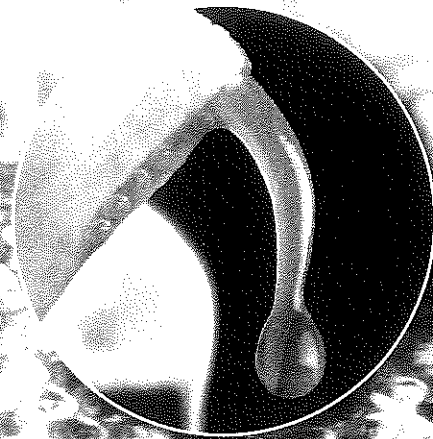


Venom opening of fang



Fang and venom

THEME FOCUS Scale, Proportion, and Quantity
Reptiles and birds are diverse due to the vast number of terrestrial niches available to fill.

BIG Idea Reptile and bird adaptations enable them to live and reproduce successfully in terrestrial habitats.

Section 1 • Reptiles

Section 2 • Birds

Section 1

Reading Preview

Essential Questions

- What is the importance of the amniotic egg in the transition to life on land?
- What are the characteristics of reptiles?
- What are the differences between orders of reptiles?

Review Vocabulary

embryo: the earliest stage of development of plants and animals after an egg has been fertilized

New Vocabulary

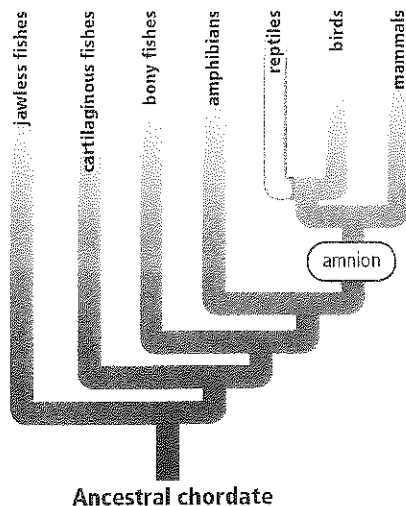
amnion
amniotic egg
Jacobson's organ
plastron
carapace



Multilingual eGlossary

Figure 1

Right: This Western fence lizard is one of 7000 species of reptiles belonging to class Reptilia. Reptiles live in a variety of terrestrial and aquatic habitats. **Left:** The phylogenetic tree shows that reptiles, along with birds and mammals, have an amnion.



Reptiles

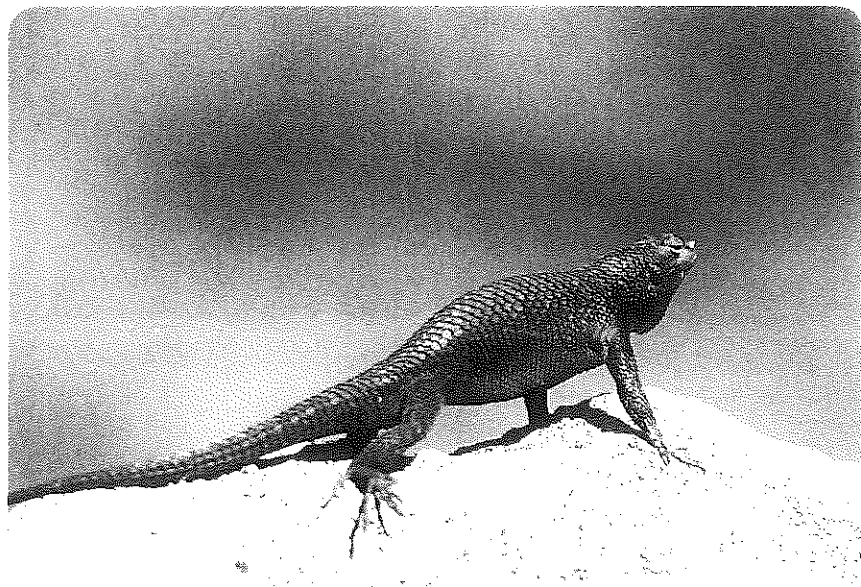
Real-World Reading Link Reptiles are fully adapted to life on land.

Real-World Reading Link Think about the last time you saw a movie in which a reptile was a main character. Maybe it was a giant anaconda or a ferocious *Tyrannosaurus rex*. Maybe it was an animated character that was funny. As you read this section, think about whether the characteristics of the reptile in the movie were scientifically accurate.

Characteristics of Reptiles

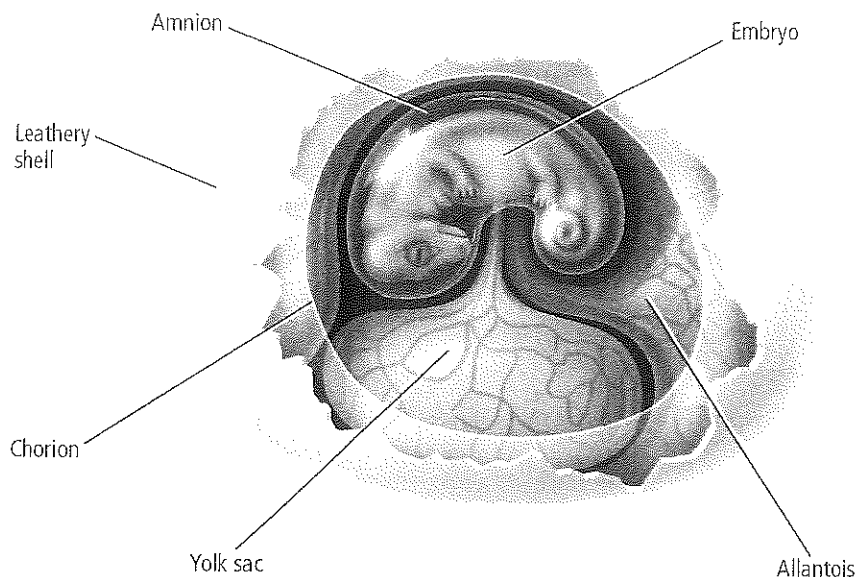
Recall that vertebrates with well-developed limbs, circulatory and respiratory systems, and other adaptations moved from water to land. However, amphibians were left vulnerable to the drying effects of life on land with their shell-less eggs and larvae that breathed through gills. In contrast, reptiles, such as the Western fence lizard shown in **Figure 1**, are fully adapted to life on land and were the first completely terrestrial vertebrates. Characteristics that allow reptiles to succeed on land include a shelled egg, scaly skin, and efficient circulatory and respiratory systems.

Amniotic eggs As you can see in the evolutionary tree in **Figure 1**, reptiles have characteristics in common with other groups that have an amnion and other membranes that surround the embryo as it develops. An **amnion** (AM nee ahn) is a membrane that surrounds a developing embryo. It is filled with fluid that protects the embryo during development. Animals that undergo this type of development are called amniotes and include reptiles, birds, and mammals.



Den Sizio/Photo Researchers





• **Figure 2** The amniotic egg is protected by a shell and membranes with fluid that help to protect the embryo and keep it from drying out during development.



Animation

An **amniotic egg**, like the one shown in **Figure 2**, is covered with a protective shell and has several internal membranes with fluids contained between the membranes. Inside the egg, the embryo is self-sufficient because it gets its nutrition from food in the yolk sac inside the egg. Bathing the embryo within the amnion is amniotic fluid. Amniotic fluid mimics the aquatic environments of fish and amphibian embryos. The allantois (uh LAN tuh wus) is a membrane that forms a sac that contains wastes produced by the embryo. The outermost membrane of the egg is the chorion (KOR ee ahn), which allows oxygen to enter and keeps fluid inside the egg. In reptiles, the leathery shell protects the internal fluids and embryo, and prevents the egg from drying out on land. In birds, the shell is hard instead of leathery.

Dry, scaly skin In addition to keeping fluid in their eggs, reptiles also must keep fluids in their bodies. The dry skin of reptiles keeps them from losing internal fluids to the air. A layer of scales on the exterior of many reptiles also keeps them from drying out. However, one problem with having a tough outer covering is that an organism could have difficulty growing larger. To grow, some reptiles, such as the snake in **Figure 3**, periodically must shed their skins in a process called molting. You might have seen the molt of a snake's skin while hiking on a nature trail.

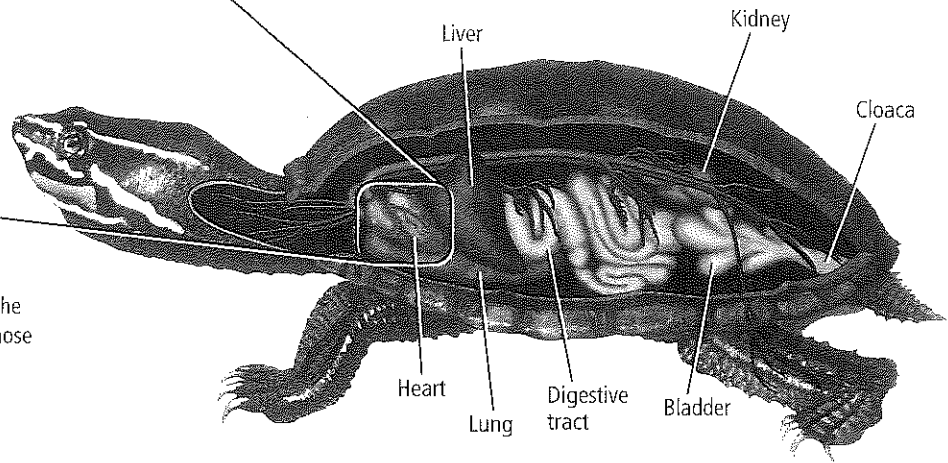
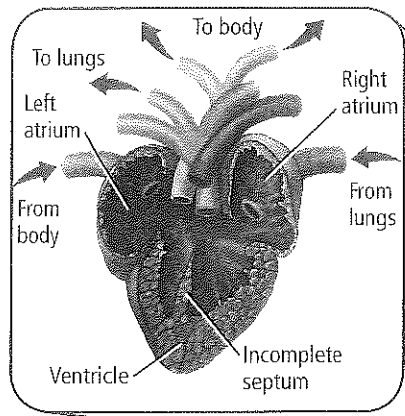
Respiration Most reptiles, except for some aquatic turtles, depend primarily on lungs for gas exchange. Recall that when amphibians breathe, they squeeze their throats to force air into their lungs. Reptiles are able to suck air into their lungs, or inhale, by contracting muscles of the rib cage and body wall to expand the upper part of the body cavity in which the lungs are held. They exhale by relaxing these same muscle groups. Reptiles exchange gases in lungs that have larger surface areas for gas exchange than the lungs of amphibians. With more oxygen, more energy can be released through metabolic reactions and made available for more complex movements.

✓ **Reading Check Evaluate** why the amniotic egg is important for an animal to be able to live exclusively on land.

• **Figure 3** Some reptiles molt as they grow larger.

Compare *molting in reptiles to molting in arthropods.*

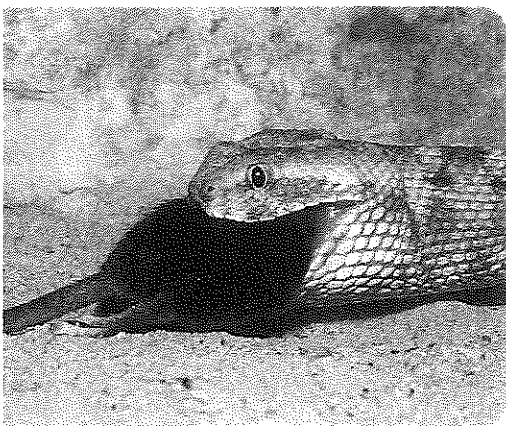




• **Figure 4** The circulatory system and the digestive system of reptiles are similar to those of amphibians.

Infer why reptiles have a similar circulatory system to that of amphibians.

• **Figure 5** Snakes can consume a meal that is larger than their mouths because their jaws are loosely jointed, and upper and lower jaws can move independently of each other.



