31–1 Reptiles

Humans have always been fascinated by—and sometimes frightened of—reptiles. Some people fear snakes because of their venomous bites or the way they crawl. Explorers' encounters with lizards and crocodiles inspired images of dragons in European folk tales. Turtles, too, are the subject of many a fable. The truth about reptiles is that they are as astonishing as any creatures of human imagination.

What Is a Reptile?

The basic body plan of a reptile is typical of land vertebrates: a well-developed skull, a backbone and tail, two limb girdles, and four limbs. The iguana in **Figure 31–1** exhibits this body plan. Two types of reptiles have slightly different body plans. Snakes are mostly limbless, while turtles have hard shells that are fused to their vertebrae.

What characteristics do snakes, turtles, and other reptiles share? **A reptile is a vertebrate that has dry, scaly skin, lungs, and terrestrial eggs with several membranes.** These characteristics enable reptiles to live their entire lives out of water, unlike their amphibious relatives.

Reptilian skin is dry and often covered with thick, protective scales. These scales may be smooth or rough. A reptile's body covering helps prevent the loss of body water in dry environments. But dry, waterproof skin can also be a disadvantage to reptiles. Because the tough, scaly layer of skin does not grow when the rest of a reptile grows, it must be shed periodically as the reptile increases in size.

Today, reptiles are widely distributed on Earth. Temperate and tropical areas contain populations of reptiles that are remarkably diverse in appearance and lifestyle. The only places on Earth that most reptiles cannot live in are very cold areas. The reason for this will soon be apparent.

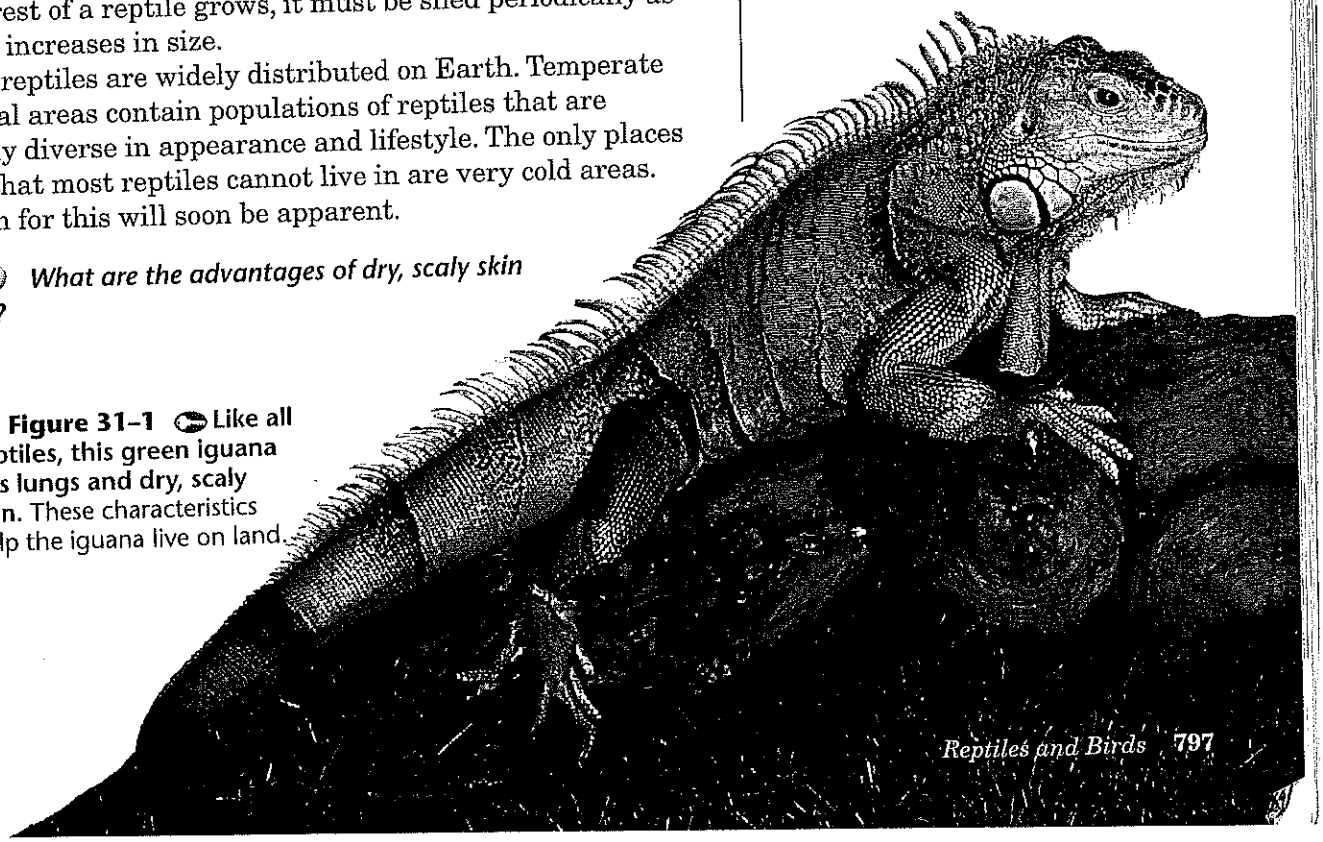
✓CHECKPOINT *What are the advantages of dry, scaly skin for reptiles?*

Guide for Reading

Key Concepts
- What are the characteristics of reptiles?
- How are reptiles adapted to life on land?
- What are the four living orders of reptiles?

