CHAPTER 29

Reptiles and Birds

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

Section 1
Reptiles
MAIN Idea Reptiles are fully adapted to life on land.

Section 2
Birds
MAIN Idea Birds have feathers, wings, lightweight bones, and other adaptations that allow for flight.

BioFacts

- The fangs of a rattlesnake lie flat on the roof of its mouth when its mouth is closed.
- When a rattlesnake's mouth is opened during a strike, its fangs rotate forward, ready to inject venom from the venom gland in the jaw through openings in the fangs.
- The speed of a rattlesnake strike is an amazing 2.4 m/s.

SPI 3210.Inq.4; SPI 3210.Inq.6; SPI 3210.5.2

LAUNCH Lab

Are cultural symbols of reptiles and birds scientifically accurate?

Throughout history, reptiles and birds have been feared, revered, and symbolized. In this lab, you will review examples of symbolized reptiles and birds and determine if the representations are scientifically accurate.

Procedure

1. Read and complete the lab safety form.
2. Research symbols, stories, or legends about reptiles or birds from different cultures.
3. Analyze the information in the materials you find from Step 2 for scientific accuracy. Hypothesize as to why a reptile or bird was used as a symbol or legend in each situation.

Analysis

1. **Evaluate** How much of the information you analyzed was scientifically accurate? Why do you think some information was inaccurate?
2. **Synthesize** Choose one symbol or legend that contained inaccurate information and modify it so that it is scientifically accurate.

Biology online

Visit biologygmh.com to:

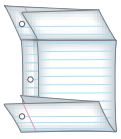
- study the entire chapter online
- explore the Concepts in Motion, the Interactive Table, Virtual Labs, Microscopy Links, and links to virtual dissections
- access Web links for more information, projects, and activities
- review content online with the Interactive Tutor, and take Self-Check Quizzes

FOLDABLES™ Study Organizer

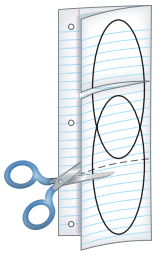
Characteristics of Reptiles and Birds Make the following Foldable to help you compare and contrast the characteristics of reptiles and birds.

STEP 1 Fold one sheet of paper lengthwise, leaving the holes uncovered.

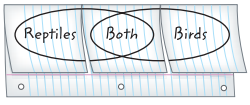
STEP 2 Fold into thirds.



STEP 3 Unfold and draw overlapping ovals. Cut the top sheet along the folds.



STEP 4 Label the Venn diagram as shown.



FOLDABLES **Use this Foldable with Sections 29.1 and 29.2.** As you read each section, record characteristics that are unique to reptiles and birds and those they have in common.

Section 29.1

CLE 3210.5.6: Explore the evolutionary basis of modern classification systems. **ALSO COVERS:** CLE 3210.2.3; CLE 3210.5.1; CLE 3210.5.2; CLE 3210.5.3; CLE 3210.5.4; SPI 3210.2.4; SPI 3210.2.6; SPI 3210.5.1; SPI 3210.5.2; SPI 3210.5.5

Reading Preview

Objectives

- **Explain** the importance of the amniotic egg in the transition to life on land.
- **Summarize** the characteristics of reptiles.
- **Distinguish** between the 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

Reptiles

MAIN Idea **Reptiles are fully adapted to life on land.**

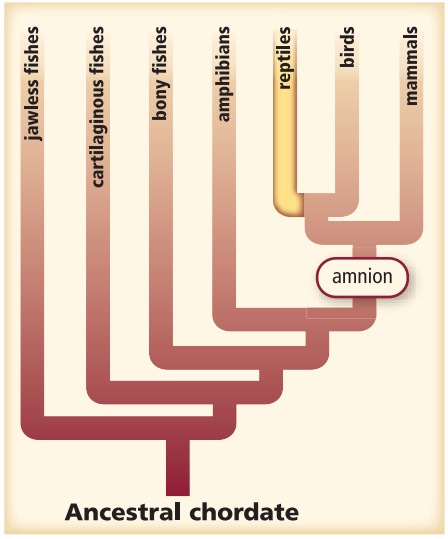
Real-World Reading Link Think about the last time you saw a movie in which a reptile was a main character. Maybe it was a giant anaconda or a ferocious *Tyrannosaurus rex.* Maybe it was an animated character that was funny. As you read this section, think about whether the characteristics of the movie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

Characteristics of Reptiles

In Chapter 28, you learned 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, like the Western fence lizard shown in **Figure 29.1,** 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 more efficient circulatory and respiratory systems.

Amniotic eggs As you can see in the evolutionary tree in **Figure 29.1,** 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.

Figure 29.1
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.



Gerold and Cynthia Merker/Visuals Unlimited

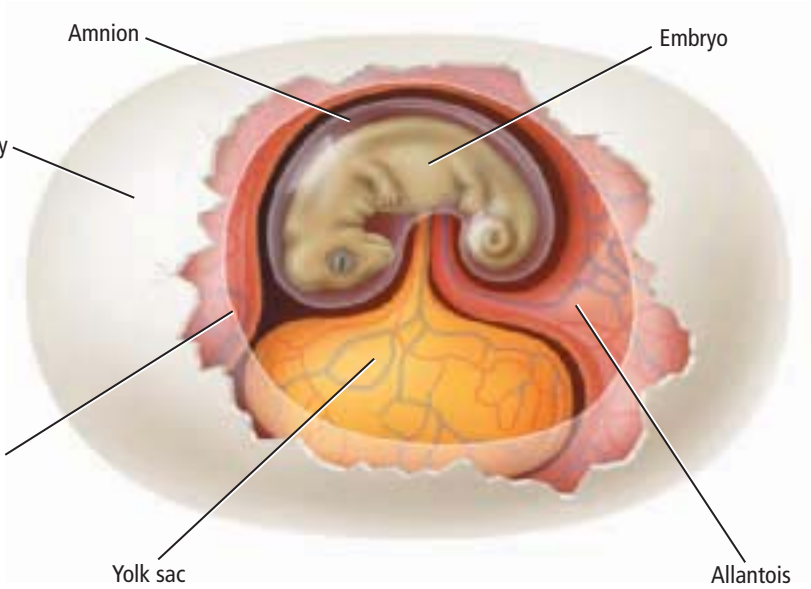


Figure 29.2 The amniotic egg is protected by a shell and membranes with fluid that help to protect the embryo and keep it from drying out during development.