Circulation In most reptiles, oxygen from the lungs enters into a circulatory system that is similar to that of amphibians. Most reptiles have two separate atria and one ventricle that is partially divided by an incomplete septum, as shown in **Figure 4**. In crocodiles, however, the septum in the ventricles is complete, thereby resulting in a four-chambered heart. The separation into two ventricles keeps oxygen-rich blood separate from the oxygen-poor blood throughout the heart.

Because reptiles generally are larger than amphibians, they need to pump blood forcefully enough to reach parts of the body far away from the heart. In an example from the past, the dinosaur *Brachiosaurus* had to pump blood more than 6 m from the heart to the head!

Feeding and digestion The organs of the digestive system of reptiles, shown in **Figure 4**, are similar to those of fish and amphibians. Reptiles have a variety of feeding methods and diets. Most reptiles are carnivores, but some, such as iguanas and tortoises, are herbivores that feed on plants, and some turtles are omnivores. Turtles and crocodiles have tongues that help them swallow. Some lizards, such as chameleons, have long, sticky tongues for catching insects.

Snakes have the ability to ingest prey much larger than themselves. The bones of the skull and jaws of snakes are joined loosely so that they can spread apart when taking in large food materials, as shown in **Figure 5**. To swallow, the opposite sides of the upper and lower jaws can alternately thrust forward and retract to draw in the food. Some snakes have venom that can paralyze and begin digestion of their prey.


Excretion The excretory system of reptiles is adapted to life on land. The kidneys, such as the one shown in **Figure 4**, filter the blood to remove waste products. When urine enters the cloaca, water is reabsorbed to form uric acid, which is a semisolid excretion. This method of water reabsorption enables reptiles to conserve water and maintain homeostasis of water and minerals in their bodies.

The brain and senses Reptile brains are similar to amphibian brains, except that the cerebrums of reptiles are larger. Because vision and muscle function are more complex, the optic lobes and cerebellum portions in the brains of reptiles are larger than those of amphibians. Vision is the most sensitive sense for most reptiles, and some reptiles even have color vision. Hearing varies in reptiles. Some reptiles have tympanic membranes similar to those of amphibians, while others, such as snakes, detect vibrations through their jaw bones.

The sense of smell is more highly evolved in reptiles than it is in amphibians. You might have seen a snake rapidly flicking its forked tongue. When a snake sticks its tongue out, odor molecules stick to it. The snake then brings the tongue and the odor molecules into its mouth. Inside the mouth, the odor molecules transfer to a pair of saclike structures that sense odors called **Jacobson's organs**. **Figure 6** shows one of these structures. Without Jacobson's organs, snakes would not be able to find prey or mates.

Temperature control Like amphibians, reptiles are ectotherms that cannot generate their own body heat. Because they cannot regulate their body temperatures internally, they must regulate them behaviorally. You might have seen a turtle basking on a rock on a sunny day. Heat from the Sun and the rock raise the turtle's body temperature. Body temperature can be lowered by moving into the shade or a cool burrow. Some reptiles in temperate regions survive winter by burrowing or going into a state of inactivity with lower body metabolism and lower body temperature. Others, such as some snakes, gather together in masses of hundreds during the winter. Heat loss is reduced when the snakes are covering each other.

Movement Compare the leg position of the salamander to the leg position of the crocodile shown in **Figure 7**. Note that the salamander's belly is on the ground, while the crocodile's belly is above the ground. Like amphibians, some reptiles move with limbs sprawled to their sides and push against the ground while swinging their bodies from side to side. Crocodiles, however, have their limbs rotated farther under the body and, as a result, can bear more weight and move faster. To bear more body weight on land, reptiles' skeletons are stronger, with a heavier bone structure. Reptiles also have claws on their toes, which aid in digging, climbing, and gripping the ground for traction.

 **Reading Check Compare and contrast** the brain and senses of reptiles to amphibians.

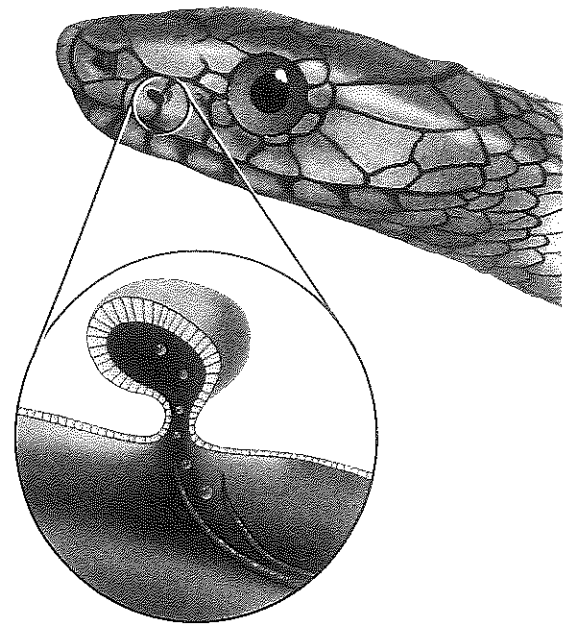
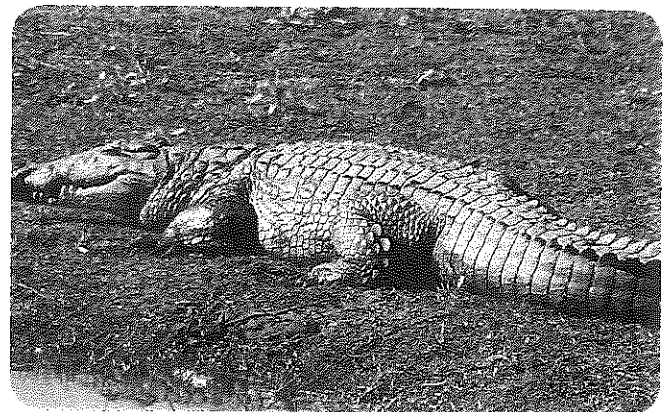


Figure 6 In snakes, Jacobson's organs in the mouth are used to sense odors.

Figure 7 Salamanders move with splayed legs pushing against the ground as their bodies drag along. Crocodiles have legs that are rotated underneath their bodies and hold their bodies off the ground.



Salamander



Crocodile



VOCABULARY

WORD ORIGIN

Squamata

squama- from Latin, meaning *scale*
-ata from Latin, meaning *to bear*

Reproduction Recall that amphibian females lay eggs that are later fertilized. Reptile reproduction is significantly different, mainly because reptiles have internal fertilization. After fertilization, an amniotic egg and embryo develop. The yolk of the egg nourishes the embryo. The female reproductive system then produces a leathery shell around the egg. The female usually digs a hole and lays her eggs in the ground or in plant debris. After laying the eggs, most female reptiles leave them unattended to hatch. Alligators and crocodiles build a nest in which to lay eggs and tend to the young after they hatch. Some snakes and lizards keep their eggs in their bodies until they hatch. In this way, the eggs are protected in the mother's body until they are fully developed young.

Diversity of Modern Reptiles

There are currently four living orders of reptiles—snakes and lizards, belonging to order Squamata (skwuh MAHD uh); crocodiles and alligators, belonging to order Crocodylia; turtles and tortoises, belonging to order Testudinata; and tuataras (tyew ah TAR ahz), belonging to order Sphenodonta (sfee nuh DAWN tuh).

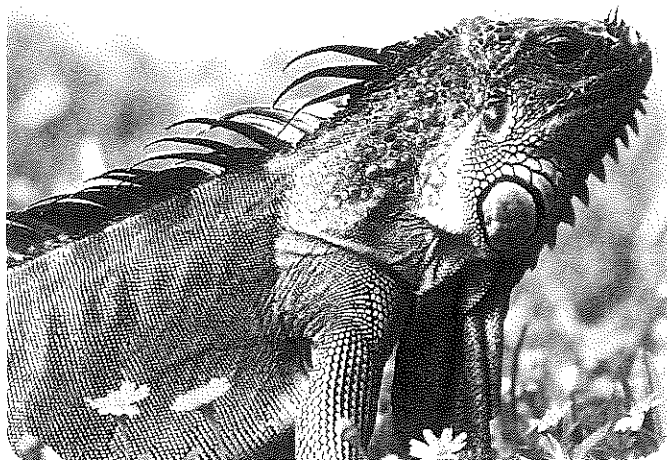
Lizards and snakes Lizards commonly have legs with clawed toes. They usually have movable eyelids, a lower jaw with a movable hinge joint allowing for flexibility in jaw movement, and tympanic membranes. Common lizards include iguanas, chameleons, geckos, and anoles. An iguana is shown in **Figure 8**.

Snakes are legless and have shorter tails than lizards do. Snakes lack movable eyelids and tympanic membranes. Like lizards, however, snakes have joints in their jaws enabling them to eat prey larger than their heads. Some snakes, such as the rattlesnake shown at the beginning of the chapter, have venom that can slow down or even kill their prey. Other snakes, such as the python shown in **Figure 8**, anacondas, and boas, are constrictors. Constrictors generally are very large snakes. They suffocate their prey by wrapping around the prey's body and tightening until the prey dies because it no longer can breathe.

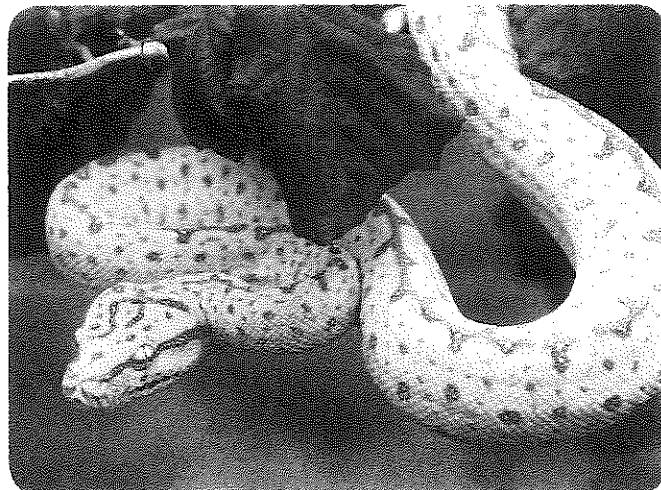


Reading Check Describe the different methods by which snakes capture prey.

✳ **Figure 8** The green iguana and the green tree python are both members of order Squamata.

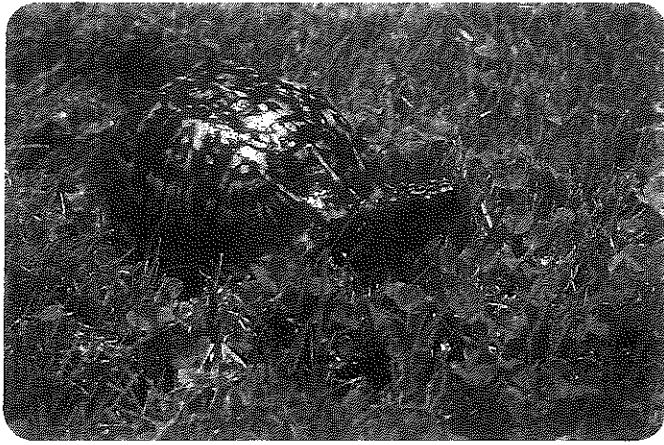


Green iguana

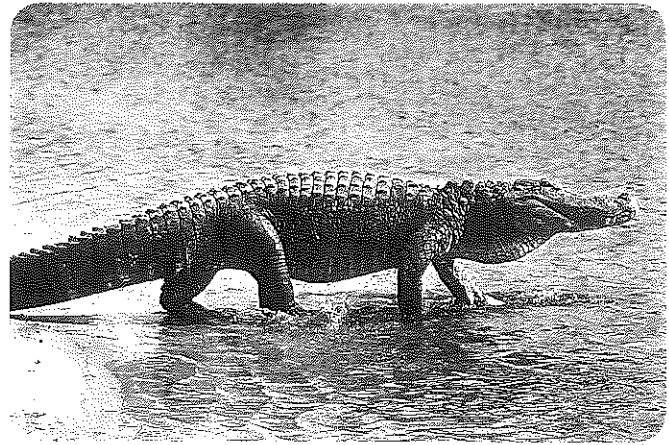


Green tree python





Eastern box turtle



American alligator

Turtles Turtles are unique because they are encased by a protective shell, as shown in **Figure 9**. A turtle can hide from predators by pulling its head and legs inside this hard shell. The ventral part of the shell is called the **plastron** (PLAS trahn), and the dorsal part of the shell is called the **carapace** (KAR ah pays). The vertebrae and the ribs of most turtles are fused to the inside of the carapace. Another unique aspect of turtles is that they do not have teeth. Instead, they have a sharp beak that can deliver a powerful bite. Like other reptiles, there are aquatic turtles and terrestrial turtles. Turtles that live on land are called tortoises.