Vocabulary
ectotherm
amniotic egg
carapace
plastron

Reading Strategy: Outlining Before you read, use the headings in this section to make an outline about reptiles. As you read, add phrases or a sentence about each topic and subtopic in your outline.



▶ **Figure 31–1 Like all reptiles, this green iguana has lungs and dry, scaly skin.** These characteristics help the iguana live on land.

Evolution of Reptiles

To colonize permanently dry habitats, animals needed a way to reproduce that did not require depositing eggs into water. Reptiles were the first animals to evolve this adaptation. The fossil of the first known reptile dates back to the early Carboniferous Period, some 350 million years ago. However, reptiles did not become common until 40 or 50 million years later. As the Carboniferous Period came to a close and the Permian Period began, Earth's climate became cooler and less humid. Many lakes and swamps dried up, reducing the available habitat for water-dependent amphibians. Under these drier conditions, the first great adaptive radiation of reptiles began.

Mammal-like Reptiles By the end of the Permian Period, about 245 million years ago, a great variety of reptiles roamed Earth. One early group was the mammal-like reptiles, which displayed a mix of reptilian and mammalian characteristics. These chordates eventually came to dominate many land habitats. However, the mammal-like reptiles went extinct in just a few million years. Toward the end of the Triassic Period, about 215 million years ago, they were replaced in the fossil record by another group of reptiles that had remained in the background for millions of years—the dinosaurs.

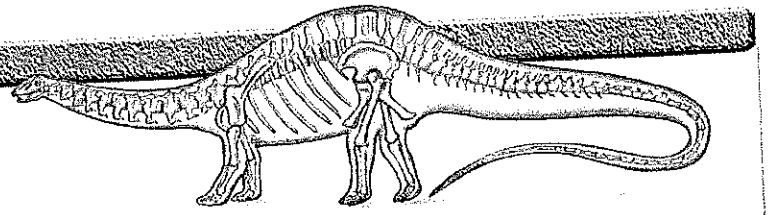
Enter the Dinosaurs During the late Triassic and Jurassic periods, a great adaptive radiation of reptiles took place. The vast diversity and abundance of reptiles during that time are the main reasons why the Mesozoic Era is often called the Age of Reptiles. Two separate groups of large aquatic reptiles swam in the seas. Ancestors of modern turtles, crocodiles, lizards, and snakes populated many land habitats. And dinosaurs were everywhere. **Figure 31–2** shows two dinosaurs, *Plateosauras* and *Coelophysis.* The illustration also shows another kind of reptile, *Teratosaurus.*

Word Origins

Dinosaur is a combination of two Greek words: *deinos,* meaning "terrible" and *sauros,* meaning "lizard." The suffix *-ian* is used to turn a noun into an adjective. The adjective *dinosaurian,* for example, describes a dinosaur-like animal. **What do you think the adjective *saurian* describes?**

▼ **Figure 31–2** In the Triassic Period, reptiles such as these lived in the forests. The herbivorous *Plateosaurus* (left), nibbling on leaves, was a dinosaur, as were the group of carnivorous *Coelophysis* (center). The large carnivorous *Teratosaurus* (right) was a reptile but not a dinosaur. **Observing** ***What characteristics did these reptiles have in common with modern reptiles?***

Problem Solving



A Massive Controversy

Dinosaurs were the largest animals ever to walk on Earth. The plant-eating dinosaur *Brachiosaurus* reached lengths greater than 22 meters and had a mass of about 50,000 kilograms. It would take about 10 elephants to match the mass of one *Brachiosaurus*. How could the skeleton of such an animal support its immense mass? Imagine that you are a paleontologist searching for an answer to this question. Your job is to examine fossil skeletons of large dinosaurs for clues.

Defining the Problem Use your own words to describe the problem you face.

Organizing Information List the kinds of skeletal adaptations that would help a dinosaur support its mass.

Creating a Solution Carefully study the above illustration of a large dinosaur. Make a model of the part of the spinal column that is supported by the animal's legs. Include the legs in the model. Make another model of an alternative shape for the spinal column, one that is not curved.

Presenting Your Plan Describe what you might do to each model to discover which would support a greater mass. Show how you would test the models. Next to the models, place a card describing the steps in your test.

Dinosaurs ranged in size from small to enormous. They ran on two legs or lumbered along on four. Some, like *Plateosaurus,* ate leafy plants. *Coelophysis* and other hunters traveled in herds. Others, such as duckbilled *Maiasaura,* lived in small family groups, caring for their eggs and young in carefully constructed nests. Certain dinosaurs may even have had feathers, which may have evolved as a means of regulating body temperature. All of the dinosaurs, however, belonged to one of two major groups: the Ornithischia (awr-nuh-THISH-ee-uh), or "bird-hipped" dinosaurs, and the Saurischia (saw-RISH-ee-uh), or "lizard-hipped" dinosaurs. From one of these two branches of dinosaurs, probably the Saurischia, came the earliest members of evolutionary lines that would lead to modern birds.

