which can have a shell measuring 6.6 feet and can weigh over a ton (2,000 lbs). The largest tortoises on land can reach 51 inches in shell length and weight 660 lbs. In contrast, the smallest turtle in the world is the Speckled Padloper Tortoise found in South Africa. In measures only 3.1 inches as an adult.

Today you will compare the size of different amphibians and reptiles by visualizing how long they can grow. While doing this think about why amphibians and reptiles come in differing sizes.

**Body lengths of adult amphibians and reptiles around the world!**

| Reptile Species | Metric | Numeric |
|---|---|---|
| Jamaica Giant Galliwasp | 60 cm | 23.6 inches |
| Yunnan Box Turtle | 19 cm | 7.5 inches |
| Tonga Ground Skink | 15.2 cm | 6 inches |
| Seismosaurus | 42.7 meters | 150 feet |
| Triceratops | 7.9 meters | 26 feet |
| Boa Constrictor | 4.3 meters | 14 feet |
| Alligator Snapping Turtle | 80.8 cm | 31.8 inches |
| American Alligator | 3.4 meters | 11.2 feet |
| Indo-Pacific Crocodile | 7 meters | 23 feet |
| Leatherback Sea Turtle | 2 meters | 6.6 feet |
| Speckled Padloper Tortoise | 7.9 cm | 3.1 inches |

| Amphibian Species | Metric | Numeric |
|---|---|---|
| Japanese Giant Salamander | 1.5 meters | 5 feet |
| American Toad | 8.9 cm | 3.5 inches |
| Jaragua Dwarf Gecko | 1.5 cm | 0.6 inches |
| Goliath Frog | 3.66 meters | 1 foot |
| Green Salamander | 12.7 cm | 5 inches |
| Spotted Salamander | 23 cm | 9 inches |

## A list of Amphibians and Reptiles found in Tennessee

### Amphibians:

Hellbender
Three-Toed Amphiuma
Black-Bellied Salamander
Tiger Salamander
Mudpuppy
American Bullfrog
American Toad
Spring Peeper
Green Treefrog

### Reptiles:

Alligator Snapping Turtle
Red-Eared Slider
Snapping Turtle
Stinkpot
Eastern Box Turtle
American Alligator
Black Ratsnake
Eastern Kingsnake
Eastern Wormsnake
Rough Greensnake
Timber Rattlesnake
Cottonmouth
Northern Watersnake
Ground Skink
Green Anole
Broad-Headed Skink

**Name: _____ Date:_____**

**Draw a picture comparing the body lengths of two species.**

**Name: _____ Date:_____**

1. **What species has the shortest body length?**

2. **What species has the longest body length?**

3. **Which is longer?**

**_____has a longer body length than _____.**

**_____has a longer body length than _____.**

4. **Which is shorter?**

**_____ has a shorter body length than _____.**

**_____ has a shorter body length than _____.**

**Name: _____ Date:_____**

1. **What species has the shortest body length?**

2. **What species has the longest body length?**

3. **Which is longer?**

**_____has a longer body length than _____.**

4. **Which is shorter?**

**_____ has a shorter body length than _____.**

5. **You want to measure out the size of a 30 cm lizard, but do not have a ruler. You find a stick and know it is 10 cm long. How many sticks of this size would you need to measure the 30 cm lizard?**

## Chemical Spill!!

**Objectives**
Students will explore the impacts of pollution on amphibians and reptiles.

**State science standards**
*Kindergarten* – GLE0007.Inq.1, GLE0007.Inq.2, GLE0007.Inq.3
*First Grade* – GLE0107.Inq.1, GLE0107.Inq.2, GLE0107.Inq.3
*Second Grade* – GLE0207.Inq.1, GLE0207.Inq.2, GLE0207.Inq.3,
*Third Grade* – GLE0307.Inq.1, GLE0307.Inq.2, GLE0307.Inq.3, GLE0307.Inq.4, GLE0307.Inq.5, GLE0307.Inq.6, GLE0307.T/E.1, GLE0307.T/E.3, GLE0307.5.2
*Fourth Grade* – GLE0407.Inq.1, GLE0407.Inq.2, GLE0407.Inq.3, GLE0407.Inq.4, GLE0407.Inq.5, GLE0407.Inq.6, GLE0407.T/E.1, GLE0407.T/E.3, GLE0407.9.1

**Supplies**
Hard boiled eggs – peeled and un-peeled
Food coloring or beet juice
Water
Cups
Ruler

For extended activities include options such as sand, dirt, oil, hard boiled eggs with cracked shells.

**Activity**
This activity explores the impact of pollution on amphibians and reptiles. Students will either observe a demonstration or conduct their own experiment to investigate properties of amphibian and reptile eggs. Since amphibian eggs lack surrounding membranes whereas amniotic reptile eggs have a protective layer, amphibians are often more readily impacted by pollutants than reptiles. However, it is also important to note that reptile eggs are also impacted by pollutants, even though the protective outer shell provides some protection from an influx of pollutants. For the purposes of this activity, peeled hard-boiled eggs will exemplify amphibian eggs while un-peeled hard-boiled eggs will represent reptile eggs.

No student background write-up is included for this activity because many students have heard about pollution in previous classes, on television, or from friends and relatives in everyday conversation. We encourage teachers to start this activity with a discussion by asking their students what they think the impacts of pollution (such as pouring motor oil or cleaner down a drain) would have on amphibian and reptile eggs. This discussion can be used to get all students to the same level if some students have not been exposed to previous discussions of pollution.

***Demonstration***
Take two hard-boiled eggs, one peeled and the other un-peeled, and place them in a cup. Tell students that the peeled egg represents an amphibian egg, while the un-peeled egg represents a reptile egg. Add enough water to the cup to cover the eggs, then add food coloring to the cup. The food coloring represents the pollutant, use a generous amount of food coloring – you want to color to be vivid. Wait at least 24 hours, cut eggs in half, and then show students what happens to

the eggs (for older age groups the penetration of the dye can be measured). Have student discuss the impact of pollution on amphibian and reptile eggs, also have them discuss the properties of the eggs. For instance, why would there be less pollutant in an egg with a hard shell?