Crocodiles and alligators Order Crocodylia includes crocodiles, alligators, and caimans. Unlike most reptiles, crocodylians have a four-chambered heart. Because a four-chambered heart can deliver oxygen more efficiently to their powerful muscles, crocodylians move quickly and aggressively, both in and out of the water. These quick movements help in capturing large prey.

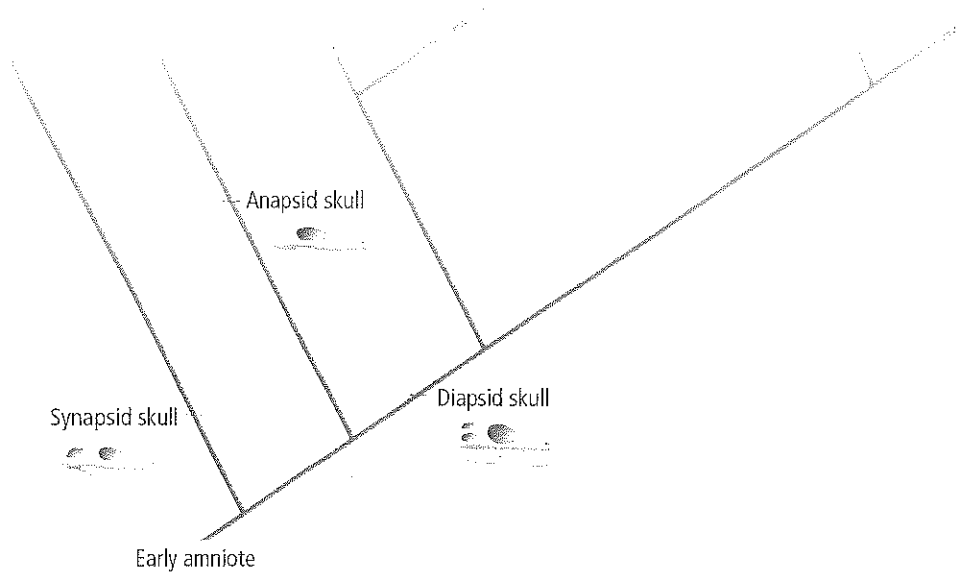
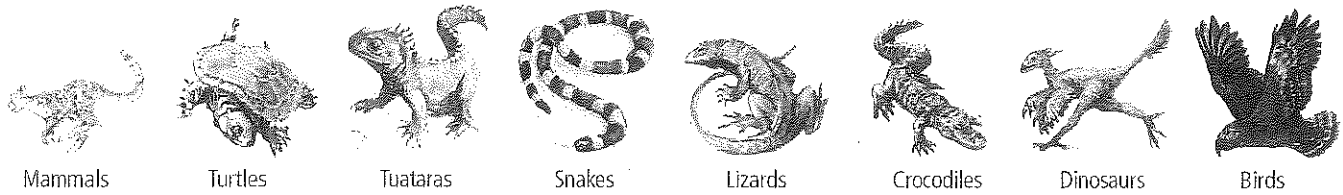
Crocodiles have a long snout, sharp teeth, and powerful jaws. Alligators, like the one in **Figure 9**, generally have a broader snout than crocodiles do. The upper jaw of an alligator is wider than the lower jaw. When an alligator closes its mouth, the upper jaw overlaps the lower jaw and its teeth are almost completely covered. The upper and lower jaws of a crocodile are about the same width. When a crocodile closes its mouth, some teeth in the lower jaw are easily visible. Caimans are closely related to alligators but lack a bony separation between their nostrils. The teeth of crocodiles are similar to those of dinosaurs and the earliest birds.

Tuataras Tuataras look like large lizards, as shown in **Figure 10**. Tuataras have a spiny crest that runs down the back and a “third eye” on top of the head. This structure is covered with scales but can sense sunlight. Biologists think that it might keep the tuatara from overheating in the Sun. One distinguishing feature of tuataras is that they have unique teeth compared to those of other reptiles. Two rows of teeth on the upper jaw shear against one row in the lower jaw, making them effective predators of small vertebrates. The only two living species of tuataras are found exclusively on islands off the coast of New Zealand.

• **Figure 9** The shell of a turtle helps protect it from predators. An alligator has a broad snout and thick scales covering its body.

• **Figure 10** Tuataras reach a length of about 2 m and can live up to 80 years in the wild.





◀ **Figure 11** The cladogram shows one interpretation of the relationships between amniotes.

Interpret Which modern reptiles evolved first? Which evolved most recently?

VOCABULARY

ACADEMIC VOCABULARY

Interpretation

a particular adaptation or version of a work, method, or style
Scientists might make several interpretations of fossil evidence.

Evolution of Reptiles

The cladogram in **Figure 11** shows one interpretation of how early amniotes underwent adaptive radiation, giving rise to reptiles as well as modern birds and mammals. Recall that amniotes are vertebrates in which the embryo is encased in an amniotic membrane. As shown in the cladogram, early amniotes separated into three lines, each having a different skull structure. Anapsids, which might have given rise to turtles, have a skull that has no openings behind the eye sockets. Diapsids, which gave rise to crocodiles, dinosaurs, modern birds, tuataras, snakes, and lizards, have a skull with two pairs of openings behind each eye socket. Synapsids, which gave rise to modern mammals, have one opening behind each eye socket.

Reading Check **Identify** which part of a reptile fossil would be a major indicator in classifying it as a lizard or a turtle.

Dinosaurs For 165 million years, dinosaurs dominated Earth. Some, such as *Tyrannosaurus rex*, stood almost 6 m high, were 14.5 m long, weighed more than 7 tonnes, and were predatory. Others, such as *Triceratops*, had massive horns and were herbivores. Despite their diversity, dinosaurs can be divided into two groups based on the structure of their hips. A comparison of the two groups is shown in **Figure 12**. Saurischians (saw RISK ee unz) had hip bones that radiated out from the center of the hip area. In Ornithischians, some bones projected back toward the tail.

Like birds and crocodiles, some dinosaurs built nests and cared for eggs and young. Some dinosaurs might have had the ability to regulate their body temperatures. Fossil evidence shows that one group of dinosaurs had feathers and likely evolved into today's birds.



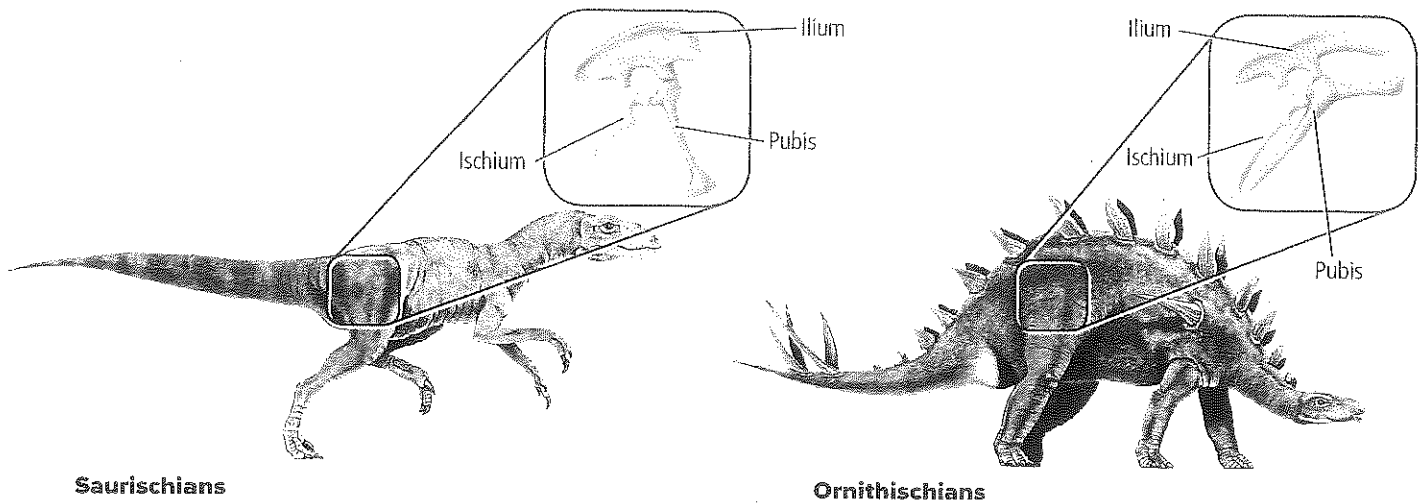


Figure 12 Saurischians had a hip bone that pointed forward. Ornithischians had the same bone pointing back toward the tail end of the animal.

Connection to Earth Science The Cretaceous period is known for worldwide mass extinction of many species, including all dinosaurs. Some scientists hypothesize that a meteorite crashed into Earth and caused this extinction. Clouds of dust might have blocked the Sun, causing a much cooler climate to develop. This change, along with fires, toxic dust, and gases, could have caused the death of many plants and animals at this time. When dinosaurs disappeared, the niches that they had occupied were made available for other vertebrates to evolve and fill.

DATA ANALYSIS LAB 1

Based on Real Data*

Interpret the Data

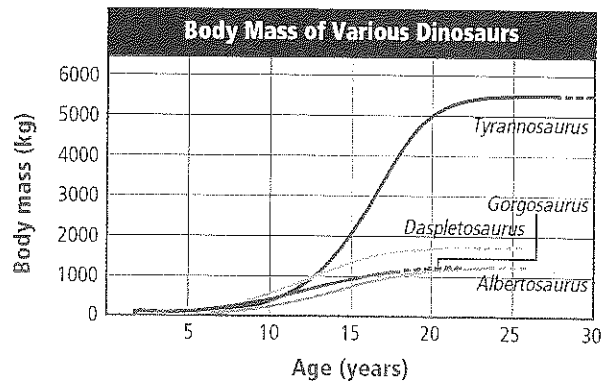
How fast did dinosaurs grow? Scientists study thin sections of fossilized bone tissue to determine how rapidly the bone grew. By studying how quickly dinosaurs grew, scientists have learned about their populations and ecology.

Think Critically

- Compare** During what age span did the dinosaurs experience the greatest growth? Explain.
- Analyze Data** Which dinosaur grew at the slowest rate? The fastest rate?
- Infer** Fast-growing bones have many blood vessels. How would the bones of *Tyrannosaurus* compare to those of *Daspletosaurus*?

Data and Observations

The graph shows bone-based growth curves comparing several dinosaurs.



*Data obtained from: Stokstad, E. 2004. Dinosaurs under the knife. *Science* 306: 962-965.



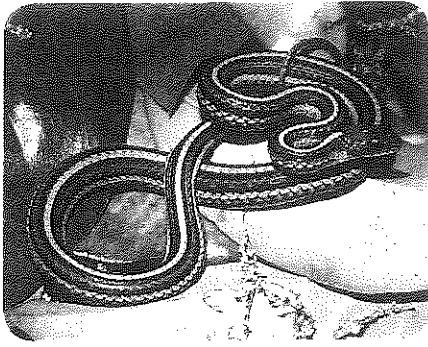


Figure 13 The San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) lives in wetlands or grasslands near ponds and marshes.

Ecology of Reptiles

Reptiles are important parts of food chains both as prey and as predators. The balance of an ecosystem can be disrupted when a reptile species is removed. For example, when certain snakes are removed from an environment, rodent populations can increase. Loss of habitat and the introduction of exotic species are factors that contribute to the decline in populations of some reptile species.