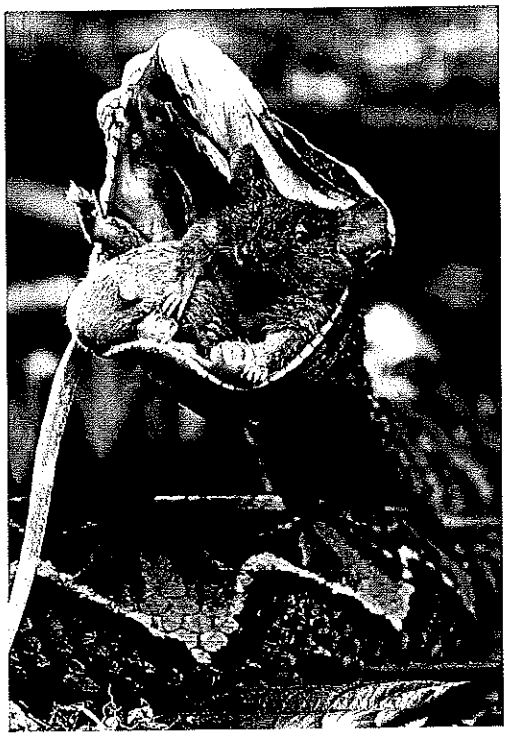
Exit the Dinosaurs At the end of the Cretaceous Period, about 65 million years ago, a mass extinction occurred worldwide. This extinction was caused by a dramatic series of natural disasters. These disasters probably included a string of massive volcanic eruptions and lava flows, the dropping of sea level, and a huge asteroid or comet smashing into what is now the Yucatan Peninsula in Mexico. The asteroid or comet collision produced major forest fires and enormous dust clouds. After these events, dinosaurs, along with many other animal and plant groups, became extinct. The disappearance of these organisms during the late Cretaceous Period provided opportunities for other kinds of organisms to evolve on land and in the seas.

✓CHECKPOINT *How did the extinction of the dinosaurs pave the way for modern reptiles?*

Form and Function in Reptiles

Most reptiles have adapted to a fully terrestrial life. Tough, scaly skin is one adaptation to this type of life. **Well-developed lungs; a double-loop circulatory system; a water-conserving excretory system; strong limbs; internal fertilization; and shelled, terrestrial eggs are the other adaptations that have contributed to the success of reptiles on land.** In addition, reptiles can control their body temperature by changing their environments.

Body Temperature Control The ability to control their body temperature is an enormous asset for active animals. All the animals that you have read about so far are ectotherms (EK-toh-thurmz). **Ectotherms** rely on behavior to help control body temperature. Turtles, snakes, and other modern reptiles are all ectotherms. To warm up, they bask in the sun during the day or stay under water at night. To cool down, they move to the shade, go for a swim, or take shelter in underground burrows.