Extensions of this demonstration include using different media that are polluted (i.e., sand, oil, or dirt instead of water). This can be done by adding food coloring directly to the substrate or by making a very concentrated solution of water and food coloring to pour over the substrate. The eggs can then be burrowed at various depths or placed on top of the substrate to determine how the pollution would impact the amphibian and/or reptile egg. This will allow students to explore the impacts of pollution in a more realistic setting for reptiles which often lay their eggs away from water. Also, this demonstration can show what happens how concentration of pollutants impacts eggs by having multiple cups with a range of concentrates of pollutant. Eggs can also be left in solutions for a range of time to determine the impact of long term exposure to pollutants. Furthermore, it can be demonstrated what happens if a reptile egg has a crack in the shell.

***Student designed experiment***

This activity lends itself easily to a student-designed experiment. Discussions of background information regarding differences in reptile and amphibian eggs with students will likely present questions, such as which egg will be more impacted by pollution, how will the degree of pollution impact the egg, what if an egg is damage, or what are the effects of exposure time to the pollutant. These discussions can be prompted by readings, or the demonstration discussed above. Then, students can be encouraged to design an experiment using similar supplies. After students conduct their experiments, they should present findings to their classmates.

***Similar activities***

This activity is similar to that of the Association of Zoos & Aquariums "Saving frogs" which can be found at:

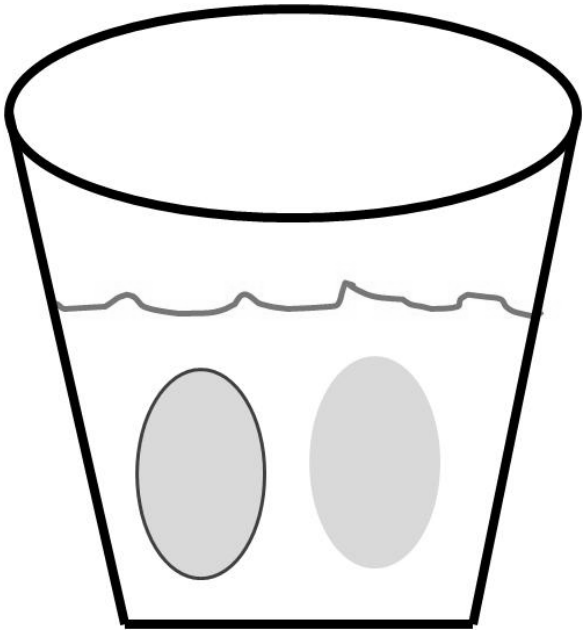
http://www.aza.org/uploadedfiles/conservation/commitments_and_impacts/amphibian_conservation/amphibian_resources/soak_it_up.pdf.

**Journal/writing prompts**

What do you think would happen to an amphibian egg if it were laid in a polluted pond?
How does pollution impact the eggs of reptiles and amphibians?
Pollution impacts the eggs of amphibians and reptiles, do you think it does to adult amphibians and reptiles?
What can you do to minimize or prevent pollution?

Name: _____ Date:_____

**What do you think will happen when amphibian and reptile eggs are exposed to pollution?**

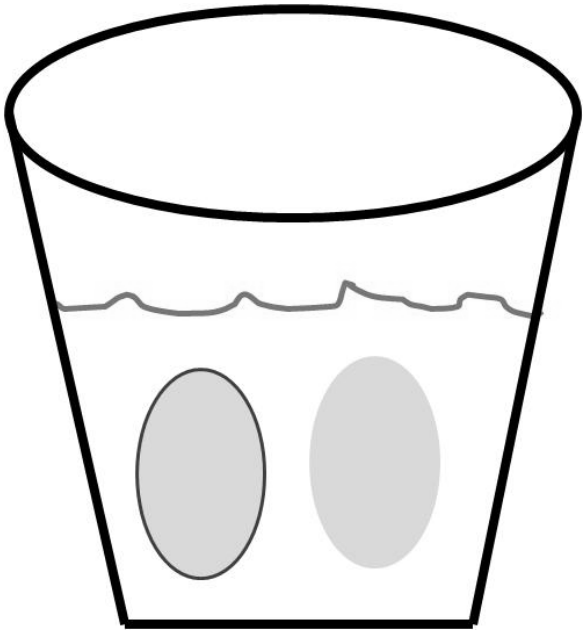


1. The reptile egg will:

2. The amphibian egg will:

Name: _____ Date:_____

**What happened when amphibian and reptile eggs were exposed to pollution?**



1. The reptile egg:

2. The amphibian egg:

Name: _____ Date:_____

**Experiment exploring properties of reptile and amphibian eggs**

1. What is your question?

2. How will you test your question? Draw or write out your experiment.

3. What supplies do you need?

4. What measurements or observations will you take?

5. What do you think will be the results of your experiment?

Name: _____ Date:_____

6. Why do you think these will be the results?

7. What are your results?

8. How do your results compare to your classmates?

## A Toad is a Frog?

**Objective**
Students will compare and contrast characteristics of frogs and toads.
Also, this lesson aims to address the misconception that toads will give you warts.

**State science standards**
*Kindergarten* – GLE0007.Inq.1, GLE0007.Inq.2, GLE0007.Inq.3, GLE0007.3.1
*First Grade* – GLE0107.Inq.1, GLE0107.Inq.2, GLE0107.Inq.3
*Second Grade* – GLE0207.Inq.1, GLE0207.Inq.2, GLE0207.Inq.3, GLE0207.2.1, GLE0207.2.2, GLE0207.3.1, GLE0207.5.1
*Third Grade* – GLE0307.Inq.1, GLE0307.Inq.2, GLE0307.Inq.3, GLE0307.Inq.4, GLE0307.Inq.5, GLE0307.Inq.6, GLE0307.2.2, GLE0307.5.1
*Fourth Grade* – GLE0407.Inq.1, GLE0407.Inq.2, GLE0407.Inq.3, GLE0407.Inq.4, GLE0407.Inq.5, GLE0407.Inq.6, GLE0407.5.1

**Supplies**
Phenylthiocarbamide (PTC) paper

**Activity**
This activity focuses on having students compare and contrast characteristics of frogs and toads. It focuses on teaching students that toads are frogs even though they have some different characteristics and adaptations. On the following pages is a student handout titled "A toad is a frog?" and a picture page with frogs and toads for background information. Students should compare what they see and read by making tables, Venn diagrams, or drawing images.