Habitat loss Both the American alligator (*Alligator mississippiensis*) and the American crocodile (*Crocodylus acutus*) have been affected by habitat loss in the Florida Everglades. The destruction and fragmentation of wetlands for building development has led to reduced numbers of these reptiles. The American crocodile remains endangered, with only 500-1200 remaining in Florida. With the passage of laws to protect wetlands in certain areas, the American alligator population has rebounded enough so that its status has been changed from endangered to threatened.

Introduction of exotic species An exotic species is a species that is not naturally found in an area, and when introduced, the local animals might suffer due to predation or competition for resources. For example, when the mongoose, a small mammal, was introduced into Jamaica to kill rats in sugarcane fields, the mongoose fed on several lizard species, which are now endangered. This includes the Jamaican iguana, which was thought to have become extinct due to the introduction of the mongoose. In 1990, a small population of the iguanas was discovered in a remote area of Jamaica.

Some species, such as the San Francisco garter snake shown in **Figure 13**, have suffered a population decline due to both habitat loss and the introduction of exotic species. The use of land for building and agriculture has led to habitat loss for this snake. The American bullfrog, which is not native to California, eats both the garter snake and the red-legged frog, a food source of the garter snake.

Section 1 Assessment

Section Summary

- Reptiles have several types of adaptations for life on land.
- Eggs of reptiles are adapted to development on land.
- Reptiles belong to four living orders: Squamata, Crocrodilia, Testudinata, and Sphenodonta.
- Modern reptiles evolved from early amniotes. Many ancient reptiles, including dinosaurs, became extinct.

Understand Main Ideas

1. **Identify** features that allow reptiles to live on land successfully.
2. **Describe** the parts of an amniotic egg. How did this structure allow reptiles to move to land?
3. **Compare and contrast** members of order Squamata with members of order Sphenodonta.
4. **Explain** the differences among anapsids, diapsids, and synapsids. Which gave rise to groups of reptiles?

Think Critically

5. **Formulate Models** Make a model of the amniotic egg shown in **Figure 2**. Relate the function of each membrane.

MATHEMATICS Biology

6. The biting force of alligators is directly proportional to their lengths. An alligator that is 1 m long has a biting force of 2653 N. What is the biting force of a larger alligator that is 3.6 m long?



Section 2

Reading Preview

Essential Questions

- What are the characteristics of birds?
- How are the adaptations of birds related to their ability to fly?
- What are the characteristics of the different orders of birds?

Review Vocabulary

terrestrial: living on or in land

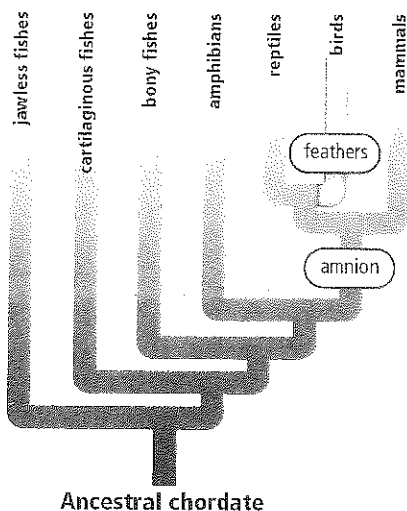
New Vocabulary

endotherm
feather
contour feather
preen gland
down feather
sternum
air sac
incubate



Multilingual eGlossary

Figure 14 The evolutionary tree shows that feathers are a unique characteristic of birds.



Birds

Key Idea Birds have feathers, wings, lightweight bones, and other adaptations that allow for flight.

Real-World Reading Link You probably have heard the sayings: “Free as a bird,” “Birds of a feather flock together,” or “Light as a feather.” As people talk, listen for “bird words.” As you read, see if these sayings refer to real science.

Characteristics of Birds

Suppose your teacher asked you to describe a bird. You might respond that birds have feathers and that they fly. Birds belong to class Aves and include about 8600 species, making them the most diverse of all terrestrial vertebrates. Birds range in size from tiny hummingbirds hovering over bright flowers to large flightless ostriches running across the African plains. Birds are found in deserts, forests, mountains, prairies, and on all seas.

As shown on the evolutionary tree in **Figure 14**, birds and reptiles have a common ancestor. Birds have many characteristics that demonstrate their reptilian roots. For example, birds lay amniotic eggs. In addition, scales similar to those of reptiles cover the legs of birds.

You can think of a bird as a collection of adaptations to a lifestyle that includes flight. The adaptations include being able to generate their own body heat internally, feathers, and lightweight bones. The respiratory and circulatory systems of birds are also adapted to provide more oxygen to working muscles to support flight.

Endotherms Unlike reptiles, birds are endotherms. An **endotherm** is an organism that generates its body heat internally by its own metabolism. The high metabolic rate associated with endothermy generates a large amount of ATP that can be used to power flight muscles or for other purposes. Endotherms generate heat from their normal body metabolism. The body temperature of a bird is about 41°C. Your body temperature is about 37°C. A high body temperature enables the cells in a bird’s flight muscles to use the large amounts of ATP needed for rapid muscle contraction during flight.

Reading Check **Explain** why endothermy is an important adaptation for flight.

Feathers Birds are the only living animals to have feathers. **Feathers** are specialized outgrowths of the skin of birds. They are made of keratin (KER ah tihñ), a protein in the skin that also makes up hair, nails, and horns of other animals. Feathers have two main functions: flight and insulation. Feathers keep heat generated during metabolism from escaping from the body of the bird. When a bird fluffs its feathers, it creates a dead air space that traps the heat. Similarly, if you are covered with a quilt while you sleep, the quilt creates dead air space between you and the cool air in the room so that you do not lose body heat.



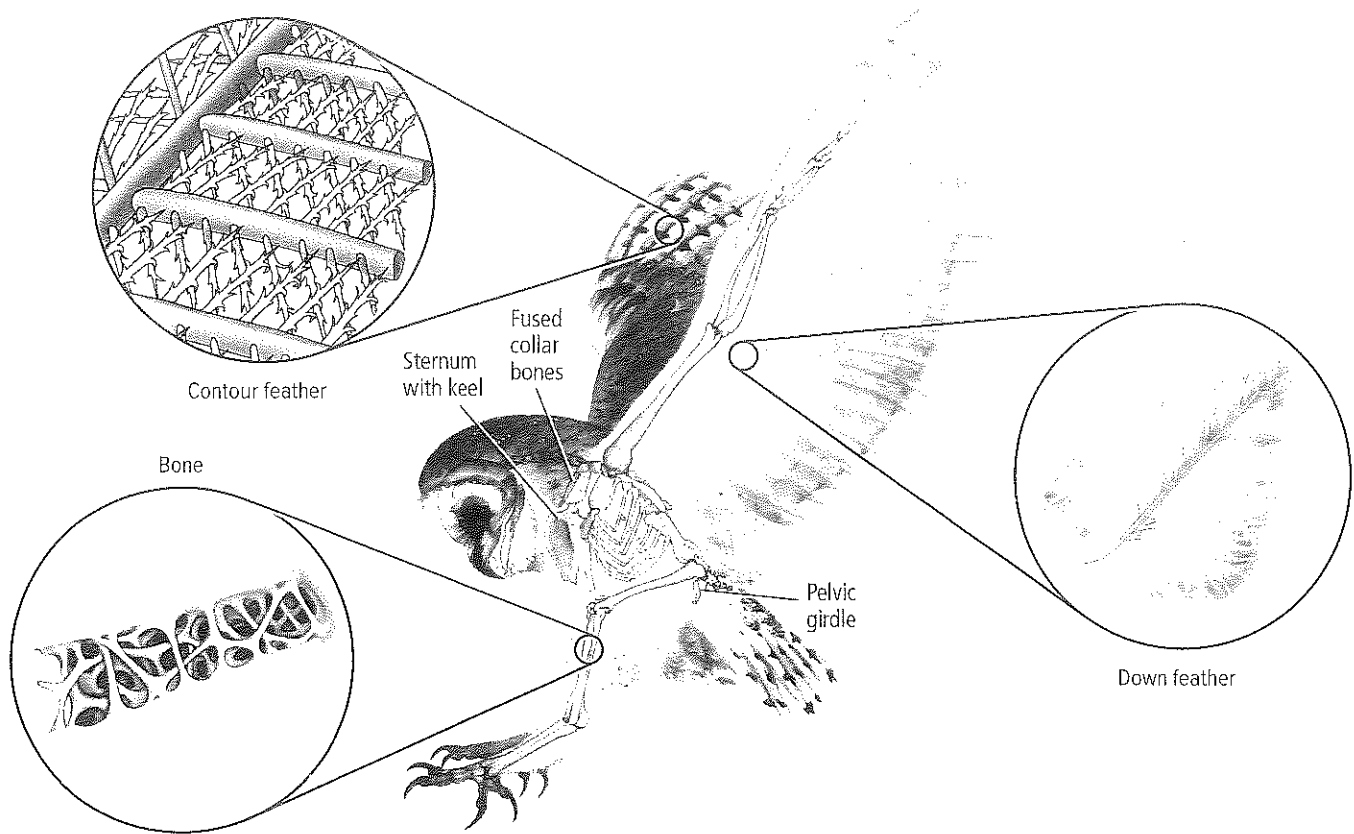


Figure 15 Birds have contour feathers, down feathers, and lightweight bones.



Animation

VOCABULARY

SCIENCE USAGE / COMMON USAGE

Preen

Science usage: to maintain or repair using a bill (of a bird)

The bluejay was preening its feathers before it flew away.

Common usage: to gloat or congratulate oneself on an achievement

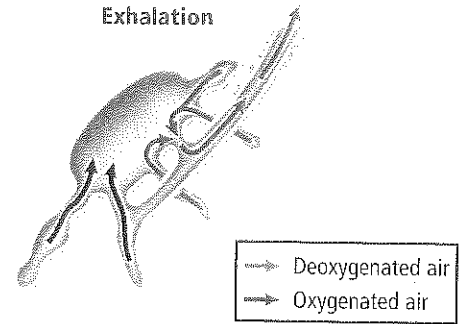
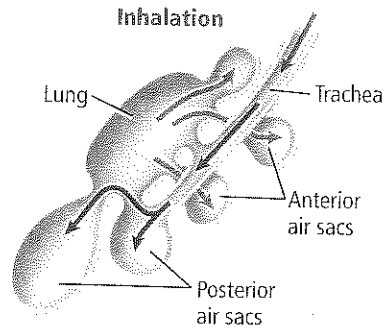
Jim was preening over his victory at the track meet.

Feathers that cover the body, wings, and tail of a bird are called **contour feathers**. Examine the contour feathers shown in **Figure 15**. A contour feather consists of a shaft with barbs that branch off. Barbules branch off barbs and are held together by hooks. If two adjoining barbs become separated, they can be rejoined like the teeth of a zipper. Birds repair broken links when they preen their feathers. They use their bills to preen their feathers, drawing the length of the feather through the bill to zip up broken links. Birds spend a large amount of time maintaining their feathers. Many birds have a **preen gland**, a gland located near the base of the tail that secretes oil. During preening, birds spread oil from the preen gland over their feathers, thereby adding a waterproofing coating. **Down feathers**, shown in **Figure 15**, are soft feathers located beneath contour feathers. Down feathers do not have hooks to hold barbs together. As a result, the looser structure of down feathers can trap air that acts as insulation.

Lightweight bones Another adaptation of birds that allows flight is their strong, lightweight skeletons. The bones of birds are unique because they contain cavities of air. **Figure 15** shows the internal structure of a bird bone. Despite the fact that the bones are filled with air, they are still strong.

Have you ever found the wishbone in a piece of chicken or turkey? The wishbone is formed from fused collarbones, as shown in **Figure 15**. Fusion of bones in the skeleton of a bird makes the skeleton sturdier, another adaptation for flight. Large breast muscles, which can make up 30 percent of a bird's total weight, provide the power for flight. These muscles connect the wing to the breastbone, called the **sternum** (STUR num), also shown in **Figure 15**. The sternum is large and has a keel to which the muscles attach.