Concepts in Motion

Interactive Figure To see an animation of the form and function of an amniotic egg, visit biologygmh.com.

CLICK HERE

An **amniotic egg,** like the one shown in **Figure 29.2,** 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. In order to grow, some reptiles, like the snake in **Figure 29.3,** periodically must shed their skins in a process called molting. You might have seen the molt of a snake's skin while hiking 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 29.3 Some reptiles molt as they grow larger.
Compare *molting in reptiles to molting in arthropods.*

Heidi & Hans-Jurgen Koch/Minden Pictures

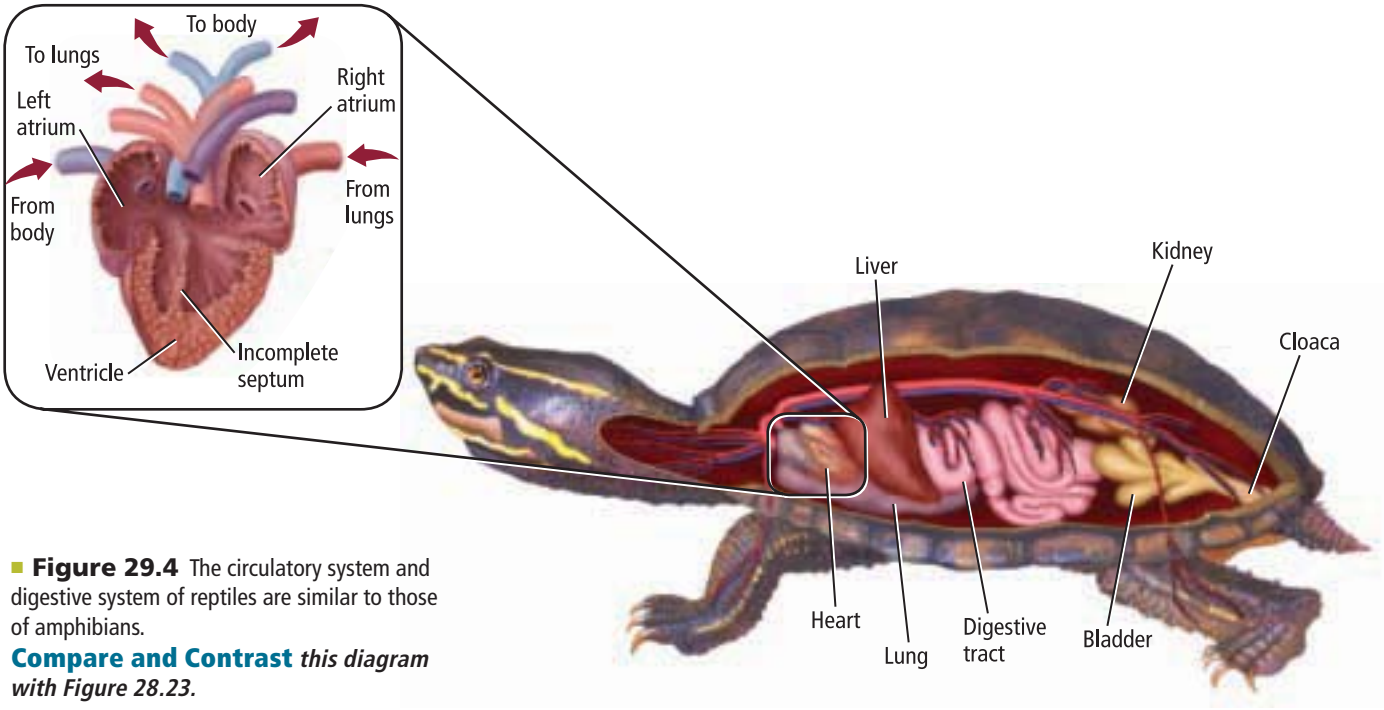


Figure 29.4 The circulatory system and digestive system of reptiles are similar to those of amphibians.
Compare and Contrast *this diagram with Figure 28.23.*

Figure 29.5 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.

Michael & Patricia Fogden/Minden Pictures

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 29.4.** 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 29.4,** 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 the chameleon, 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 29.5.** 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 29.4,** 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 cerebrum of reptiles is larger. Because vision and muscle function are more complex, the optic lobes and cerebellum portions in the brain 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 29.6** shows one of these structures. Without Jacobson organs, snakes would not be able to find prey or mates.

Temperature control Like amphibians, reptiles are ectotherms that cannot generate their own body temperatures. Because they cannot regulate their body temperatures internally, they must regulate it 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 29.7.** 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 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.

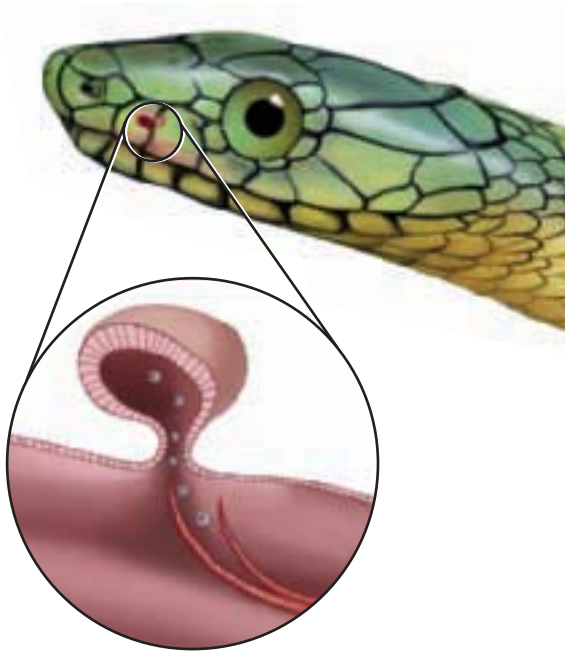


Figure 29.6 In snakes, Jacobson's organs in the mouth are used to sense odors.

Figure 29.7 Salamanders move with splayed legs pushing against the ground as their bodies drag along. Crocodiles have legs that are rotated underneath their bodies, which holds their bodies off the ground.

Salamander

Crocodile

Reproduction Recall from Chapter 28, amphibian females lay eggs that later get 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 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 Crocodilia, turtles and tortoises belonging to order Testudinata, and tuataras belonging to order Sphenodonta (sfee nuh DAHN tuh).