An extension of this lesson focuses on the fact that frogs and toads use chemical defenses. While this activity can be used with any frog or toad that secretes chemical defenses, we recommend using the American Toad since it is commonly found in Tennessee. Also, by using the toad as an example, you can address the misconception that "toads will give you warts." American Toads release Bufotoxin, a white milky bitter tasting chemical from large glands behind their eggs and bumps ("warts") all over their bodies, when predators grasp them. Phenylthiocarbamide paper will be used to simulate this bitter taste of Bufotoxin. Most students are able to taste the phenylthiocarbamide, but some students will not be able to taste it. Students who cannot taste the phenylthiocarbamide would be able to eat the American Toad and could be a predator. In the wild, Gartersnakes are resistant to this chemical and actively prey on toads. Students who taste the phenylthiocarbamide would not be predators of the toad because the toxin is distasteful and would make them sick. This activity lends itself well for discussion of predator-prey relationships, adaptations, and chemical defenses in the Animal Kingdom. For example, students could be asked about the impact to predator-prey relationships if toads did not exhibit chemical defenses, or what they think the impacts of the removal of toads would have on the food web. For example, students can act like they are frogs or toads and are trying to escape from a predator. How do the jumps of frogs and toads differ?

**Journal/writing prompts**
Can toads give you warts?
What characteristics do both frogs and toads share, and what characteristics differ?
What are chemical defenses?
What would happen if all toads or frogs were removed from a habitat?
Why does it appear as if toads have warts?

# FROGS

# TOADS

## A Toad is a Frog?

Toads and frogs are both **amphibians**. In fact, toads *are* frogs even though they differ in some characteristics. Frogs and toads have many things in common. For example, frogs and toads are **vertebrates** meaning they have a backbone. Frogs and toads are also **tetrapods** meaning they have four limbs. Also, frogs and toads begin their life in water, and as they mature they acquire characteristics that allow them to survive both on land and in water. Frogs and toads inhabit every continent except Antarctica.

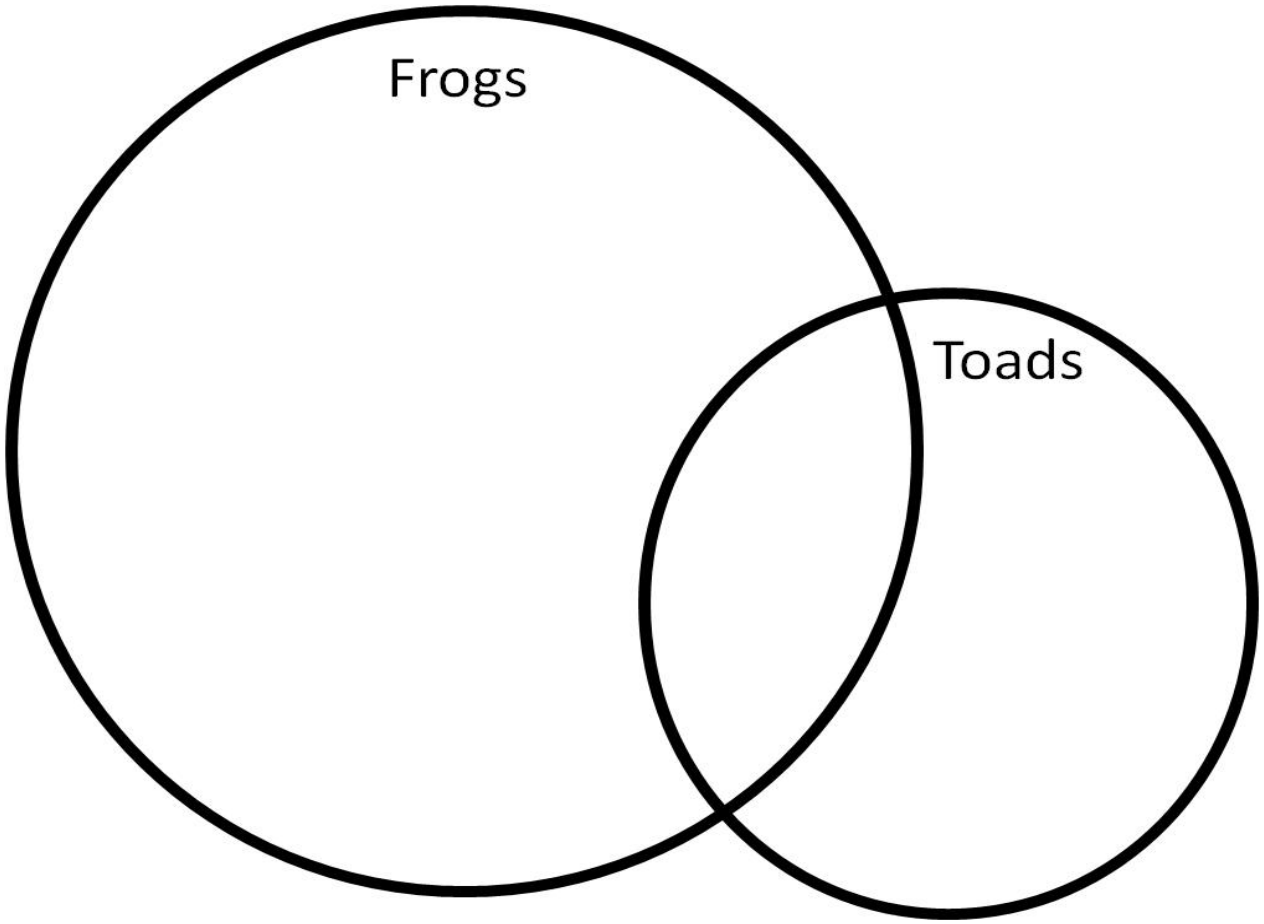
**Frogs** are usually characterized as having moist skin that is smooth to the touch and appears slimy. A frog must keep its skin moist, so it has to live near water. A frog's skin also protects it from predators by releasing chemicals (toxic poisons). These chemicals make the frogs taste bad so predators do not try to bite or eat them. For example, dart frogs produces poisons that make predator very sick or die if it eats a frog. Frogs have a slim appearance because of their narrow bodies, and they have big, round, bulgy eyes! Frogs have long hind legs that allow them to leap far and take high jumps to escape from predators. The tongue of a frog is attached at the front of the mouth, and is sticky. When a frog throws out its tongue the tongue wraps around the prey and snaps it back to the frog. Frogs have small teeth that help them eat their prey, which includes insects, snails, spiders, worms, and even small fish! Frogs must lay their eggs in water and the usually lay them in masses that are clumped together.