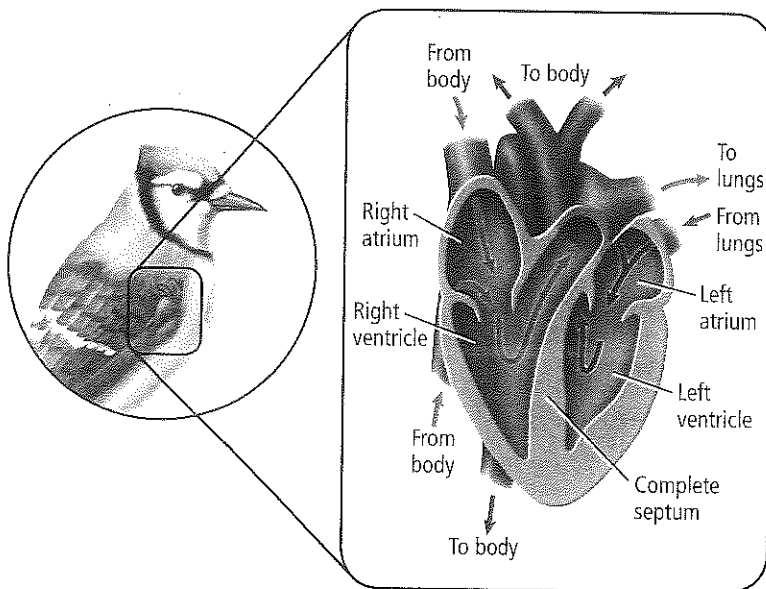




• **Figure 16** When a bird breathes, air always flows in a single direction, and highly efficient gas exchange can be achieved.

Respiration Flight muscles use a large amount of oxygen, and the respiratory systems of birds are well-adapted to provide it. Not only do birds have much more space for air in their respiratory system than reptiles, but birds also have one-way air circulation. When a bird inhales, oxygenated air moves through the trachea into posterior **air sacs**, shown in **Figure 16**. Other air already within the respiratory system is drawn out of the lungs, where gas exchange occurs, and into the anterior air sacs. When a bird exhales, the deoxygenated air in the anterior air sacs is expelled from the respiratory system and oxygenated air from the posterior air sacs is sent to the lungs. The net result is that only oxygenated air is moved through the lungs, and it is moved in a single direction relative to blood flow.

Circulation A bird's circulatory system also helps it maintain high levels of energy by efficient delivery of oxygenated blood to the body. Recall that crocodiles are the only reptiles to have a heart ventricle completely divided by a septum. Birds also have a four-chambered heart, as shown in **Figure 17**. Having two ventricles keeps the oxygenated and deoxygenated blood separated and makes delivery of oxygenated blood more efficient. The left atrium receives blood from the lungs. This blood is pumped into the left ventricle and out to the body. Blood returning from the body is delivered to the right atrium, then moves into the right ventricle and on to the lungs, where it will pick up more oxygen.



• **Figure 17** Birds have a four-chambered heart that keeps oxygenated and deoxygenated blood separate.

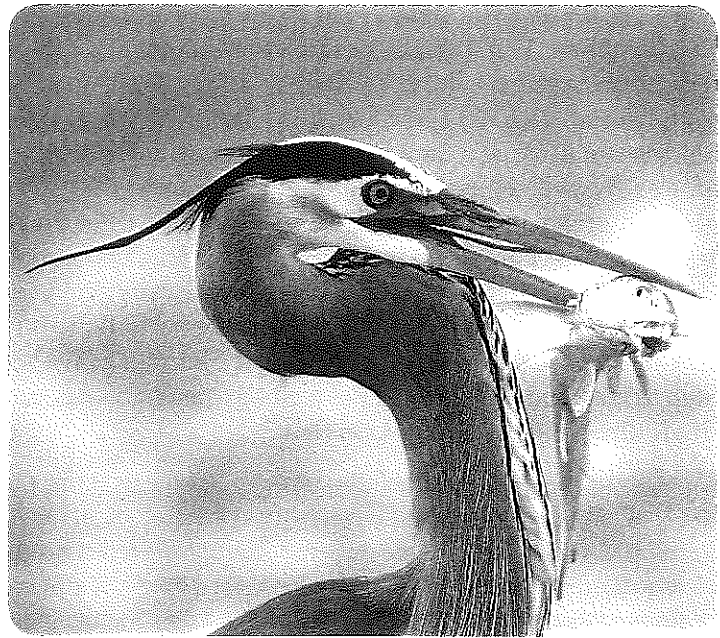
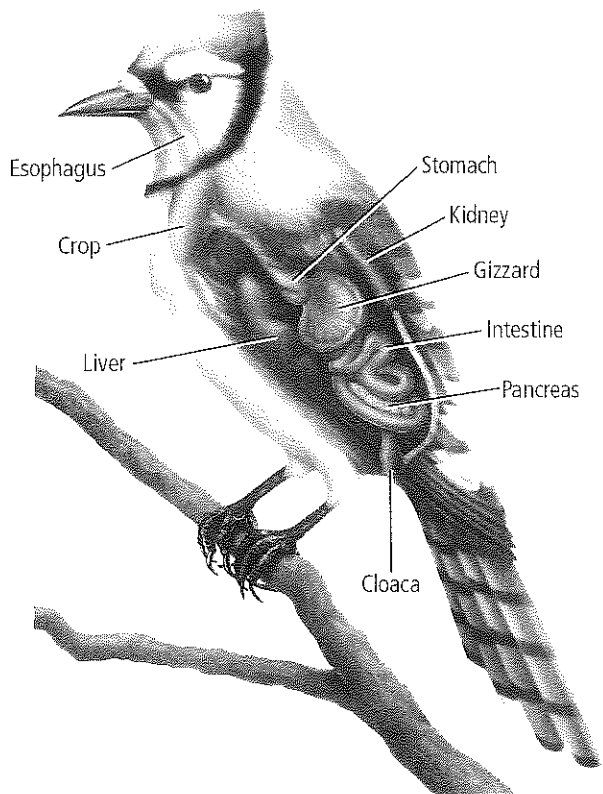
Compare the heart of a bird to that of the reptile shown in Figure 4.



Visualizing Feeding and Digestion

Figure 18

Examine the organs in the digestive system of a bird. Aside from having unique adaptations to their digestive systems, birds have beaks that are adapted to the type of food they eat.



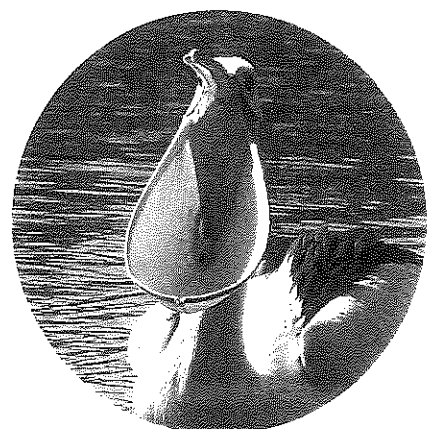
Hérons use their long, thin, sharp bills to stab and capture fish and small amphibians as prey.



Hummingbirds have long, thin beaks shaped for drinking nectar from flowers.



An eagle uses its sharp beak to tear flesh from its prey.



A pelican uses its beak to scoop fish out of the water.



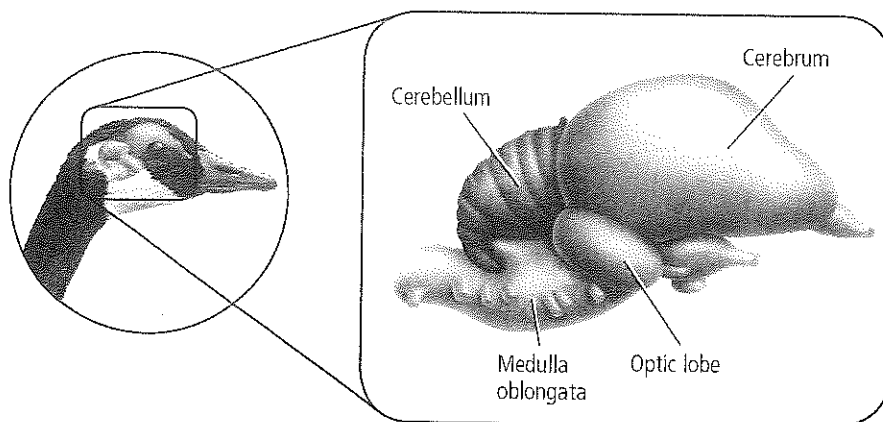
Animation

Feeding and digestion Birds require large amounts of food to maintain their high metabolic rate. Once they have taken in food, birds process it with unique adaptations of their digestive systems, shown in **Figure 18**. Many birds have a storage chamber, called the crop, at the base of their esophagus. The crop stores food that the bird is ingesting. From the crop, food moves to the stomach. The posterior end of the stomach is a thick, muscular sac called the gizzard (GIH zurd). The gizzard often contains small stones that, together with the muscular action of the gizzard, crush food the birds have swallowed. The smaller food particles that result are easier to digest. Birds have no teeth and cannot chew their food. Digestion and absorption of food occurs primarily in the small intestine, where secretions from the pancreas and liver aid the digestive process.

Excretion As in reptiles, bird kidneys filter wastes from the blood and convert it to uric acid. Birds also have a cloaca, shown in **Figure 18**, where the water is reabsorbed from the uric acid. Birds do not have urinary bladders to store urine. Stored urine would add weight during flight, so having no urinary bladder can be considered an adaptation for flight. Birds excrete uric acid in the form of a white, pasty substance.

The brain and senses The brain of a bird, shown in **Figure 19**, is large compared to the body size of the bird. The cerebellum is large because birds need to coordinate movement and balance during flight. The optic lobes coordinate visual input. The core of the cerebrum also is large because it is the primary integrating center of the brain. This area of the brain controls eating, singing, flying, and instinctive behavior. The medulla oblongata controls automatic functions such as respiration and heartbeat.

Birds generally have excellent vision. Birds of prey, such as the hawk shown in **Figure 19**, have a focusing system that instantaneously enables them to stay focused on moving prey as they make a dive for their food. The position of a bird's eyes on its head relates to its life habits. Birds of prey have eyes that are at the front of the head. This enables them to recognize the distance of an object because both eyes can focus on the object. A pigeon has eyes on the sides of its head. This enables the bird to see nearly 360 degrees of the space nearby, with each eye focusing on different areas. A pigeon eats grain and seeds and does not pursue prey. Its eyesight is adapted to scout out predators that might be nearby. Birds also have a good sense of hearing. Owls can hear the faintest sound of a scurrying mouse in the night. Even as the mouse runs for cover, the owl can catch it by following just the sound.



FOLDABLES

Incorporate information from this section into your Foldable.



Launch Lab

Review Based on what you have read about reptiles and birds, how would you now answer the analysis questions?

Figure 19

Left: Birds have large cerebellums that enable them to balance and coordinate movements. The medulla oblongata controls automatic processes. **Right:** A hawk's eyes stay focused on moving prey as it dives.



Reproduction The reproductive activities of birds are complex. They include establishing territories, locating mates, courtship behavior, mating, constructing nests, incubating eggs, and feeding young. During breeding season, many birds gather in large colonies where they breed and take care of young. All birds have internal fertilization. Generally, after fertilization, the amniotic egg develops and is encased within a hard shell while still within the body of the female. After the shell forms, the egg or eggs are released through the cloaca to a nest, where the male or female or both birds incubate the egg or eggs and feed the young after hatching. To **incubate** means to maintain favorable conditions for hatching. Birds sit on their eggs to incubate them.