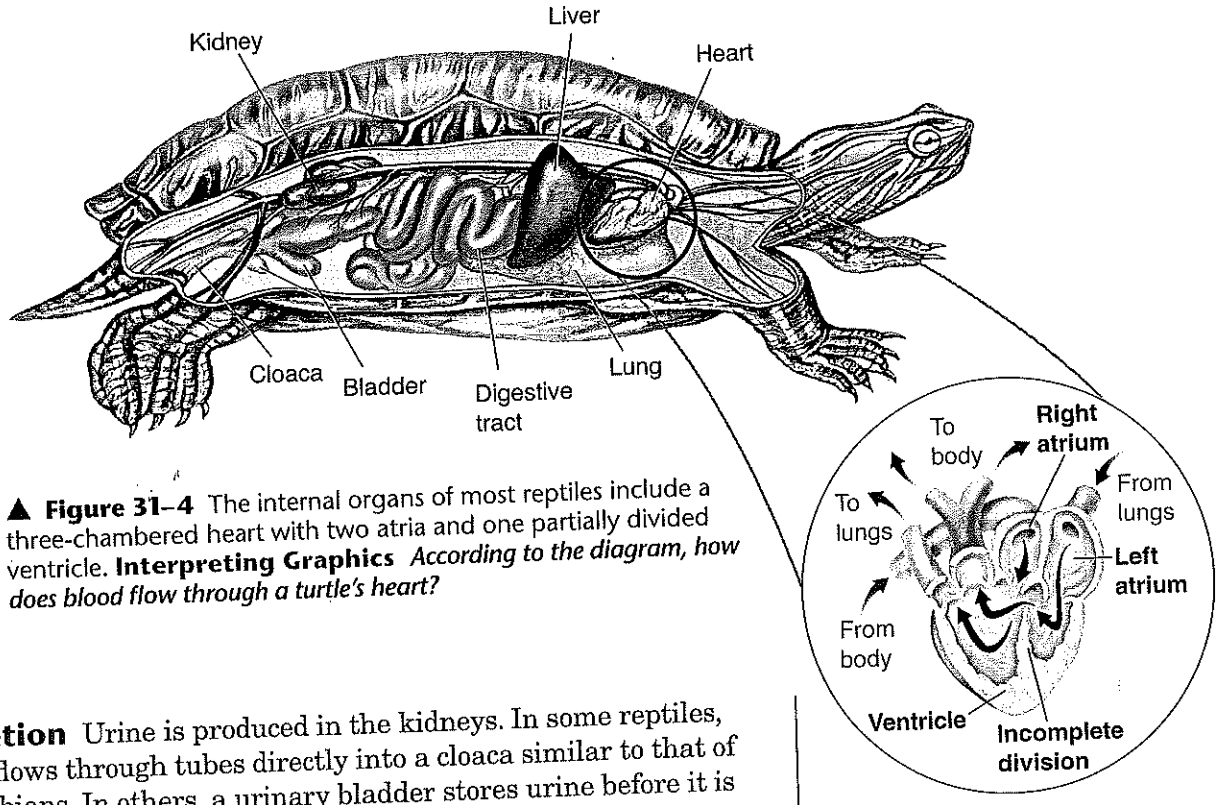


▲ **Figure 31–3** The gaboon viper, like all snakes, is entirely carnivorous. It eats mice and other small mammals by stretching its jaws wide and swallowing its prey whole. **Inferring** *Besides feeding, what other function might fangs serve in snakes?*

Feeding Reptiles eat a wide range of foods. Iguanas, which are herbivores, tear plants into shreds and swallow the tough, fibrous chunks. Their long digestive systems enable them to break down plant material. Many other reptiles are carnivores. Snakes, for example, prey on small animals, bird eggs, or even other snakes, grabbing them with their jaws and swallowing them whole as shown in **Figure 31–3.** Crocodiles and alligators eat fish and even land animals when they can catch them. Chameleons have sticky tongues as long as their bodies that flip out to catch insects.

Respiration The lungs of reptiles are spongy, providing more gas-exchange area than those of amphibians. This isn't surprising, because most reptiles cannot exchange gases through their skin the way many moist-skinned amphibians do. Many reptiles have muscles around their ribs that expand the chest cavity to inhale and collapse the cavity to force air out. Several species of crocodiles also have flaps of skin that can separate the mouth from the nasal passages, allowing these crocodiles to breathe through their nostrils while their mouth remains open. To exchange gases with the environment, reptiles have two efficient lungs or, in the case of certain species of snakes, one lung.

Circulation Reptiles have an efficient double-loop circulatory system. One of the loops brings blood to and from the lungs, and the other loop brings blood to and from the rest of the body. The heart diagram in **Figure 31–4** shows how blood flows through a turtle's heart. Reptile hearts contain two atria and either one or two ventricles. Most reptiles have a single ventricle with a partial septum, or wall, that helps separate oxygen-rich and oxygen-poor blood during the pumping cycle. Crocodiles and alligators, however, have the most developed hearts of living reptiles. The heart consists of two atria and two ventricles—an arrangement that is also found in birds and mammals.



▲ **Figure 31–4** The internal organs of most reptiles include a three-chambered heart with two atria and one partially divided ventricle. **Interpreting Graphics** *According to the diagram, how does blood flow through a turtle's heart?*

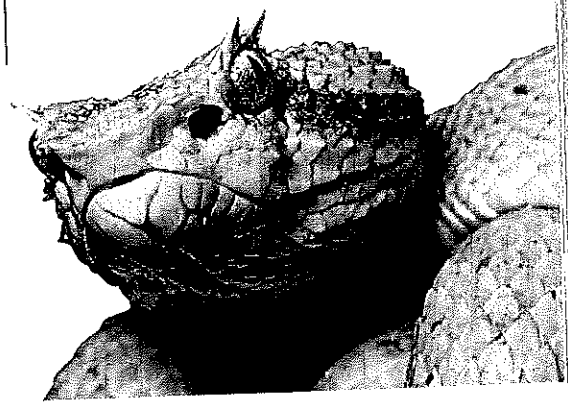
Excretion Urine is produced in the kidneys. In some reptiles, urine flows through tubes directly into a cloaca similar to that of amphibians. In others, a urinary bladder stores urine before it is expelled from the cloaca.

Reptiles' urine contains either ammonia or uric acid. Reptiles that live mainly in water, such as crocodiles and alligators, excrete most of their nitrogenous wastes in the form of ammonia, a toxic compound. Crocodiles and alligators drink a large amount of water, which dilutes the ammonia in the urine and helps carry it away. In contrast, many other reptiles—especially those that live entirely on land—do not excrete ammonia directly. Instead, they convert ammonia into a compound called uric acid. Uric acid is much less toxic than ammonia, so it does not have to be diluted as much. In these reptiles, excess water is absorbed in the cloaca, reducing urine to crystals of uric acid that form a pasty white solid. By eliminating wastes that contain little water, a reptile can conserve water.