Lizards and snakes Lizards commonly have legs with clawed toes. Also, lizards 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 29.8.**

Snakes are legless and have shorter tails than lizards. 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 29.8,** 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.

VOCABULARY

WORD ORIGIN

Squamata

squama– from Latin, meaning *scale.*

–ata from Latin, meaning *to bear.*

■ **Figure 29.8** The green iguana and the green tree python are both members of order Squamata.

Green iguana

Green tree python

Eastern box turtle

American alligator

Figure 29.9 The shell of a turtle helps protect it from predators. An alligator has a broad snout and thick scales covering its body.

Turtles Turtles are unique because they are encased by a protective shell, as shown in **Figure 29.9.** 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 the land are called tortoises.

Crocodiles and alligators Order Crocodilia includes crocodiles, alligators, and caimans. Unlike most reptiles, Crocodilians have a four-chambered heart. Because a four-chambered heart can deliver oxygen more efficiently to their powerful muscles, crocodilians 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 29.9,** generally have a broader snout than crocodiles. 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. So 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 (tyew ah TAR ahz) look like large lizards, as shown in **Figure 29.10.** 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 29.10 Tuataras reach a length of about 2 m and can live up to 80 years in the wild.

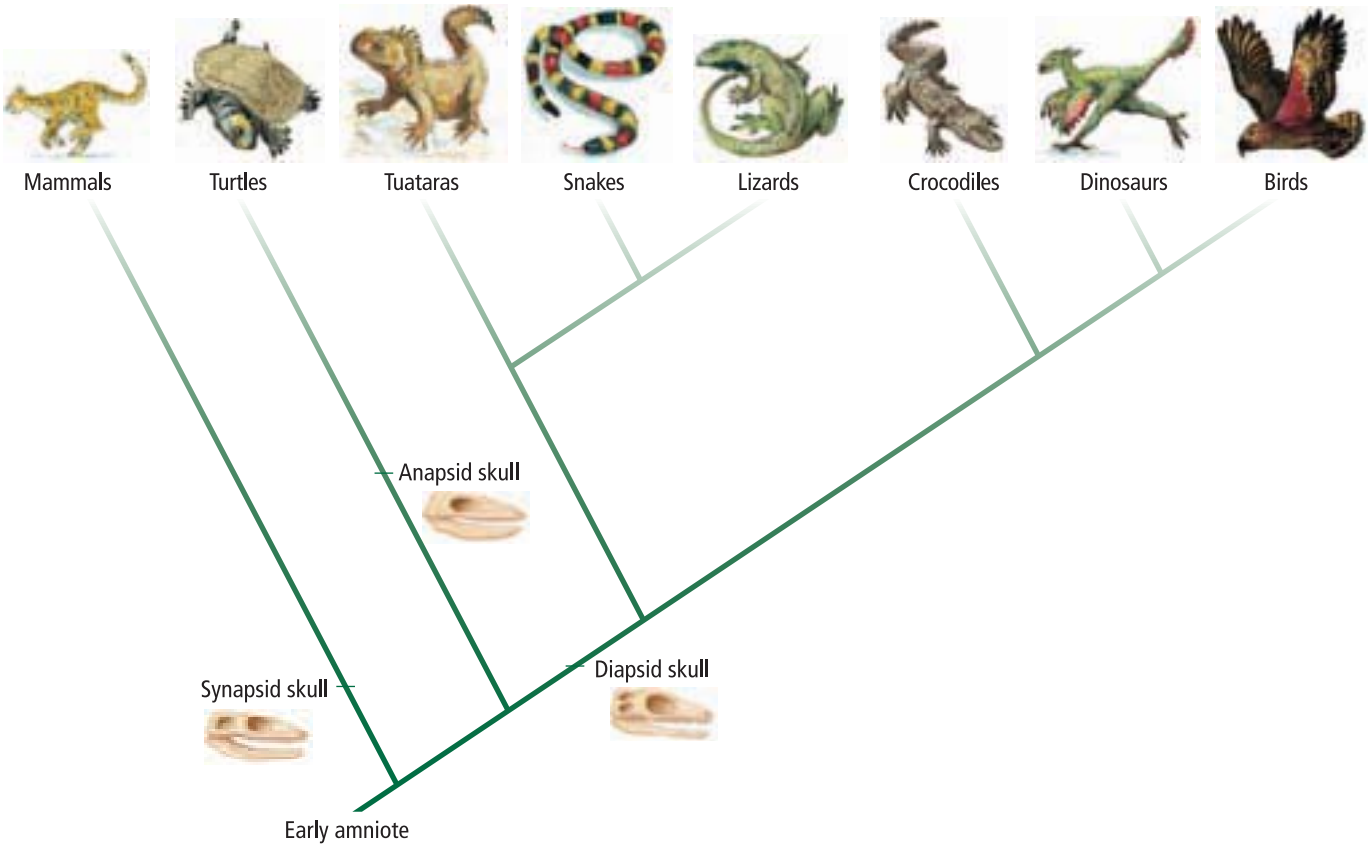


Figure 29.11 The cladogram shows one interpretation of the relationships between amniotes.

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 29.11** 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 dinosaur.

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 29.12.** 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 evolved into today's birds.