Diversity of Modern Birds

Modern birds are divided into about 27 orders, depending on the classification system used. Anatomical differences, specific behaviors, songs, and the habitats occupied distinguish the orders. In **Table 1**, you will study the most common orders of birds and their adaptations. The largest order of birds is the Passeriformes, which often are called perching birds or songbirds. There are more than 5000 species in order Passeriformes. Flightless birds, including ostriches, emus, and kiwis, have reduced or no wings. The kiwi, a bird about the size of a chicken found in New Zealand, lays an egg that is extremely large given the size of the bird. Some birds, such as penguins, geese, and ducks, have adaptations that allow them to swim. Penguins use their wings as paddles to swim through the water. Ducks and geese have webbed feet.

Mini Lab 1

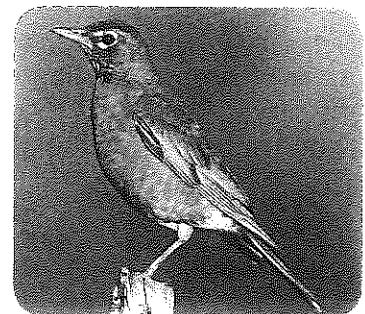
Survey Local Birds



What birds live in your local area? A variety of birds can be found in almost any environment. Explore the area around your school to survey the different birds that live there.

Procedure

1. Read and complete the lab safety form.
2. Predict the number of different kinds of birds you can observe in the area around your school. Make a data table to keep track of birds that you observe.
3. Go for a 10-min walk in the area near your school. Be sure to follow your teacher's instructions about where you are allowed to go. Record information about the birds that you observe. Use **binoculars** if necessary. If you cannot identify a bird, use a **field guide** for local birds.
4. Compile your findings as a class. Research information about the birds that you observed.








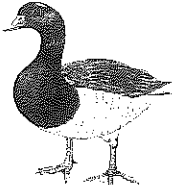


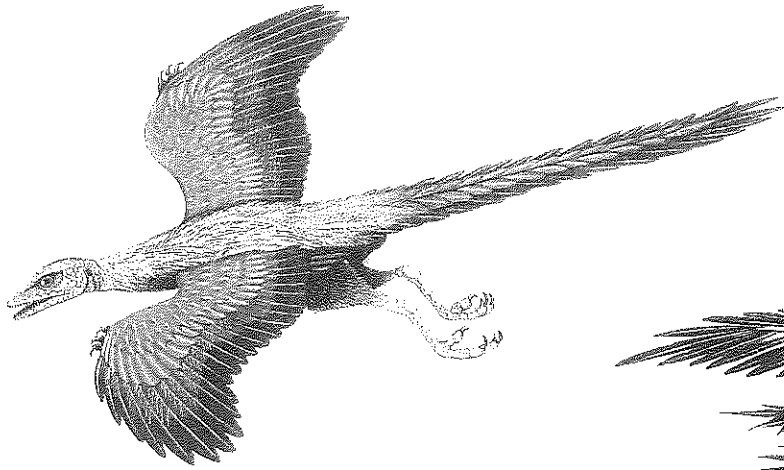
Analysis

1. **Count** the number of bird species that you observed. List the types of birds that you observed.
2. **Identify** Were the birds you saw native to your area or have they been introduced?
3. **Analyze** whether any patterns emerged as you compiled the data.
4. **Predict** Would this list differ if you surveyed the area around your home? If so, how?

Table 1**Diversity of Bird Orders**

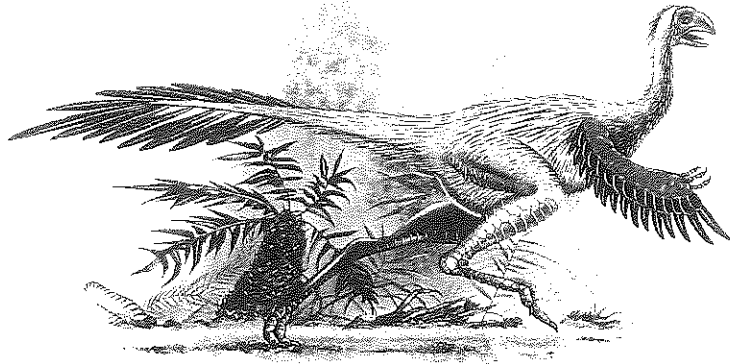
Interactive Table

Order	Example	Members	Distinguishing Characteristics
<i>Passeriformes</i> Perching song-birds; about 5000 species		Thrushes, warblers, mockingbirds, crows, blue jays, nuthatches, finches	Members of this order have feet that are adapted to perching on thin stems and twigs. Many birds in this order sing. The vocal organ, called the syrinx, is well-developed in these birds. Other species, such as crows and ravens, do not sing.
<i>Piciformes</i> Cavity-nesters; about 380 species		Woodpeckers, toucans, honeyguides, jacamars, puffbirds	Members of this order have highly specialized bills that are related to their feeding habits. They all build nests in cavities—for example, a hole in a dead tree. The feet have two toes that extend forward and two toes that extend backward, allowing them to cling to tree trunks.
<i>Ciconiiformes</i> Wading birds and vultures; about 90 species		Herons, egrets, bitterns, storks, flamingoes, ibises, vultures	Members of this order are medium- to large-sized birds that have long necks and long legs. Most are wading birds that live in large colonies in wetlands. Vultures are closely related to storks but are detritivores.
<i>Procellariiformes</i> Marine birds; about 100 species		Albatrosses, petrels, shearwaters, storm-petrels	All members of this order are marine birds. They have hooked beaks that aid in feeding on fish, squid, and small crustaceans. They all have tube-shaped nostrils located on the top of their beaks. Many have webbed feet.
<i>Sphenisciformes</i> Penguins; about 17 species		Penguins	Penguins are marine birds that use their wings as flippers to swim through the water rather than fly. The bones of penguins are solid, lacking the air spaces of other birds. All species are found in the southern hemisphere.
<i>Strigiformes</i> Owls; about 135 species		Owls	Owls are nocturnal birds with large eyes, strong, hooked beaks, and large, sharp talons on their feet. All of these adaptations aid in capturing prey. Many species have feathers on their legs. Owls are found worldwide except for Antarctica.
<i>Struthioniformes</i> Flightless birds; 10 species		Ostriches, kiwis, cassowaries, emus, rheas	All members of this order have reduced wings and are flightless birds. The ostrich is the largest living bird, reaching a height of more than 2 m and a weight of 130 kg. All species are found in the southern hemisphere.
<i>Anseriformes</i> Waterfowl; about 150 species		Swans, geese, ducks	Members of this order live in aquatic environments. They have webbed feet that aid in moving them through the water. Many have broad, round beaks. They feed on aquatic plants and sometimes crustaceans or small fish.



Archaeopteryx

Figure 20 *Archaeopteryx* had a long, reptilelike tail, clawed fingers, teeth, and feathers. This artist's rendering of *Caudipteryx* shows long feathers that might have been used for insulation and balance.



Caudipteryx

Evolution of Birds

Fossil evidence shows that birds descended from archosaurs, the same line from which crocodiles and dinosaurs evolved, as you saw in **Figure 11**. Similarities between birds and reptiles are apparent. They have similar skeletal features, kidney and liver function, amniotic eggs, and behaviors such as nesting and caring for young.

Feathered dinosaurs Three different species of birdlike dinosaurs from Chinese fossil beds have been carefully studied. *Sinosauropteryx* had a coat of downy, featherlike fibers. *Protoarchaeopteryx* and *Caudipteryx*, illustrated in **Figure 20**, had long feathers on their front appendages and on their tails. The downy dinosaur feathers might have functioned as insulation, and the front appendage feathers might have served as balancing devices as the dinosaurs ran along the ground.

Connection to History In 1861, in southern Germany, paleontologist Hermann von Meyer discovered what is now known to be the oldest bird fossil—*Archaeopteryx*. *Archaeopteryx*, illustrated in **Figure 20**, lived about 150 million years ago. This ancient bird had a long reptilelike tail, clawed fingers in the wings, and teeth. These are features that modern birds do not have. Yet, like modern birds, its body was covered with feathers. The feathers were asymmetrical, like those found only in modern birds that fly. Recent fossil evidence also shows that the brain of *Archeopteryx* was much like that of modern birds.

Recent discoveries In 2006, a new fossil bird, *Gansus yumenensis*, was discovered. It lived 110 mya and might be the link between *Archaeopteryx* and modern birds. *Gansus* had webbed feet, leading some scientists to think that modern birds evolved from aquatic birds. Scientists say that *Gansus* likely would have looked a lot like a modern duck.

CAREERS IN BIOLOGY

Paleontologist Scientists who learn more about the history of life on Earth by studying fossils are paleontologists. Many paleontologists teach at colleges and conduct research in the field by uncovering fossils. Some work at museums, managing fossil exhibits.

Ecology of Birds

Birds are important parts of food chains as predators of small mammals, arthropods, and other invertebrates. For example, you probably have seen a robin pulling a worm out of the ground. Birds are also important parts of food chains and food webs as prey of larger birds and mammals.

Birds play an important role in the dispersal of seeds. Birds eat seeds or fruits and berries, and, after digestion, eliminate them in a different location. Seeds also get caught on the feathers and drop off as birds move from one location to another. Some birds, such as hummingbirds, feed on the nectar of flowers and pollinate the flowers as they feed.

Habitat destruction Many birds are threatened with extinction as the habitat they require either disappears or is degraded by pesticides and other chemical pollutants. Waterfowl populations depend on wetlands—a habitat that is disappearing rapidly as wetlands are drained for development. Deforestation of tropical rain forests has also led to some species of birds being endangered.

Illegal trade Illegal pet-bird trade is increasing. Many pet birds are raised in captivity, but other exotic birds are taken from the wild in a multibillion dollar industry. In some cases, illegal capture has led to the disappearance of rare birds in the wild. The little blue macaw, shown in **Figure 21**, exists only in captivity. An international trade agreement was enacted in 1975 to ensure that the buying and selling of wild animals does not endanger their survival. Currently, 160 countries participate in the agreement; however, illegal wildlife trade continues.

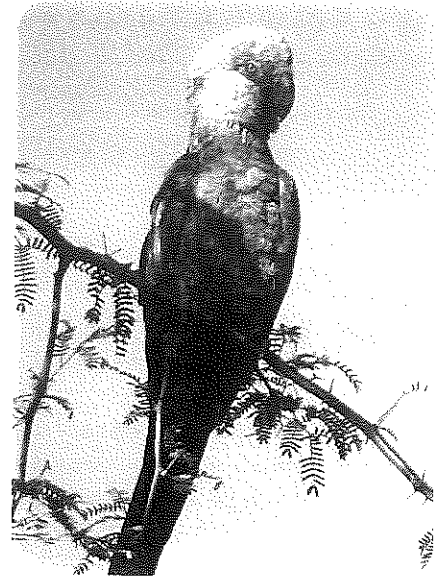


Figure 21 There are no little blue macaws left in the wild. Only about 70 of these birds remain in captivity.

Section 2 Assessment

Section Summary

- Birds have characteristics that make them well-adapted for flight.
- The shape of a bird's beak is related to the type of food it eats.
- Birds generally have excellent vision.
- Birds belong to about 27 orders.
- Modern birds evolved from dinosaurs.
- Habitat destruction and illegal trade can negatively affect some species of birds.

Understand Main Ideas

1. **Identify** the characteristics of birds that make them adapted for flight.
2. **Compare and contrast** contour feathers and down feathers.
3. **Explain** how respiration and circulation in birds are adapted for flight.
4. **Compare and contrast** reproduction in birds and reptiles.
5. **Describe** how the characteristics of birds in order Strigiformes are different from those of birds in order Anseriformes.
6. **Describe** how scientists have been able to conclude that birds evolved from dinosaurs.

Think Critically

7. **Scientific Illustrations** Draw and label the parts of a bird's brain. Explain the function of the different parts of the brain.

Writing in Biology

8. Most small land birds that feed their young lay from 2 to 12 eggs in their nests. Some larger birds, such as waterfowl, have young that are able to care for themselves after hatching and are not fed by parents. These birds lay up to 20 eggs in their nests. Write a detailed hypothesis that explains why some bird species might lay fewer eggs than other species do.