Response The basic pattern of a reptile's brain is similar to that of an amphibian, although the cerebrum and cerebellum are considerably larger compared to the rest of the brain. Reptiles that are active during the day tend to have complex eyes and can see color well. Many snakes also have an extremely good sense of smell. In addition to a pair of nostrils, most reptiles have a pair of sensory organs in the roof of the mouth that can detect chemicals. Reptiles have simple ears with an external eardrum and a single bone that conducts sound to the inner ear. Snakes can also pick up vibrations in the ground through bones in their skulls. Some snakes, such as the viper in **Figure 31–5**, have the extraordinary ability to detect the body heat of their prey.

CHECKPOINT *How does a reptile's brain compare to an amphibian's?*

▼ **Figure 31–5** The heat-sensitive pits above this eyelash viper's mouth enable it to locate prey, even in total darkness. Snakes that have these pits are commonly called pit vipers. **Inferring** *How would these organs give pit vipers an advantage over other reptiles?*



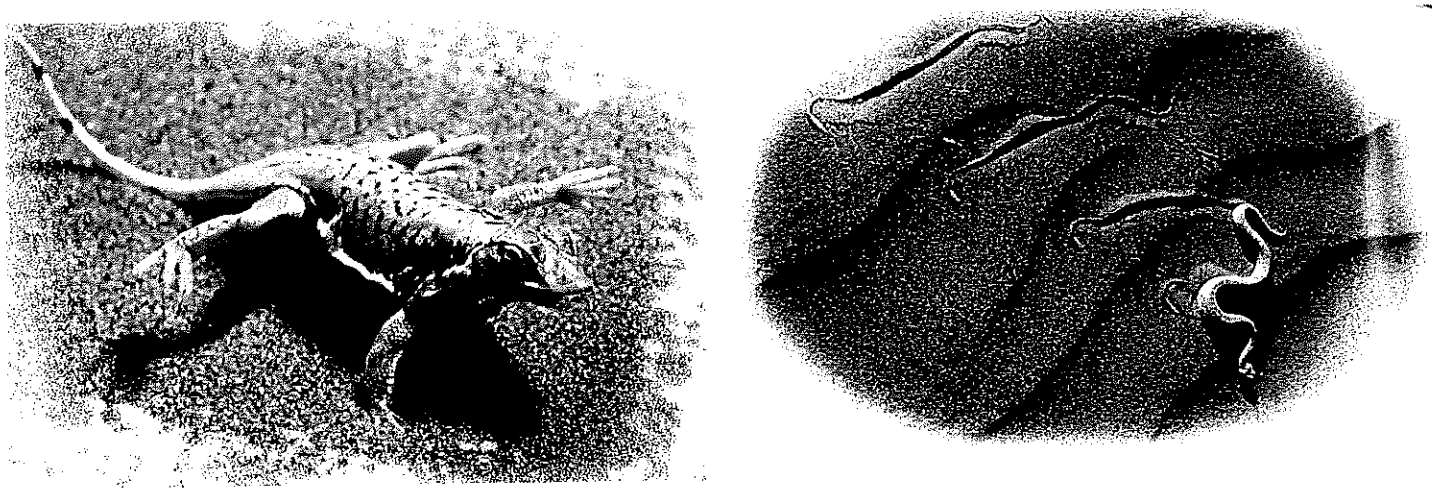


Figure 31–6 The shovel-snouted lizard (left) is not moving forward; rather, it lifts its feet to limit contact with the hot desert sand. The sidewinding adder propels itself forward by digging its ventral scales against the dunes while pushing its body into long curving waves. **Comparing and Contrasting** *How are the lizard's legs different from those of an amphibian?*

Movement Compared with most amphibians, reptiles with legs tend to have larger, stronger limbs that enable them to walk, run, burrow, swim, or climb. The legs of some reptiles are also rotated further under the body than those of amphibians, enabling reptiles to carry more body weight. The legs and feet of many aquatic turtles have developed into flippers. **Figure 31–6** shows some ways that reptiles can move. As with amphibians, the backbones of reptiles help accomplish much of their movement.