The skin of **toads** is thick and rough. This thick skin helps toads stay moist and allows them to live away from water. Because the skin is thick and dry, it often looks bumpy, this is why sometimes people say "toads have warts and can give them to you." However, toads will not give you warts if you touch them, but they might release water from their bodies on you if you pick them up, so make sure to wash your hands after you touch them! The bumps on toads' skins are also a chemical defense that prevents predators from eating toads. When an animal attempts to eat a toad, the toad will release a toxic substance from glands in its skin called Bufotoxin. Bufotoxin is a white milky liquid that tastes really bitter so predators will drop the toad! If you touch a toad make sure not to touch your eyes or mouth because it will sting and taste bitter – wash your hands first. Toads are usually stout with short hind legs and wide bodies so their hind legs are not as powerful as frogs. Toads usually take short hops rather than jumping. Although toads can live on land in dry habitats, they must return to water to lay their eggs, and they usually lay them in a long chain. Toads have a diet very similar to that of frogs. They eat insects, worms, snails, slugs, and worms.

Name: _____ Date: _____

Toads are frogs! Frogs and toads belong to the Order Anura and are collectively referred to as anurans. Complete the Venn Diagram comparing and contrasting characteristics of frogs and toads.

# Anurans



Name: _____ Date: _____

Complete the table by listing characteristics of frogs and toads.

| Frogs | Toads |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

Name: _____ Date: _____

Draw a picture of a frog.

Draw a picture of a toad.

Name: _____ Date: _____

**Chemical Defense**

1. Frogs and toads release chemicals to deter _____ from eating them.

2. True or False: Chemical defenses from frogs and toads can make predators very sick.

3. I (can or cannot) taste the PTC.

4. If I can taste the PTC then I am a predator that (can or cannot) eat the American Toad.

## Cycle of life!

**Objectives**
Students will recognize that living organisms change as they grow.
Students will sequence the life cycle of a frog.
Students will sequence life cycles of salamanders.

**State science standards**
*Kindergarten* – GLE0007.4.1
*First Grade* – GLE0107.3.1, GLE0107.4.1
*Second Gra*de – GLE0207.4.1, GLE0207.4.2, GLE0207.5.1
*Third Grade* – GLE0307.3.1, GLE0307.4.1, GLE0307.5.1
*Fourth Grade* – GLE0407.4.2, GLE0407.5.1

**Supplies**
Coloring supplies
Scissors

**Activity**
The first activity focuses on the physical changes of frogs and salamanders as they grow and develop. Students obtain a basic understanding of metamorphosis by investigating the frog life cycle. In the following pages we have included a short student background information sheet for older grades, as well as an assignment handout. Also included are various coloring images for younger grades. These images include a full depiction of the life cycle with arrows showing the order, an ordered life cycle without arrows, and flash cards that can be put into the correct developmental order. While these coloring images do not include the names of each stage, they can be added by the instructor or students.

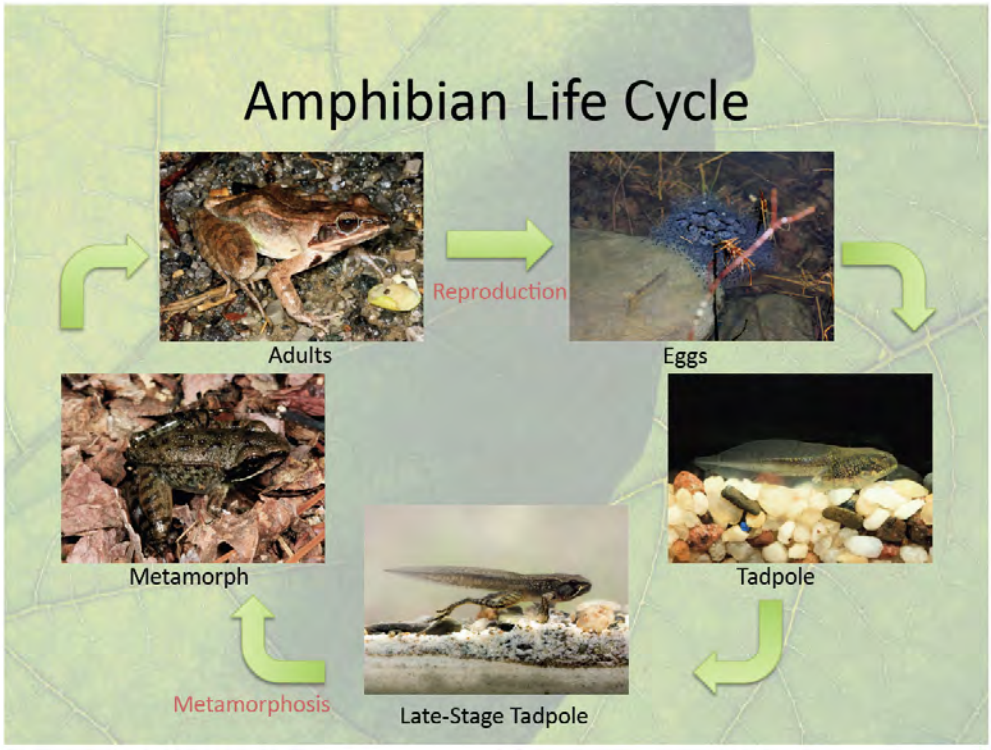
The second activity allows students to compare and contrast variations to the basic amphibian life cycle, such as direct development (bypassing the larval stage in the egg) and neoteny (becoming sexually mature adults in the larval stage). A brief student background sheet is included with information on salamanders that undergo complete metamorphosis (the general amphibian biphasic life cycle) as well as those that undergo direct development and neoteny. Images are included for examples of salamanders of these life cycles. These can be printed and cut into flash cards for students to place in the correct order, or can simply be used to show students the changes. Students can discuss the differences they see and what this would implications these differences have for survival (i.e., if the salamander still utilizes gills to breath then it must remain in water to survive).