Biology & Society

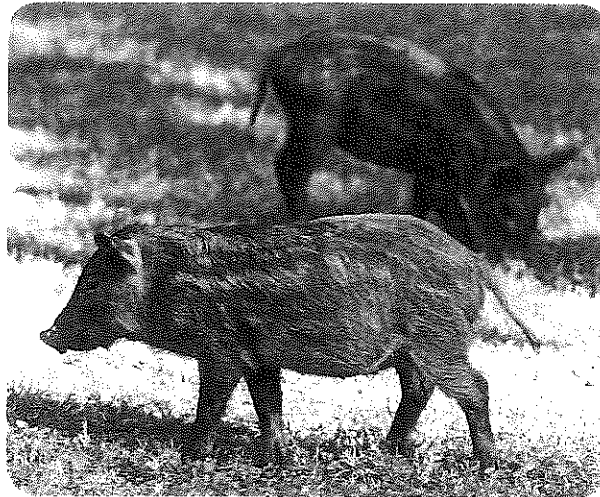
Invasive Species Run Wild

What happens when pet owners buy infant Burmese pythons and then decide when the pythons grow to be 4–5 m long that they no longer can care for them? Scientists have discovered that pet owners are dumping these large snakes in the Everglades. In the Everglades, Burmese pythons now are considered an invasive species that is causing increasing problems in the area. Other invasive species cause similar problems for their host environments around the country.

What are invasive species? Invasive species are organisms that are introduced, by human action, to an area where they do not naturally live and where they do not naturally breed. They successfully breed, become pests in the new area, and threaten biodiversity. The Burmese python is just one of thousands of nonnative species that are now in the United States. The rooting of feral pigs, which have spread throughout Florida, is destructive to native vegetation and the nests of sea turtles. Officials actively have been removing feral pigs from Florida state parks in an effort to reduce their impact. The image to the right shows a feral pig.

What are the costs of invasive species? Invasive species can cause billions of dollars of damage annually to crops, rangelands, and waterways throughout the United States. The presence of invasive species is the second-leading cause of species endangerment and extinction. Invasive plant species can threaten bird populations by causing habitat loss at their breeding or wintering grounds. Invasive animal species prey on animals native to an area. Competing for space and prey is another major way in which invasive species overrun the native species.

Solutions Invasive species can be controlled through various methods, including legislation such as the National Invasive Species Act established in 1996. Research is ongoing by scientists who are constantly examining invasive species to understand methods to control their spread, life cycle, and behavior. Public education can provide people with knowledge to make informed decisions to vote on important policies. Legislation related to environmental issues also can help improve situations involving invasive species.



Feral pigs have been removed from Florida State Parks since 1993.

COMMUNITY INVOLVEMENT

Lesson Plan Develop a lesson plan about an invasive species of your choice that is affecting your state. The lesson plan should be geared toward the elementary school children in your district. Be sure that you involve the elementary students in an activity.



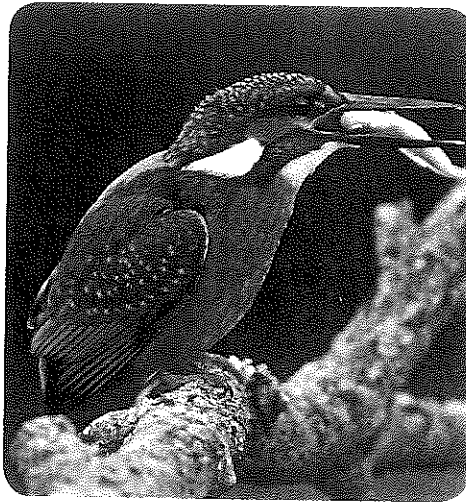
BIOLAB

Design Your Own

HOW CAN YOU MODEL A HABITAT FOR REPTILES AND BIRDS?

Background: Your class has been asked to help plan a new zoo exhibit about adaptations in birds and reptiles. In this lab, you will research a variety of birds and reptiles to understand how their body structures are adapted to habitats and food sources. You will use this information to help make a model habitat in which reptiles and birds would live in the zoo.

Question: How can you make a model habitat based on what you know about an organism's adaptations to its environment?



Materials

field guides for birds and reptiles	toothpicks
sand	glue
soil	scissors
cardboard pieces	colored markers
cardboard box	dried beans
wooden sticks	rocks/pebbles
	felt pieces

Safety Precautions

Plan and Perform the Experiment

1. Read and complete the lab safety form.
2. Choose one reptile species and one bird species. Research the adaptations of each species. Find out information about the habitat in which they live, the food they eat, and their behavior. Examine how their body structures and behaviors give them a competitive advantage in the habitats in which they live.
3. Use the information you collected to make a detailed description of the habitat that should be set up in the exhibit for each reptile and bird that you investigated.
4. Make sure your teacher approves your plan before you proceed.

5. Use the materials available to make a model habitat for the reptile species and a model habitat for the bird species that they would live in at the zoo.
6. Present and explain your models to the class.

Analyze and Conclude

1. **Describe** how the differences between reptiles and birds lead to differences in the models you made for each habitat.
2. **Identify** any weaknesses in your model. Would your model habitats support the needs of each species? What changes would you make to your model?
3. **Describe** how the structures and behaviors of the organisms give them a competitive advantage in their habitat.

WRITING in Biology

Take-Home Pamphlet Write and illustrate a pamphlet that people visiting your exhibit could take home. Include informational text about the animals in the exhibit as well as illustrations of their natural habitats.

Chapter 29 Study Guide

THEME FOCUS **Scale, Proportion, and Quantity** Reptiles and birds are diverse due to the vast number of terrestrial niches available to fill.

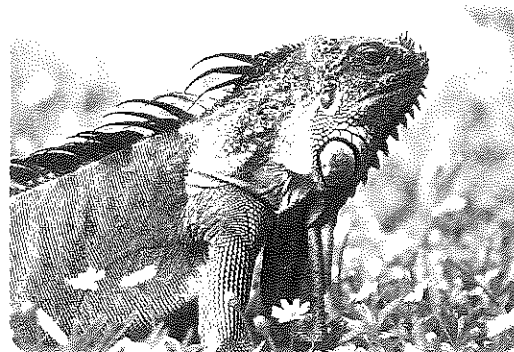
BIG Idea Reptile and bird adaptations enable them to live and reproduce successfully in terrestrial habitats.

Section 1 Reptiles

amnion (p. 852)
amniotic egg (p. 853)
Jacobson's organ (p. 855)
plastron (p. 857)
carapace (p. 857)

BIG Idea Reptiles are fully adapted to life on land.

- Reptiles have several types of adaptations for life on land.
- Eggs of reptiles are adapted to development on land.
- Reptiles belong to four living orders: Squamata, Crocodylia, Testudinata, and Sphenodontia.
- Modern reptiles evolved from early amniotes. Many ancient reptiles, including dinosaurs, became extinct.

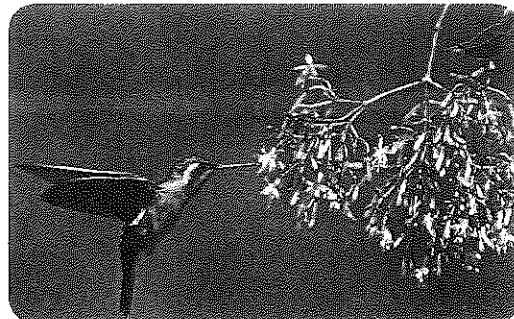


Section 2 Birds

endotherm (p. 861)
feather (p. 861)
contour feather (p. 862)
preen gland (p. 862)
down feather (p. 862)
sternum (p. 862)
air sac (p. 863)
incubate (p. 866)

BIG Idea Birds have feathers, wings, lightweight bones, and other adaptations that allow for flight.

- Birds have characteristics that make them well-adapted for flight.
- The shape of a bird's beak is related to the type of food it eats.
- Birds generally have excellent vision.
- Birds belong to about 27 living orders.
- Modern birds evolved from dinosaurs.
- Habitat destruction and illegal trade can negatively affect some species of birds.



(c) iStockphoto.com/SuperStock, (c) Wildscapshots/Wamy

Section 1

Vocabulary Review

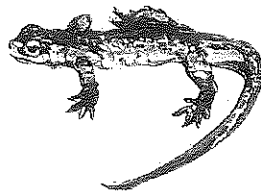
Each of the sentences below is false. Make each sentence true by replacing the italicized word with the correct vocabulary term from the Study Guide page.

- Several membranes are inside a(an) *carapace*.
- The ventral part of a turtle's shell is called the *Jacobson's organ*.
- The *plastron* is responsible for the sense of smell in snakes.
- The dorsal part of a turtle's shell is the *amniotic egg*.

Understand Main Ideas

5. Which is not a reptile?

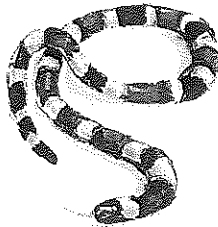
A.



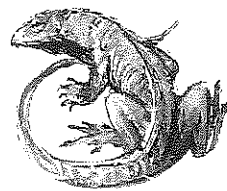
C.



B.



D.



6. Which is not true about respiration in reptiles?
- Most reptiles use lungs for gas exchange.
 - As reptiles inhale, the muscles of the rib cage relax.
 - As reptiles exhale, the muscles of the body wall relax.
 - The lungs of reptiles have a larger surface area than those of amphibians.
7. In which structure in reptiles can uric acid be found?
- the lungs
 - the cloaca
 - the heart
 - the stomach

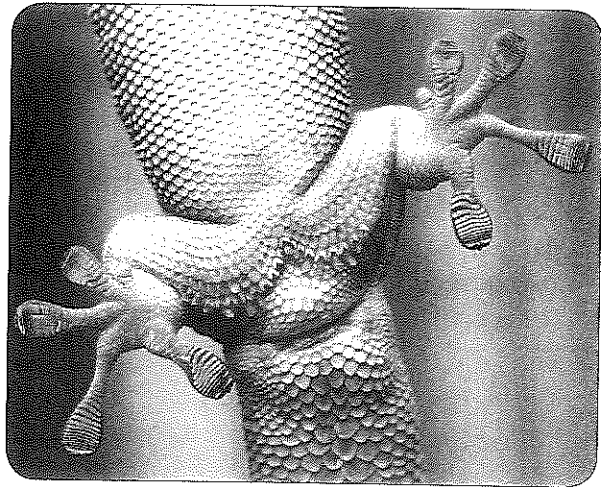
8. Which statement best represents scientists' understanding of early reptiles?
- Dinosaurs evolved into modern-day reptiles such as lizards, snakes, and turtles.
 - Birds and crocodiles are the closest relatives of dinosaurs.
 - The earliest reptiles did not have amniotic eggs.
 - Dinosaurs became extinct because they were too big.

Constructed Response

9. Make a table that lists the following structures, their functions, and an analogy of what that structure is like in the world of human-made devices: amnion, ventricle, bladder, Jacobson's organ, carapace and plastron, kidney.
10. **Open Ended** Make a dichotomous key that would allow a person to determine which order of reptile he or she is examining.

Think Critically

Use the figure below to answer question 11.

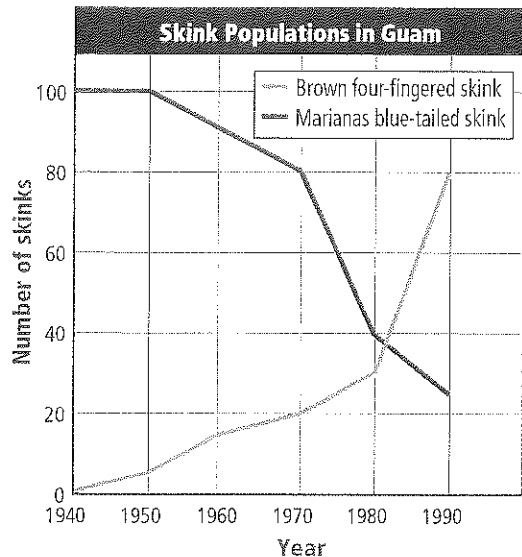


11. **Apply Concepts** The feet of a gecko are covered by billions of tiny hairlike structures that stick to surfaces. When the hairs contact a surface, attractions between molecules bond the gecko's feet to the surface. These structures can support up to 400 times the body weight of the gecko. How could scientists use the way in which a gecko's feet stick to surfaces to make a tool that would be useful to people?