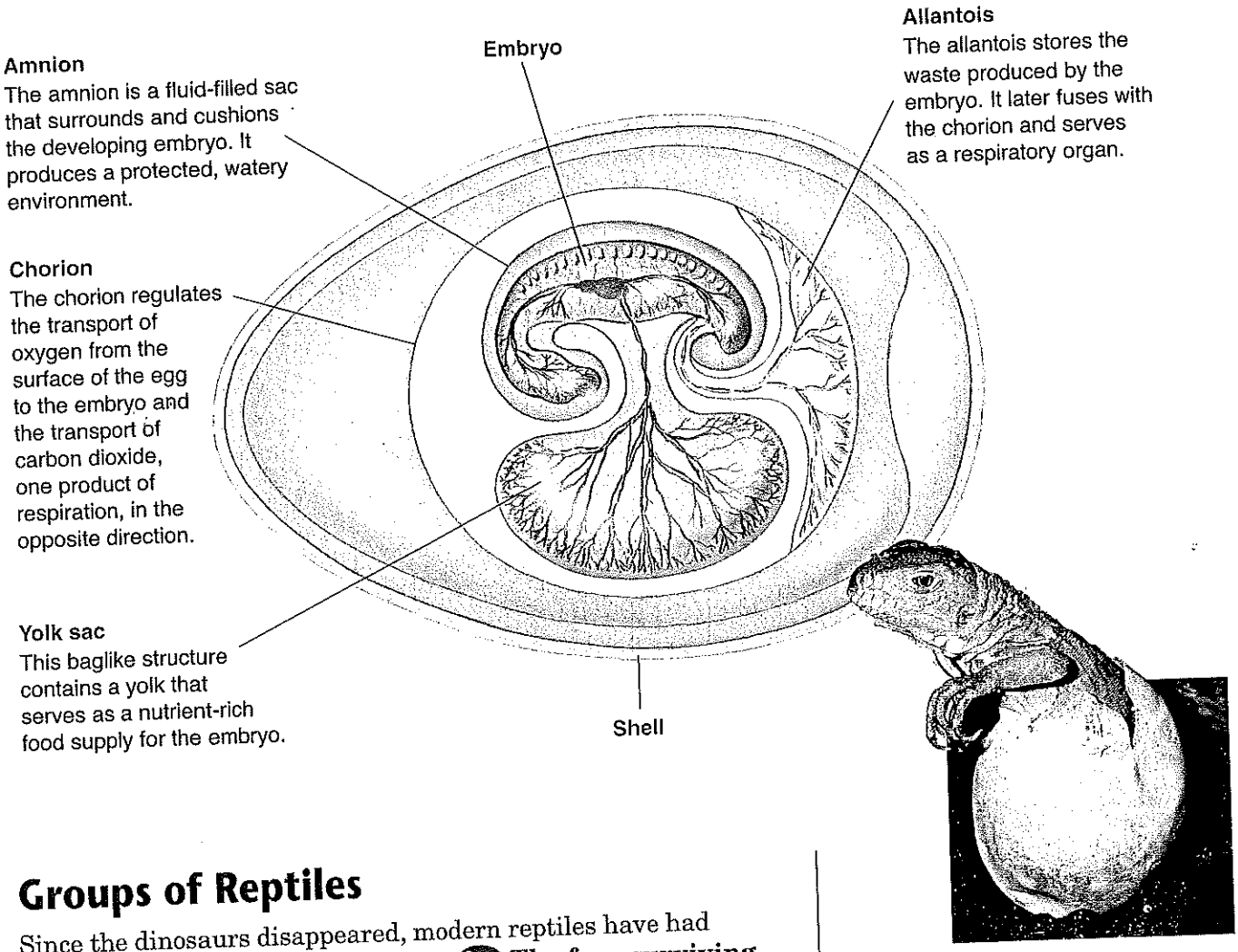
Reproduction All reptiles reproduce by internal fertilization, in which the male deposits sperm inside the body of the female. Most male reptiles have a penis that allows them to deliver sperm into the female's cloaca. After fertilization has occurred, the female's reproductive system covers the embryos with several membranes and a leathery shell.

Most reptiles are oviparous, laying eggs that develop outside the mother's body. Some species, such as the box turtle in **Figure 31–7**, lay their eggs in carefully prepared nests, then abandon them. Alligators also lay their eggs in nests, but they guard the eggs until they hatch, and provide some care after hatching. Some snakes and lizards are ovoviviparous, and the young are born alive. By carrying her eggs within her body, the female can protect the eggs and keep them warm.

Unlike an amphibian egg, which almost always needs to develop in water, the shell and membranes of a reptilian egg create a protected environment in which the embryo can develop without drying out. This type of egg is called an **amniotic egg** (am-nee-AHT-ihk), named after the amnion, one of the four membranes that surrounds the developing embryo. The other three membranes are the yolk sac, the chorion, and the allantois. Find each of these membranes in **Figure 31–8** and learn about their functions. The amniotic egg, also seen in birds, is one of the most important adaptations to life on land.

✓CHECKPOINT *What are the four parts of an amniotic egg?*

▼ **Figure 31–7** After a female box turtle digs a hole in the ground for her nest, she lays her eggs, dropping them one by one and gently lowering them into the hole with her hind feet. When she finishes, she will cover up her nest and leave without a backward glance. **Inferring** *Why would it be an advantage for turtles to lay a large number of eggs?*



▲ **Figure 31–8** An amniotic egg contains several membranes and an external shell. Although it is waterproof, the egg shell is porous, allowing gases to pass through. The shell of reptile eggs is usually soft and leathery. The photograph shows a hatching iguana leaving the broken shell of its amniotic egg. **The amniotic egg is one of the most important adaptations to life on dry land.**

Groups of Reptiles

Since the dinosaurs disappeared, modern reptiles have had plenty of time and space to diversify. **The four surviving groups of reptiles are lizards and snakes, crocodilians, turtles and tortoises, and the tuatara (too-uh-TAH-ruh).**

Lizards and Snakes Modern lizards and snakes belong to the order Squamata (skwah-MAH-tuh), or scaly reptiles. Most lizards have legs, clawed toes, external ears, and movable eyelids. Some lizards have evolved into highly specialized forms. For example, Gila (HEE-luh) monsters—large, stocky lizards that live in the southwestern United States and Mexico—have glands in the lower jaw that produce venom for defense against predators.