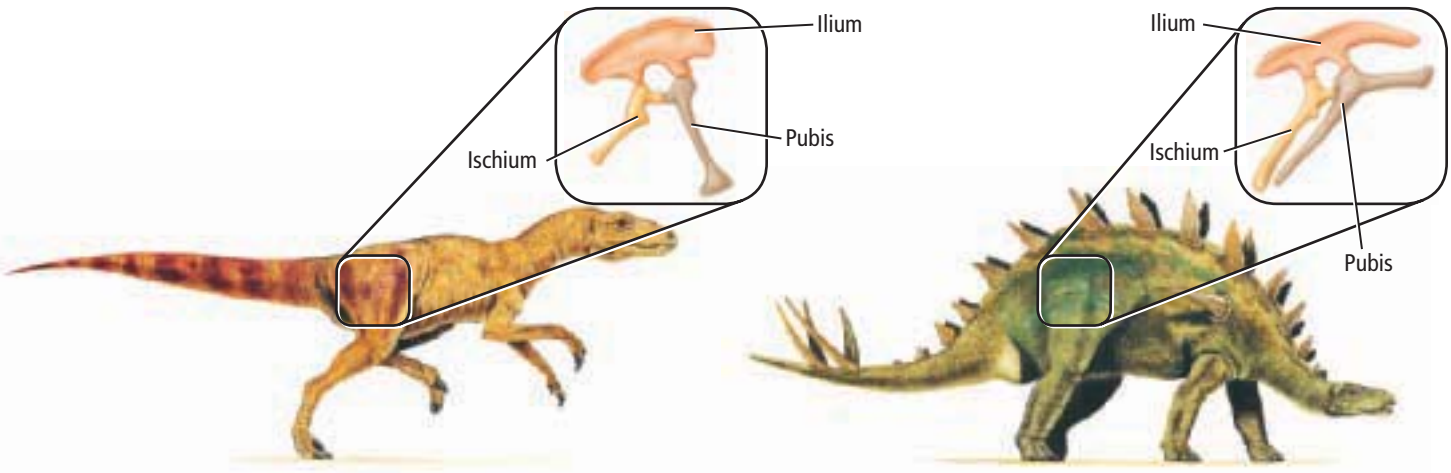


Figure 29.12 Saurischians had a hip bone that pointed forward. Ornithischians had the same bone pointing back toward the tail end of the animal.

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 to 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 they had occupied were made available for other vertebrates to evolve.

✓3210.Inq.4; ✓3210.Math.2; ✓3210.5.3; SPI 3210.Math.1

DATA ANALYSIS LAB 29.1

Based on Real Data*

Interpret the Data

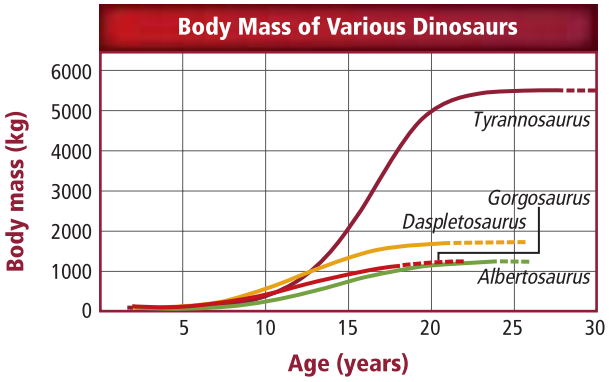
How fast did dinosaurs grow? Scientists study thin sections of fossilized bone tissue to determine how rapidly bone grew. By studying how quickly dinosaurs grew, scientists can learn about their populations and ecology.

Think Critically

1. **Compare** During what age span did the dinosaurs experience the greatest growth? Explain.
2. **Analyze Data** Which dinosaur grew at the slowest rate? The fastest rate?
3. **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 29.13 The San Francisco garter snake *(Thamnophis sirtalis tetrataenia)* lives in wetlands or grasslands near ponds and marshes.

Suzanne L. and Joseph T. Collins/Photo Researchers

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 population 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 mostly on several lizard species which are now endangered. This includes the Jamaican iguana, which was thought to have been extinct due to the introduction of the mongoose. In 1990, a small population was discovered in a remote area of Jamaica.

Some species, such as the San Francisco garter snake shown in **Figure 29.13,** have suffered a population decline due to both habitat loss and the introduction of exotic species. The use of land for building houses, other buildings, and agriculture has led to habitat loss for this snake. The American bullfrog, which is not native to California, eats both the garter snake as well as the red-legged frog, a food source of the garter snake.

Section 29.1 Assessment

CLE 3210.5.1; CLE 3210.5.3; CLE 3210.5.6

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: snakes and lizards, crocodiles and alligators, turtles and tortoises, and tuataras.
- Modern reptiles evolved from early amniotes. Many ancient reptiles, including dinosaurs, became extinct.

Understand Main Ideas

1. MAIN Idea **Identify** features that allow reptiles to live on land successfully.
2. **Describe** the parts of an amniotic egg. How did this structure allow the move to land?
3. **Compare and contrast** members of order Squamata with members of order Sphenodonta.
4. **Explain** the difference between 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 29.2.** Relate the function of each membrane.

MATH in 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 268 kg. What is the biting force of a larger alligator that is 3.6 m long?

Biology online **Self-Check Quiz** biologygmh.com

CLE 3210.5.2: Analyze the relationship between form and function in living things. **ALSO COVERS:** CLE 3210.2.3; CLE 3210.5.1; CLE 3210.5.3; CLE 3210.5.6; SPI 3210.2.4; SPI 3210.2.6; SPI 3210.5.1; SPI 3210.5.2; SPI 3210.5.5

Reading Preview

Objectives

- **Summarize** the characteristics of birds.
- **Relate** the adaptations of birds to their ability to fly.
- **Describe** 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

Birds

MAIN 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 29.14,** 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.

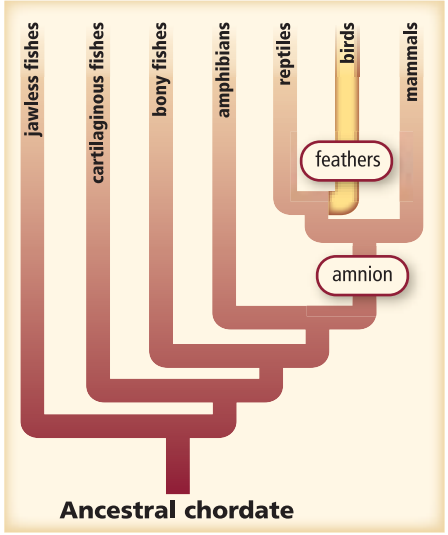
You can think of a bird as a collection of adaptations to a lifestyle that includes flight. The adaptations include being able to generate their own body heat internally, feathers, and lightweight bones. The respiratory and circulatory systems of birds are also adapted to provide more oxygen to working 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 due to 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 tihn), 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 29.14 The evolutionary tree shows that feathers are a unique characteristic of birds.