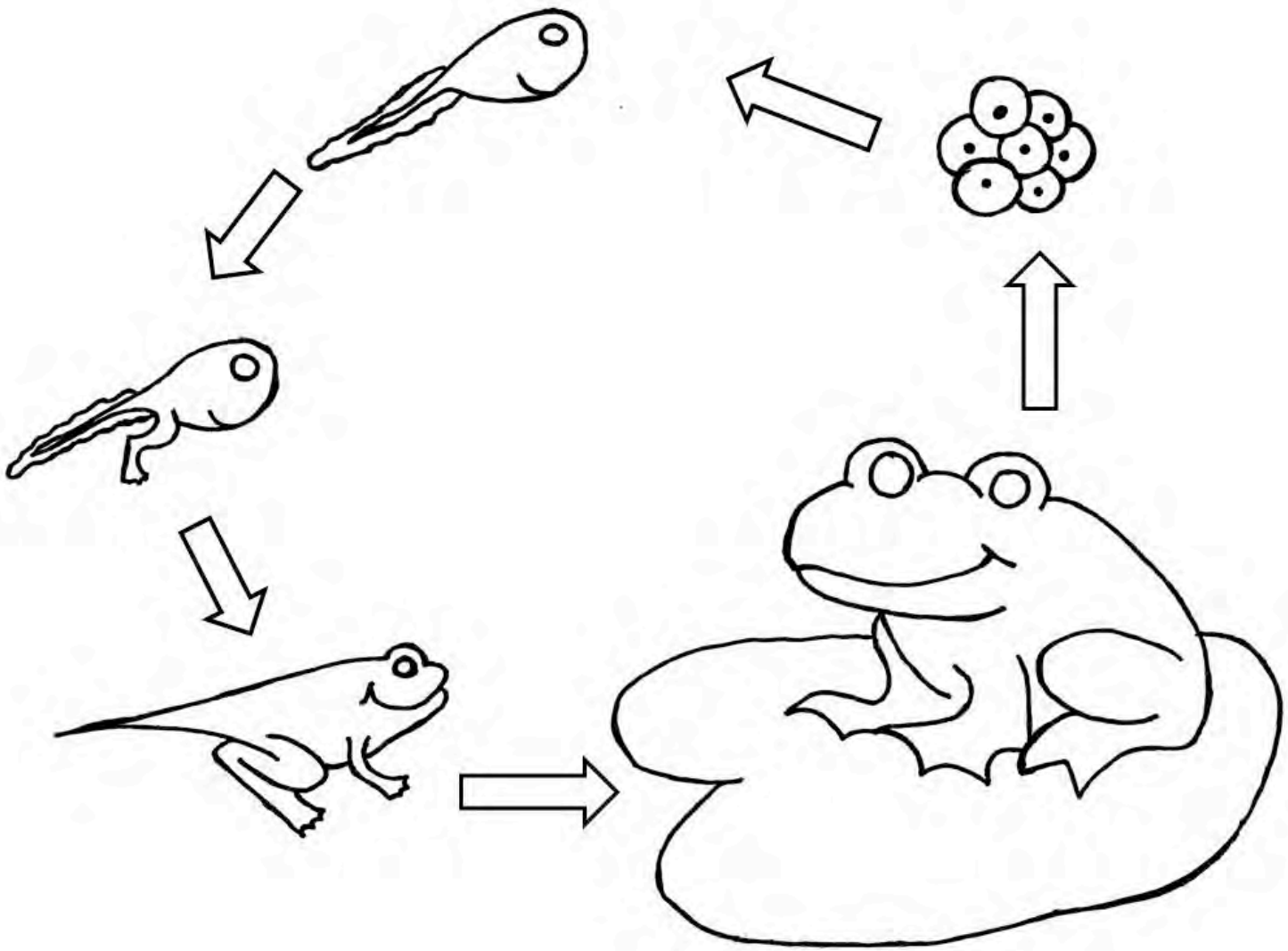
**Journal/writing prompts**
Describe the life cycle of a frog.
What is neoteny in salamanders?
What is direct development in salamanders?
What impact does the life cycle of an organism have on where it can live?
How do you change as you get older?