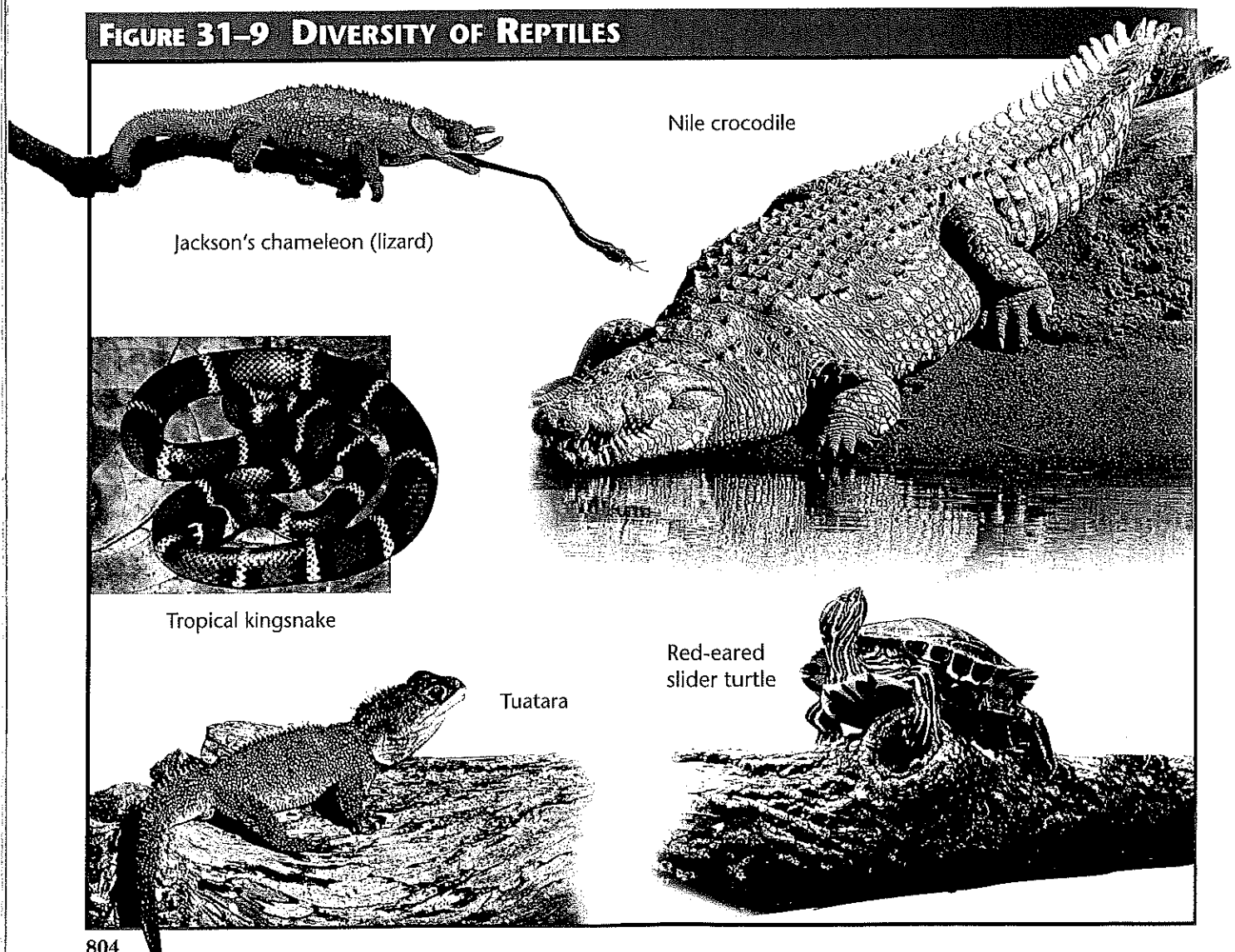
Snakes have lost both pairs of legs during the course of their evolution. Although they are legless, snakes are highly efficient predators, even in the ocean. Some snakes are so small that they resemble earthworms. Others, such as some species of python, can grow to more than 8 meters in length. The ability of certain snakes to produce venom has caused some people to harbor an unjustified fear of all snakes. More people in the United States die from bee stings than from snakebites. In fact, most snakes tend to avoid people, not to confront them!

Crocodilians Examples of crocodilians and other reptile groups are shown in **Figure 31–9.** Any member of the order Crocodilia—including alligators, crocodiles, caimans, and gavials—can easily be recognized by its long and typically broad snout and its squat appearance. Crocodilians are fierce carnivores that prey on animals such as fishes, deer, and even humans. Crocodilians are very protective of their young. The females guard their eggs from predators. After the eggs are hatched, the mother gently carries her young to a nursery area and watches over them.