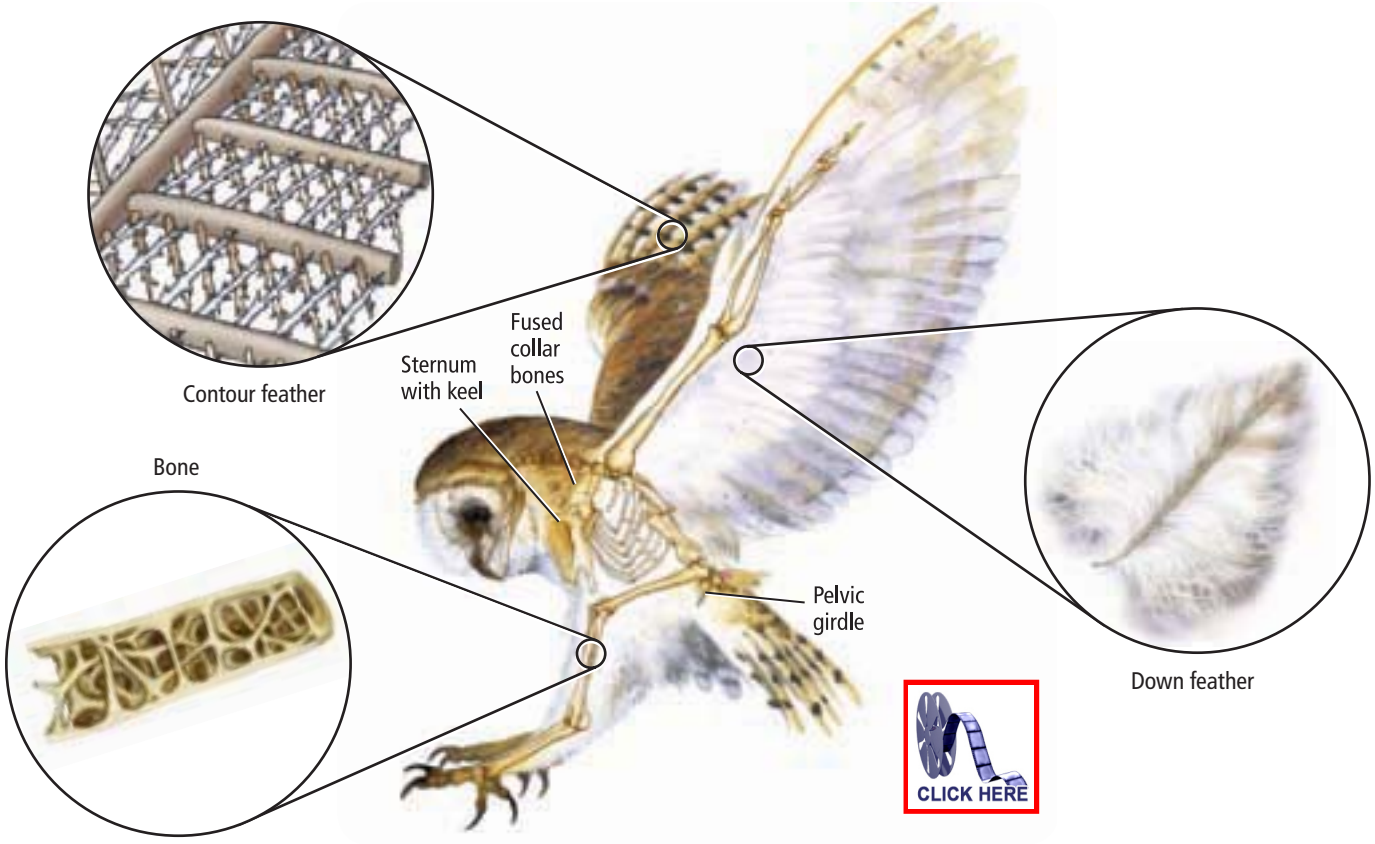


Figure 29.15 Birds have contour feathers, down feathers, and lightweight bones.

Concepts in Motion

Interactive Figure To see an animation of the adaptations of a bird, visit biologygmh.com.

Vocabulary

Science usage v. 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 29.15.** Contour feathers consist 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 29.15,** 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 29.15** 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 29.15.** 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 29.15.** The sternum is large and has a keel to which the muscles attach.

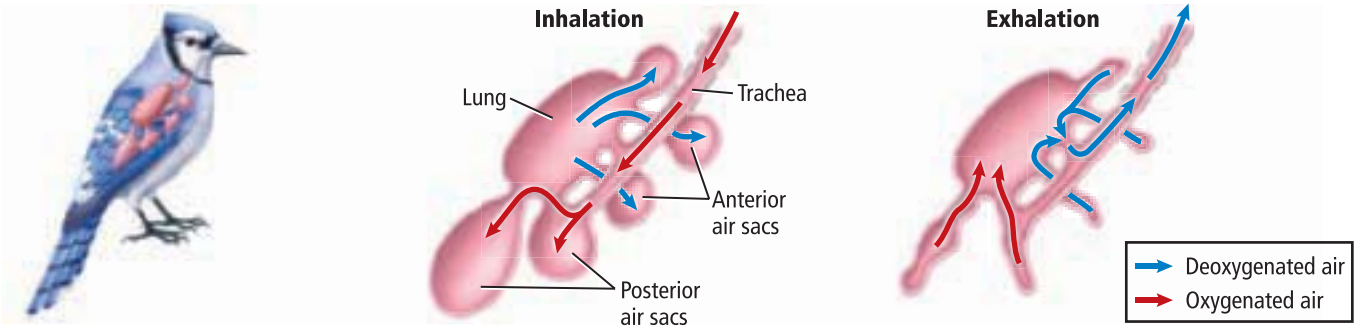


Figure 29.16 When a bird breathes, air always flows in a single direction, and highly efficient gas exchange can be achieved.

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, birds also have one-way air circulation. When a bird inhales, oxygenated air moves through the trachea into posterior **air sacs,** shown in **Figure 29.16.** 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 29.17.** 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.