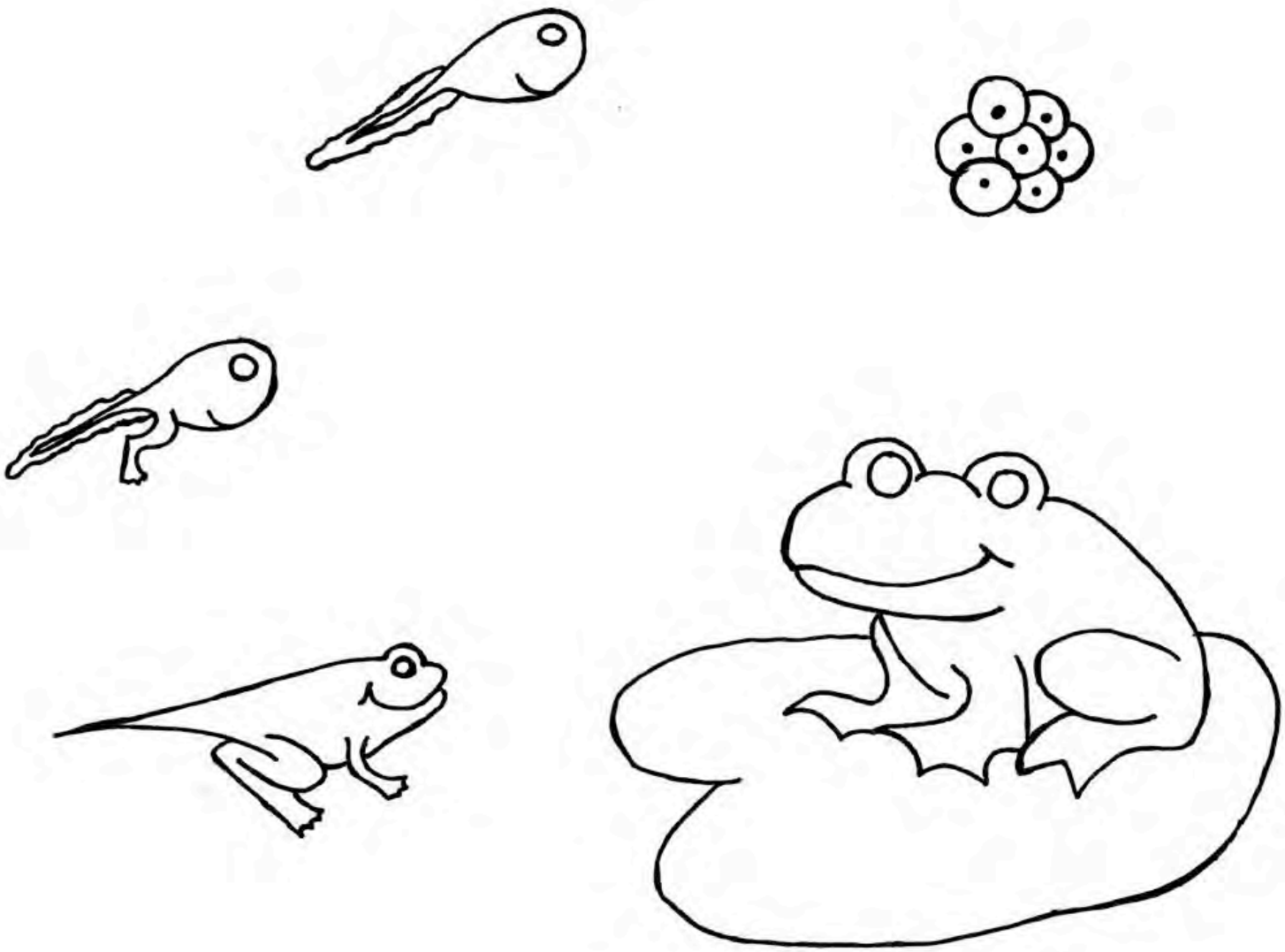
## Frog life cycle

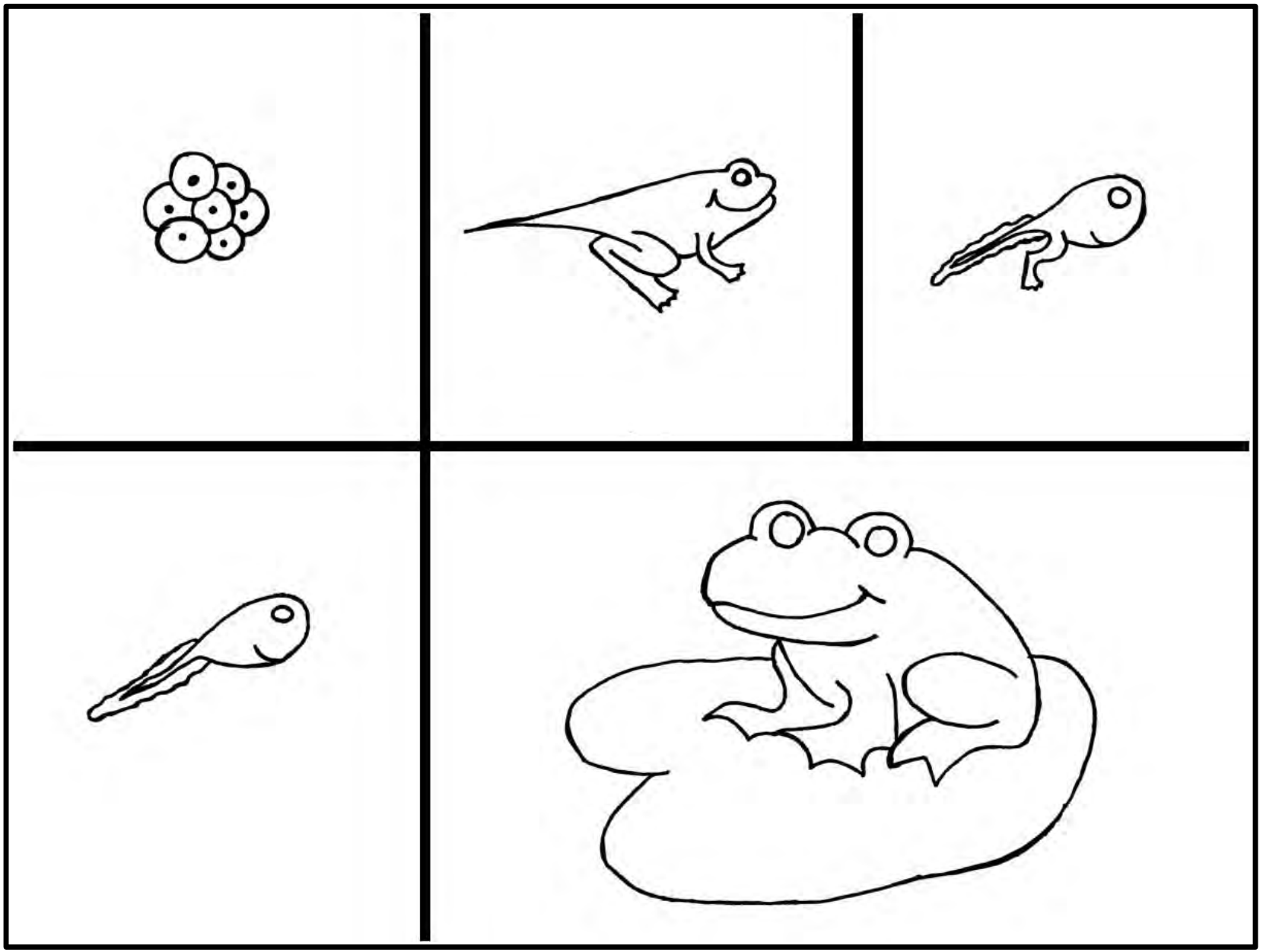
Amphibians and reptiles are animals. Amphibians and reptiles change and grow overtime, and as they do they go through different life stages. Today you will explore the life cycle of a frog.