Chapter 29 Assessment

Use the graph below to answer questions 12 and 13. The brown four-fingered skink was introduced to the Pacific island of Guam in the early 1950s.



- Analyze Data** How have the populations of the brown four-fingered skink and the Marianas blue-tailed skink changed since the 1950s?
- Hypothesize** Form a detailed hypothesis that might explain the decline in population of the Marianas blue-tailed skink.
- Compare** How does circulation in reptiles compare to circulation in amphibians?
- THEME FOCUS Scale, Proportion, and Quantity** Make a diagram, flowchart, concept map, or illustration that shows how the loss of habitat and the introduction of exotic species have affected the population of the San Francisco garter snake.

Section 2

Vocabulary Review

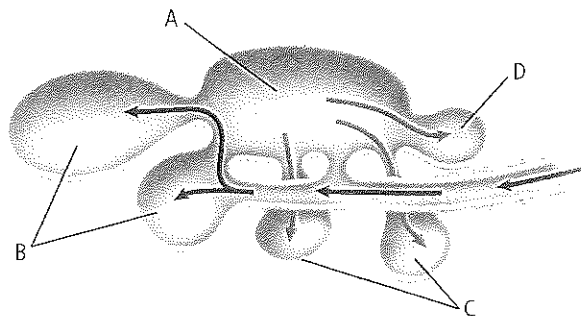
Explain the relationship that exists between the vocabulary terms in each pair.

- endotherm, down feather
- contour feather, down feather
- preen gland, contour feather
- sternum, air sac

Understand Main Ideas

- Which group of words has a word that does not belong?
 - ventricle, atrium, oxygenated blood, deoxygenated blood
 - kidney, nitrogenous waste, uric acid, cloaca
 - cerebellum, cerebrum, optic lobes, medulla
 - amniotic egg, cloaca, kidney, amnion

Use the figure below to answer question 21.



- When a bird breathes in, oxygenated air goes into which structure(s)?
 - Structure A
 - Structure B
 - Structure C
 - Structure D
- To which system do the kidney and cloaca belong?
 - excretory
 - nervous
 - digestive
 - reproductive
- What type of beak would a bird need if it feeds on aquatic plants?
 - broad and flat
 - large and scooped
 - sharp and hooked
 - long, thin, and pointed
- What does fossil evidence in dinosaurs show?
 - Dinosaurs were not related to birds.
 - Dinosaurs were not warm-blooded.
 - Dinosaurs were not flying animals.
 - Dinosaurs were not feathered.



Constructed Response

25. **CAREERS IN BIOLOGY** Ornithologists hypothesized that the long-term memory of certain migratory birds is better than that of non-migrants. To test this hypothesis, two rooms were decorated differently. Food was placed in only one room. Both migrant and nonmigrant birds explored both of the rooms. One year later, the same birds were allowed to explore the rooms. Migrant birds spent significantly more time exploring the room that had contained food than the nonmigrants did. Draw a conclusion about the long-term memories of these birds.

Think Critically

26. **Hypothesize** Biologists have discovered that the larger a bird's eyes are, the earlier in the day it sings. Form a hypothesis about why eye size might be correlated to how early birds begin to sing.
27. **Infer** Biologists know that the young of modern birds curl up their bodies in their nests to conserve body heat. Recently, fossils of dinosaurs' young have been found in a curled position in their nests. This particular line of dinosaurs is one with a direct lineage to birds. Infer what this curled-up position might mean about the bodies of these dinosaurs.

28. **IDEA** Birds have many adaptations for flight. Identify three of these adaptations and explain how each contributes to making flight possible.

Use the figure below to answer question 28.



29. **Infer** What type of food does this bird eat? How does it use its beak during feeding?

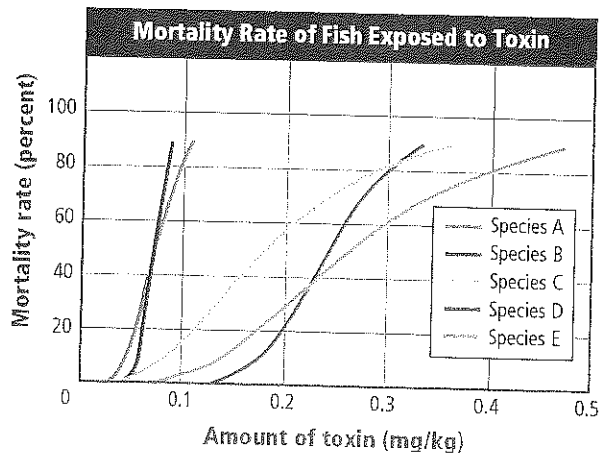
Summative Assessment

30. **WRITING** Review the different adaptations that enable reptiles and birds to live on land. Which adaptation do you think is the most important for living on land? Support your answer scientifically.
31. **WRITING in Biology** Write a summary for a yearbook page about the Ornithology Club, in which students went bird watching, recorded observations of species, and conducted species counts.

DB Document-Based Questions

Sea snakes have highly toxic venom that they inject into prey. In many cases, the toxin paralyzes the muscles that pump water across the gills of fishes. The graph shows the rate of mortality of five species of fish when given different doses of venom from an olive sea snake.

Data obtained from: Zimmerman, K.D., et al. 1992. Survival times and resistance to sea snake (*Aipysurus laevis*) venom by five species of prey fish. *Toxicol* 30: 259-264.



32. Which fish species is most affected by the venom? Which species is least affected? Explain how you know this.
33. The species of fish least affected by the venom have the ability to respire through their skin as well as through their gills. Why would this ability be important to surviving a bite by a sea snake?



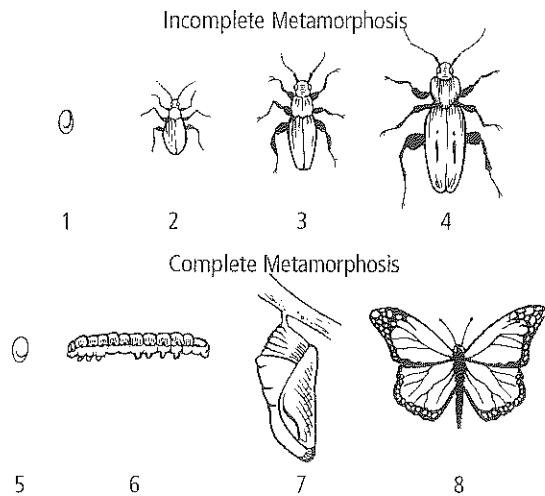
Standardized Test Practice

Cumulative

Multiple Choice

- The word *echinoderm* means "spiny skin." Which describes the skin of an echinoderm?
 - calcium carbonate plates with spines covered with a thin skin
 - calcium carbonate spines that protrude through the skin
 - silicon plates with spines covering the entire surface
 - silicon spines that protrude through the skin

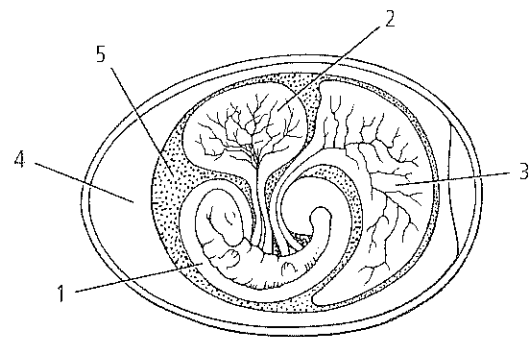
Use the figure below to answer questions 2 and 3.



- Which of these stages are identical in both of the processes?
 - 1, 5
 - 2, 7
 - 3, 8
 - 4, 7
- During which stages do immature insects feed?
 - 1, 5
 - 1, 7
 - 2, 6
 - 4, 8
- How do pseudocoelomates take in gases and excrete metabolic wastes?
 - The digestive tract is used for gas exchange.
 - Gas exchange occurs through the endoderm tissue.
 - Materials diffuse through their body walls.
 - Materials exchange in the primitive respiratory system.

- Which is a function of the lateral line system in fishes?
 - detecting chemicals in the water
 - detecting water pressure changes
 - keeping a fish upright and balanced
 - sending signals between fishes

Use the diagram below to answer questions 6 and 7.

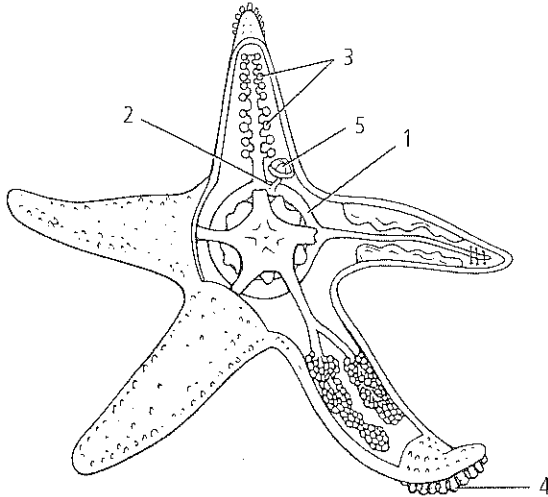


- Which number represents the fluid-filled membrane that prevents dehydration and cushions the pictured embryo?
 - 1
 - 2
 - 4
 - 5
- Which number represents the main food supply for the pictured developing reptile embryo?
 - 1
 - 2
 - 3
 - 4
- Which structures are used in most adult amphibians to take in oxygen and transport it to body cells?
 - gills and a closed circulatory system
 - gills and an open circulatory system
 - lungs and a closed circulatory system
 - lungs and an open circulatory system



Short Answer

Use the diagram to answer questions 9 and 10.



9. Name each of the numbered structures, and describe how it enables a sea star to move.
10. Analyze how a sea star opens an oyster by relating the process to the above numbered structures.
11. Give a reason why most viruses are limited to attacking only a few types of cells, and hypothesize why this might be important information for a medical researcher.
12. Relate evidence that scientists use to propose that the lobe-finned fishes are the ancestors of the amphibians.
13. Describe how reptiles regulate their body temperatures.
14. Explain why birds need an efficient respiratory system.
15. Generalize changes that a tadpole goes through before becoming a frog.

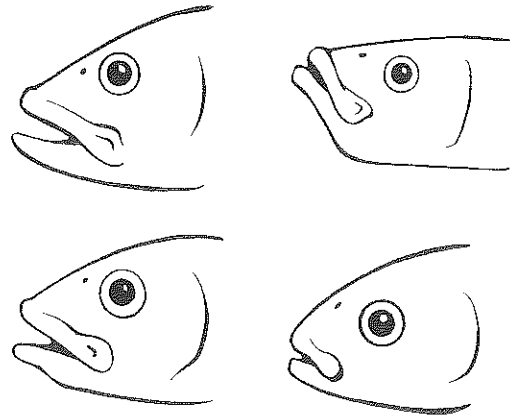
NEED EXTRA HELP?

If You Missed Question ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Review Section ...	27.1	26.3	26.3	25.1, 25.2	28.1	29.1	29.1	28.3	27.1	27.1	18.2	28.2	29.1	29.2	28.3	28.3	13.1	28.1

Extended Response

16. Contrast the circulatory system of a frog with the circulatory system of a fish, and assess the importance of those differences.
17. Select a technology that has changed the way in which scientists learn about genetics, and describe how that technology has brought about the change.

Essay Question



The evolution of a jaw was an important advancement in fish structure. The evolution of the jaw was a specialized adaptation for feeding. The jaw of fishes continued to evolve as fishes became more specialized in their feeding behaviors. The shape of the jaw gives important information about how a fish feeds and, in some cases, what it feeds on. By studying the different shapes of the jaw, scientists can understand how different species became adapted for their particular environments.

Using the information in the paragraph above, answer the following question in essay format.

18. Justify how each of these four types of jaws is suited for the food that fishes eat.