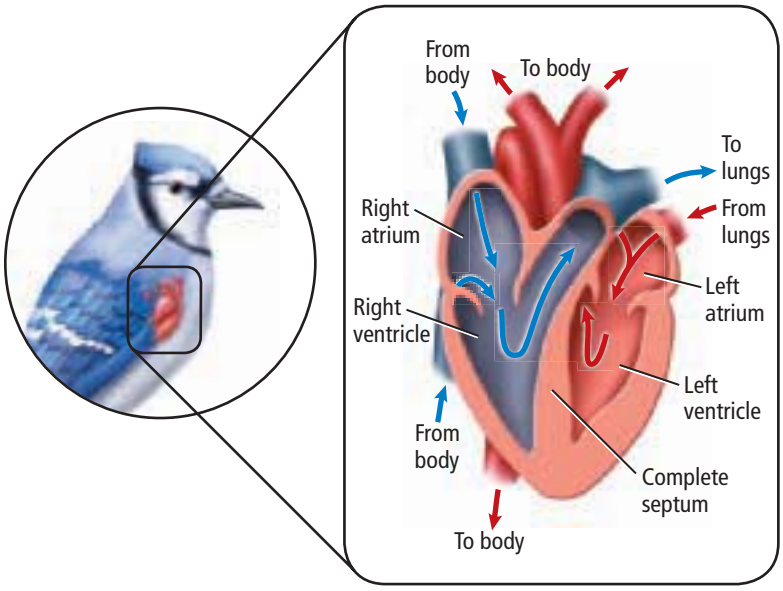
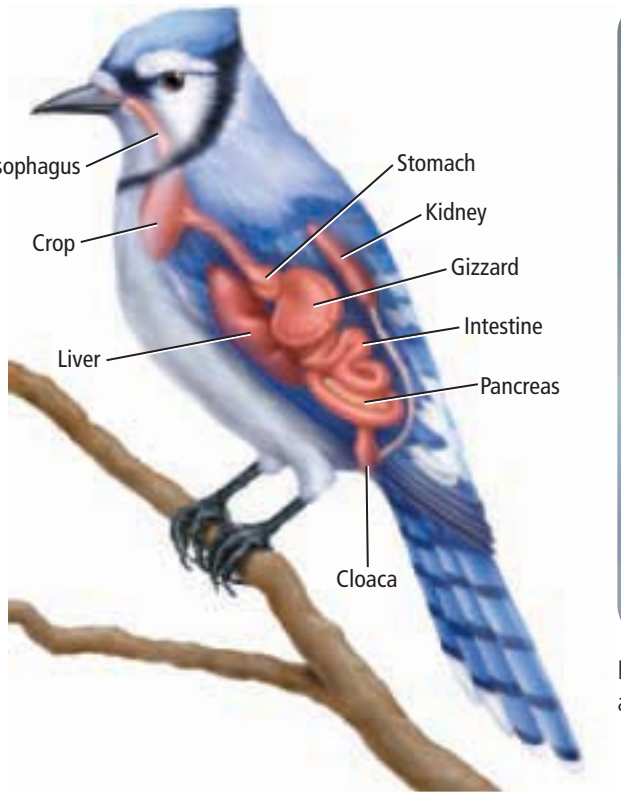


Figure 29.17 Birds have a four-chambered heart that keeps oxygenated and deoxygenated blood separate.
Compare *the heart of a bird to that of the reptile shown in Figure 29.4.*

NATIONAL GEOGRAPHIC

Visualizing Feeding and Digestion

Figure 29.18
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.



Herons 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.

Concepts in Motion **Interactive Figure** To see an animation of feeding and digestion in birds, visit biologygmh.com.

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 29.18.** 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 29.18,** where the water is reabsorbed from the uric acid. Birds do not have urinary bladders where urine is stored. 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 brains of birds, shown in **Figure 29.19,** are 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, like the hawk shown in **Figure 29.19,** 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 same 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've read about reptiles and birds, how would you now answer the analysis questions?**

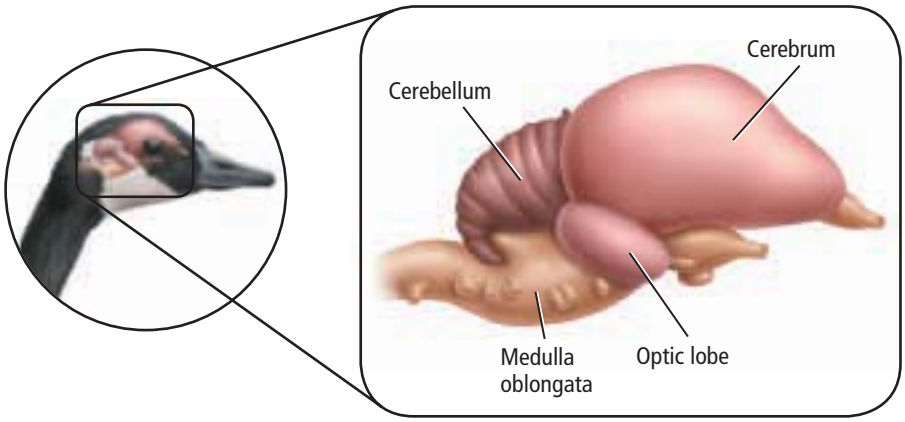


Figure 29.19
Left: Birds have large cerebellums that enable them to balance and coordinate movements. The medulla oblongata controls automatic processes.
Right: A hawk's eyes stay focused on moving prey as it dives.

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 living orders, depending on the classification system used. Anatomical differences, specific behaviors, songs, and the habitats occupied distinguish the orders. In **Table 29.1,** 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.

CLE 3210.Inq.4; ✓3210.Inq.3; ✓3210.Inq.4; SPI 3210.4.2

Mini Lab 29.1

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 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 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 you observed.

Analysis

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

Table 29.1 Diversity of Bird Orders

Concepts in Motion

Interactive Table To explore more about bird orders, visit biologygmh.com.

Order	Example	Members	Distinguishing Characteristics
Passeriformes **Perching songbirds; about 5000 species**		Thrushes, warblers, mockingbirds, crows, blue jays, nuthatches, finches	Members of this order have feet that are adapted for 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.
Piciformes **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.
Ciconiiformes **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 detritovores.
Procellariiformes **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.
Sphenisciformes **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.
Strigiformes **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.
Struthioniformes **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.
Anseriformes **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 using broad, round beaks.

CLICK HERE

CLICK HERE

Archaeopteryx

Caudipteryx

Figure 29.20 *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.

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 29.11.** 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 29.20,** 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 29.20,** 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, *Ganus youmenensis,* was discovered. It lived 110 mya and might be the link between *Archaeopteryx* and modern birds. *Ganus* had webbed feet, leading some scientists to think modern birds evolved from aquatic birds. Molecular evidence from *Tyrannosaurus rex* soft tissue has also strengthened the link between dinosaurs and birds.

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. For more information on biology careers, visit biologygmh.com.

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 29.21,** only exists 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.

Claus Meyer/Minden Pictures

Figure 29.21 There are no little blue macaws left in the wild. Only about 70 of these birds remain in captivity.

Section 29.2 Assessment

CLE 3210.5.1; CLE 3210.5.2; SPI 3210.5.5

Section Summary

- Birds have characteristics that make them well-adapted for flight.
- Birds can generate their body heat internally.
- Birds have lightweight bones.
- 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.