Frogs have a life cycle with two main life stages: adults and tadpoles. Most frog species lay their **eggs** in water. These eggs are laid in masses and develop over a period of a few days to a few weeks. The eggs hatch into an aquatic life stage called a **tadpole**. Tadpoles, also called polliwogs, have oval-shaped bodies with flattened tails. Tadpoles lack eyelids, but they have gills on each side of the head that are covered by skin. Most tadpoles are **herbivorous** (plant eaters) and have jaws and mouthparts adapted for feeding on algae and other plant matter. However, some species are **carnivorous** (meat eaters) as tadpoles, some even **cannibalistic** (eats other tadpoles of the same species). As tadpoles continue to grow it begins to undergo **metamorphosis** into the adult form. Tadpoles first grow back legs and then front legs. Lungs begin to develop so that it can breathe oxygen from the air and not water. The tadpole becomes more and more frog-like. The gills are lost, the mouth widens and the tail gets shorter. Finally, the tadpole hops out onto land and is called a **froglet**. The froglet will continue to grow until it becomes an adult frog that breathes air and lives on land near water.





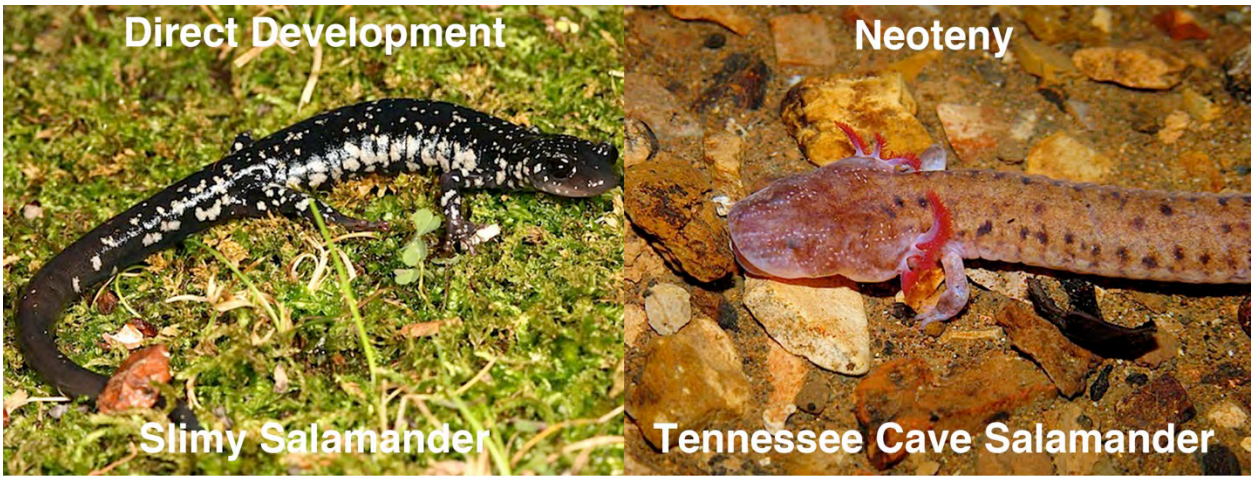




## Salamander life cycle

Salamanders, like frogs, go through a life cycle in which they change and grow as they develop. Many salamander species have a life cycle similar to the life cycle of frogs in that they undergo **complete metamorphosis**. Eggs are laid in water that hatch into larvae. The larvae are aquatic meaning they live in water, and they develop limbs, lose their gills, and typically gain lungs as they mature. Unlike frogs, salamanders keep their tails. When development is complete adult salamanders climb out of the water and start a terrestrial life (meaning they live on land). Even though adult salamanders live on land, they must stay in moist areas (you often find them under rocks and logs) or near water so they do not dry out!

Other salamanders undergo **direct development** meaning they hatch from eggs as miniature adults. This means they completely skip the aquatic larval stage! Many woodland salamanders in Tennessee, like the Slimy Salamander and Zigzag Salamander, have direct development. Their eggs are laid in moist areas on land, often in caves! Some salamanders never completely undergo metamorphosis into a terrestrial adult. Instead, they grow bigger and bigger until they mature but they keep their gills and must live in water throughout their lives! This condition is known as **neoteny**. Tennessee's state amphibian, the Tennessee Cave Salamander, is a species that exhibits neoteny.



Photos by Brad M Glorioso and Matthew L. Niemiller

## Why do turtles sunbathe?

**Objective**

Students will design an experiment to compare effects of thermal heat on different materials. Students will infer the impact of thermal regulation on animals.

**State science standards**

*Kindergarten* – GLE0007.Inq.1, GLE0007.Inq.2, GLE0007.Inq.3, GLE0007.10.1
*First Grade* – GLE0107.Inq.1, GLE0107.Inq.2, GLE0107.Inq.3
*Second Grade* – GLE0207.Inq.1, GLE0207.Inq.2, GLE0207.Inq.3, GLE0207.5.1, GLE0207.10.1
*Third Grade* – GLE0307.Inq.1, GLE0307.Inq.2, GLE0307.Inq.3, GLE0307.Inq.4, GLE0307.Inq.5, GLE0307.Inq.6, GLE0307.T/E.1, GLE0307.T/E.3, GLE0307.3.1, GLE0307.5.1
*Fourth Grade* – GLE0407.Inq.1, GLE0407.Inq.2, GLE0407.Inq.3, GLE0407.Inq.4, GLE0407.Inq.5, GLE0407.Inq.6, GLE0407.T/E.1, GLE0407.T/E.3, GLE0407.3.2, GLE0407.5.1

**Supplies**

Thermometers
Differing substrates – sand, dirt, grass, water, etc.
Environmental conditions – sunny, shady, burrowed, etc.
Different types of lighting – fluorescent, sunlight, etc.