Crocodilians live only in the tropics and subtropics, where the climate remains warm year-round. Alligators, and their relatives the caimans, live only in fresh water and are found almost exclusively in North and South America. Crocodiles, on the other hand, may live in either fresh or salt water and are native to Africa, India, and Southeast Asia.

Turtles and Tortoises Turtles and tortoises are members of the order Chelonia (kuh-LOH-nee-uh). The name *turtle* usually refers to members of this order that live in water; the name *tortoise* refers to those that live on land. A terrapin is a turtle that is found in water that is somewhat salty.

▼ **Figure 31–9** The four orders of living reptiles are the Squamata, Crocodilia, Testudines, and Sphenodonta. **The common names of these modern reptile groups are lizards and snakes, crocodilians, turtles and tortoises, and the tuatara.**



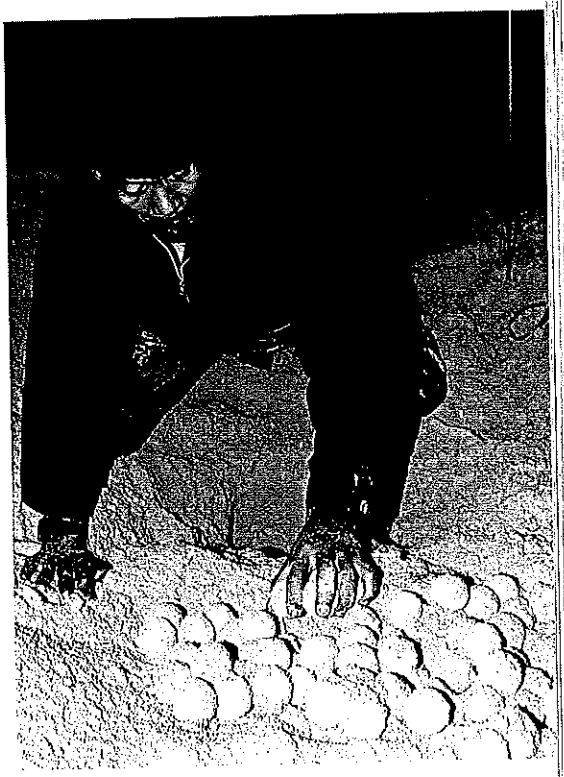
Turtles and tortoises have a shell built into the skeleton, although in a few species the shell is not very hard. The shell consists of two parts: a dorsal part, or **carapace,** and a ventral part, or **plastron.** The animal's backbone forms the center of the carapace. The head, legs, and tail stick out through holes where the carapace and plastron join. Tortoises and most turtles pull into their shells to protect themselves.

Several other adaptations allow turtles and tortoises to live in a wide range of habitats—dry, wet, and in-between. Lacking teeth, these reptiles have horny ridges that cover the upper and lower jaws. The jaws are often powerful enough to deliver a damaging bite. All possess strong limbs to lift their body off the ground when walking or, in the case of sea turtles, to drag themselves across a sandy shore to lay eggs.

Tuataras The tuatara is the only surviving member of the order Rhynchocephalia (ring-koh-suh-FAY-lee-uh), or "beak-headed" reptiles. It is found only on a few small islands off the coast of New Zealand. Tuatura resemble lizards, but they differ from lizards in many ways. For example, they lack external ears and retain primitive scales. Tuatara also have a legendary "third eye," which is part of a complex organ located on top of the brain. The function of this organ, if any, is still unknown.

Ecology of Reptiles

Many reptiles are in danger because their habitats have been, and are being, destroyed. In addition, humans hunt reptiles for food, to sell as pets, and for their skins, from which bags, boots, and combs are made. Laws now protect some species, such as sea turtles, which were once numerous in both the Atlantic and Pacific oceans. Sea turtle recovery programs, such as the one shown in **Figure 31–10,** give many young turtles a head start on survival. Although there are many other programs in place that protect reptiles, more conservation efforts are needed worldwide to counteract their dwindling numbers.



▲ **Figure 31–10** This wildlife ranger is retrieving green sea turtle eggs on Turtle Island National Park in Borneo. He will bring the eggs to an incubation station, where they can hatch safe from harm. After hatching, the young turtles will be released to the sea. **Inferring** *What might harm sea turtle eggs that are left on a beach to hatch?*

31–1 Section Assessment

1. **Key Concept** List the main characteristics of reptiles.
2. **Key Concept** List five ways that reptiles are adapted to life on dry land.
3. **Key Concept** Name the four orders of modern reptiles and give an example of each.
4. How is excretion carried out in animals that live on land?
5. How does a lizard control its body temperature?
6. **Critical Thinking Predicting** What might happen to reptiles if conditions on Earth became permanently warmer and much damper?

iTEXT Assessment Use iText to review the important concepts in Section 31–1.

MAKING CONNECTIONS

Biodiversity

In Chapter 6, you learned about threats to biodiversity. Do research to find out what factors threaten a reptile such as the sea turtle, and what steps are taken to protect this reptile. Make a brochure that shows what you have learned.