Understand Main Ideas

1. MAIN Idea **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

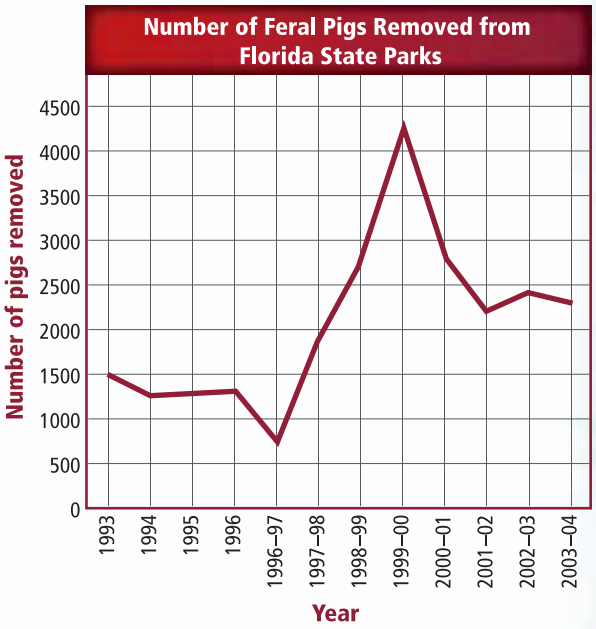
8. Most small land birds that feed their young lay from two to 12 eggs in their nests. Some larger birds, such as waterfowl, have young that are able to care for themselves after hatching and are not fed by parents. These birds lay up to 20 eggs in their nests. Write a detailed hypothesis that explains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

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 are causing similar problems for their host environments around the country.

What is an invasive species? Invasive species are organisms that are introduced, by human action, to an area where they do not naturally live, and in which they do not naturally breed. They successfully breed, become a pest 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 graph shows the number of feral pigs that have been removed each year since 1993.

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 key way invasive species overrun the native species.



Feral pigs have been in the process of being removed from Florida State Parks since 1993.

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 in order 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.

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 you involve the elementary students in an activity. For more information about invasive species, visit biologygmh.com.

Claus Meyer/Minden Pictures

BIOLAB

Design Your Own

CLE 3210.5.1; SPI 3210.Inq.1; SPI 3210.5.1

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
sand
soil
cardboard pieces
cardboard box
wooden sticks
toothpicks
glue
scissors
colored markers
dried beans
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 you investigated.
4. Make sure your teacher approves your plan before your 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 did 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. To learn more about zoo exhibits, visit BioLabs at biologygmh.com.

CHAPTER 29

Study Guide

STUDY TO GO

Download quizzes, key terms, and flash cards from **biologygmh.com.**

FOLDABLES **Infer** why fishes and amphibians do not have amniotic eggs, and describe your reasoning on the back of your Foldable.

Section 29.1 Reptiles

Vocabulary

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

Key Concepts

MAIN 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: snakes and lizards, crocodiles and alligators, turtles and tortoises, and tuataras.
- Modern reptiles evolved from early amniotes. Many ancient reptiles, including dinosaurs, became extinct.

Section 29.2 Birds

Vocabulary

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

Key Concepts

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

- Birds have characteristics that make them well-adapted for flight.
- Birds can generate their body heat internally.
- Birds have lightweight bones.
- 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.

Biology online **Vocabulary PuzzleMaker** biologygmh.com

CHAPTER 29 Assessment

Questions are correlated to the Tennessee Science Curriculum for Biology I.

Section 29.1

Vocabulary Review

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

1. Several membranes are inside a(an) *carapace.* SPI 3210.5.2
2. The ventral part of a turtle's shell is called the *Jacobson's organ.* SPI 3210.5.2
3. The *plastron* is responsible for the sense of smell in snakes. CLE 3210.5.2
4. The dorsal part of a turtle's shell is the *amniotic egg.* SPI 3210.5.2

Understand Key Concepts

5. Which is not a reptile? ✓3210.5.4

A.

C.

B.

D.

6. Which is not true about respiration in reptiles?
   - **A.** Most reptiles use lungs for gas exchange.
   - **B.** As reptiles inhale, the muscles of the rib cage relax.
   - **C.** As reptiles exhale, the muscle of the body wall relax.
   - **D.** The lungs of reptiles have a larger surface area than those of amphibians. CLE 3210.5.2

7. In which structure in reptiles can uric acid be found? CLE 3210.5.2
   - **A.** the lungs
   - **B.** the cloaca
   - **C.** the heart
   - **D.** the stomach

8. Which statement best represents scientists' understanding of early reptiles? CLE 3210.5.6
   - **A.** Dinosaurs evolved into modern-day reptiles such as lizards, snakes, and turtles.
   - **B.** Birds and crocodiles are the closest relatives of dinosaurs.
   - **C.** The earliest reptiles did not have amniotic eggs.
   - **D.** Dinosaurs became extinct because they were too big.

Constructed Response

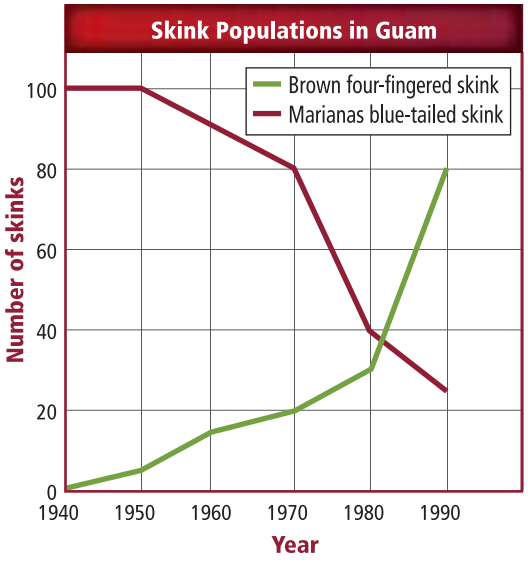
9. **Open Ended** Make a table that lists the following structures, their functions, and an analogy of what that structure is like in the world of human-made devices: amnion, ventricle, bladder, Jacobson's organ, carapace and plastron, kidney. ✓3210.5.1
10. **Open Ended** Make a dichotomous key that would allow a person to determine which order of reptile they are examining. ✓3210.5.5

Think Critically

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 foot 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 foot sticks to surfaces to make a tool that would be useful to people? ✓3210.T/E.2

Breck P. Kent/Animals Animals

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.