**Activity**

Amphibians and reptiles are vertebrates that exhibit ectothermy (regulating their body temperature from their surrounding environment). Therefore, this activity focuses on having students investigate body temperature regulation based on environmental surroundings. Younger students can be led through an activity where thermometers are placed in different substrates and/or in different environmental conditions (i.e., on sand in the shade, under dirt in the sun, floating on water in the sun, etc.) or different types of lighting (i.e., is the temperature warmer under fluorescent lighting or in natural sunlight) and then record and compare the temperatures. Older students can be asked to design their own experiment to determine how environmental conditions impact temperature. Students can be guided to compare similar substrates in differing environmental conditions, or differing substrates in similar environmental conditions. We have included a student background information sheet to prompt questions and provide background information.

Students can be challenged to consider the implications of habitat destruction, such as removal of forests on environmental conditions, and thereby the ability of amphibians and reptiles to regulate body temperature.

**Journal/writing prompts**

How do turtles (and other reptiles) regulate their body temperature?
What does it mean to be ectothermic?
Why is the sun important for reptiles?
What do you think would happen if trees were removed from the habitat of a reptile?
Are reptiles warmer when they lay in sunlight or in the shade?

## Why do turtles sunbathe?

All amphibians and most reptiles are **ectothermic** meaning that they regulate their body temperature from their surrounding environment. So, amphibians and reptiles become hotter and colder depending on the temperature outside. Since amphibians and reptiles are **ectothermic** (you may know this as **cold-blooded**), they are limited to where they can live around the world. Most amphibians and reptiles need warmer temperatures for at least part of the year to regulate their body functions. This is why they are most active during warmer parts of the day or warmer times of the year. Also, this is why you see more frogs, turtles, salamanders, lizards, snakes and crocodilians in warmer habitats. In colder places many species hibernate underground for much of the year to avoid the cold temperatures.

Turtles are often seen basking, kind of like sunbathing, on logs or the bank. Why do you think turtles sunbathe? It is because they are ecothermic? Turtles need warmth in order to perform everyday functions, like to digest their food. When the sun is out, they soak up the heat from the sun's rays with their bodies and become warmer. But when the sun sets at night their bodies begin to cool as the temperature drops. Some turtles have adaptations that allow them to perform daily functions when it is cold out. For instance, the Painted Turtle can remain active even in near-freezing temperatures and can even tolerate being frozen only to emerge in the spring suffering no ill effects! However, most aquatic turtles bask either out of the water on logs or in shallow water to regulate their body temperature.

Name: _____ Date:_____

**Experiment exploring environmental impact on temperature**

1. What is your question?

2. How will you test your question? Draw or write out your experiment.

3. What supplies do you need?

4. What measurements or observations will you take?

5. What do you think will be the results of your experiment?

Name: _____ Date:_____

6. Why do you think these will be the results?

7. What are your results?

8. How do your results compare to your classmates?

Name: _____ Date:_____

**Why do turtles sunbathe?**

Draw a picture of where you put your thermometers:

Which thermometer recorded the warmest temperature?

What is the best place for a turtle to sunbathe?

## Resources

### Adult Books


Buhlmann, Kurt, Tracey Tuberville, and J. Whitfield Gibbons: Turtles of the Southeast (2008)
Conant, Roger, and Joseph T. Collins: A Field Guide to Reptiles and Amphibians of Eastern and Central North America (1998)
Dodd, C.K.: The Amphibians of Great Smoky Mountains National Park (2004)
Dorcas, Michael , and J. Whitfield Gibbons: Frogs and Toads of the Southeast (2008)
Elliott, Lang, Carl Gerhardt, and Carlos Davidson: The Frogs and Toads of North America: A Comprehensive Guide to Their Identification, Behavior, and Calls (2009)
Gibbons, J. Whitfield, and Michael Dorcas: Snakes of the Southeast (2005)
Gibbons, J. Whitfield, Judy Greene, and Tony Mills: Lizards and Crocodilians of the Southeast (2009)
Mitchell, Joseph C., and J. Whitfield Gibbons: Salamanders of the Southeast (2010)
Niemiller, Matthew L. and R. Graham Reynolds: The Amphibians of Tennessee (2011)
Niemiller, Matthew L., R. Graham Reynolds, and Brian T. Miller: The Reptiles of Tennessee (2013)


### Children Books


Aloian, Molly: Endangered frogs (2006)
Bredeson, Carmen: Fun facts about turtles! (2008), Fun facts about salamanders! (2008), Fun facts about snakes! (2008), Fun facts about frogs! (2008)
Cleary, Brian: Salamander, frog, and polliwog: what is an amphibian? (2013), Tortoise, tree snake, gator, and sea snake: what is a reptile? (2013)
Gibbons, Gail: Alligators and crocodiles (2010)
Kolpin, Molly: Salamanders (2010), Newts (2010)
Leedy, Loreen: The great graph contest (2005)
Lobel, Arnold: Frog and Toad are Friends, Frog and Toad Together, Frog and Toad All Year, and Days with Frog and Toad
Pringle, Laurence: Frogs!: Strange and wonderful (2012)
Rockwell, Anne: Who lives in an alligator hole? (2006)
Spilsbury, Richard: The life cycle of amphibians (2003)
Sweeney, Alyse: Frogs (2010), Toads (2010), Mudpuppies (2010)


### Amphibian and Reptile Organizations

Amphibian and Reptile Conservancy (http://amphibianandreptileconservancy.org/)
Partners in Amphibian and Reptile Conservation (http://parcplace.org/)
Southeast Partners in Amphibian and Reptile Conservation (http://www.separc.org/)
Tennessee Herpetological Society (http://www.tennsnakes.org/)
Tennessee Wildlife Resources Agency (http://www.tn.gov/twra/)

About the Authors:

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