12. Analyze Data How have the populations of the brown four-fingered skink and the Marianas blue-tailed skink changed since the 1950s? SPI 3210.Math.1

13. Hypothesize Form a detailed hypothesis that might explain the decline in population of the Marianas blue-tailed skink. CLE 3210.Inq.6

14. Compare How does circulation in reptiles compare to circulation in amphibians? CLE 3210.5.2

15. Illustrate Make a diagram, flowchart, concept map, or illustration that shows how the loss of habitat and the introduction of exotic species has affected the population of the San Francisco garter snake. CLE 3210.2.3

Section 29.2

Vocabulary Review

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

16. endotherm, down feather SPI 3210.5.2

17. contour feather, down feather SPI 3210.5.2

18. preen gland, contour feather SPI 3210.5.2

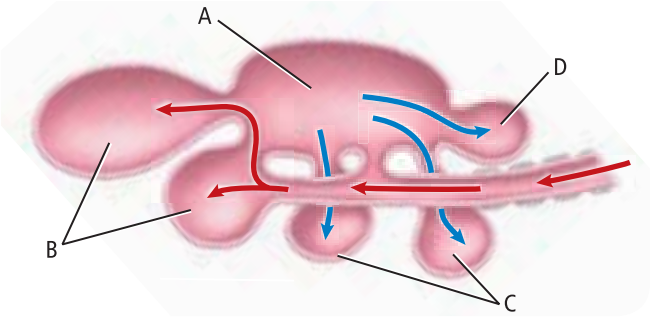
19. sternum, air sac SPI 3210.5.2

Understand Key Concepts

20. Which group of words has a word that does not belong? SPI 3210.5.2

A. ventricle, atrium, oxygenated blood, deoxygenated blood
B. kidney, nitrogenous waste, uric acid, cloaca
C. cerebellum, cerebrum, optic lobes, medulla
D. amniotic egg, cloaca, kidney, amnion

Use the figure below to answer question 21.



21. When a bird breathes in, oxygenated air goes into which structure(s)? CLE 3210.5.2

A. Structure A
B. Structure B
C. Structure C
D. Structure D

22. To which system do the kidney and cloaca belong? CLE 3210.5.2

A. excretory
B. nervous
C. digestive
D. reproductive

23. What type of beak would a bird need if it feeds on aquatic plants? CLE 3210.5.2

A. broad and flat
B. large and scooped
C. sharp and hooked
D. long, thin, and pointed

24. What does fossil evidence in dinosaurs show? ✓3210.5.3

A. Dinosaurs were not related to birds.
B. Dinosaurs were not warm-blooded.
C. Dinosaurs were not flying animals.
D. Dinosaurs were not feathered.

Constructed Response

25. CAREERS IN BIOLOGY Ornithologists hypothesized that the long-term memory of certain migratory birds would be better than that of nonmigrants. To test this hypothesis, two rooms were decorated—one with ivy and one with geraniums. Food was placed in only one room. Both migrant and nonmigrant birds were allowed to explore 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. Draw a conclusion about the long-term memories of these birds. SPI 3210.Inq.5

Think Critically

26. Hypothesize Birds often sing at dawn. Biologists think that the birds are announcing their territories or letting potential mates know where they are. Biologists also 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 sing. CLE 3210.5.2

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. CLE 3210.5.2

Use the figure below to answer question 28.

James Zipp/Photo Researchers

28. Infer What type of food does this bird eat? How does it use its beak during feeding? CLE 3210.5.2

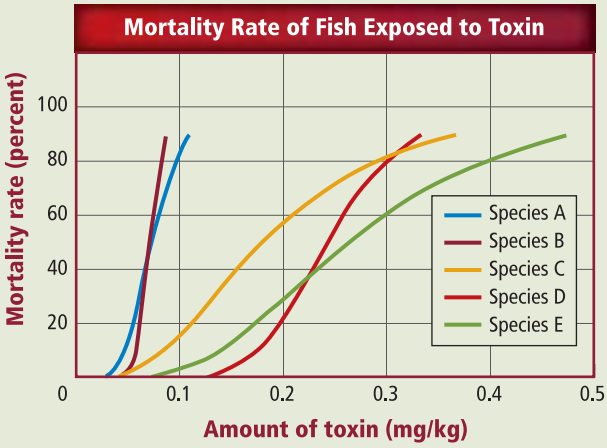
Additional Assessment

29. WRITING in Biology Write a summary for a yearbook page about the Ornithology Club, in which students went bird watching, recorded species, and conducted species counts. SPI 3210.5.1

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. *Toxicon* 30: 259–264.



30. Which fish species is most affected by the venom? Which species is least affected? Explain how you know this. 3210.Math.2

31. 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? SPI 3210.Inq.2

Cumulative Review

32. Sketch the four phases of mitosis in a cell with two chromosomes. **(Chapter 9)** CLE 3210.1.4

33. Explain the meaning of alternation of generations as it applies to plants. **(Chapter 21)** SPI 3210.4.7

Assessment Practice

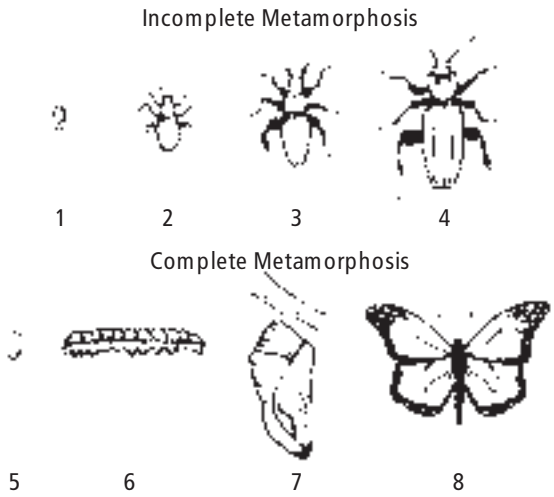
Cumulative

All questions are correlated to the Tennessee Biology I Curriculum on the next page.

Multiple Choice

1. The word *echinoderm* means "spiny skin." Which describes the skin of an echinoderm?
- **A.** Calcium carbonate plates with spines covered with a thin skin.
- **B.** Calcium carbonate spines that protrude through the skin.
- **C.** Silicon plates with spines covering the entire surface.
- **D.** Silicon spines that protrude through the skin.

Use the figure below to answer questions 2 and 3.



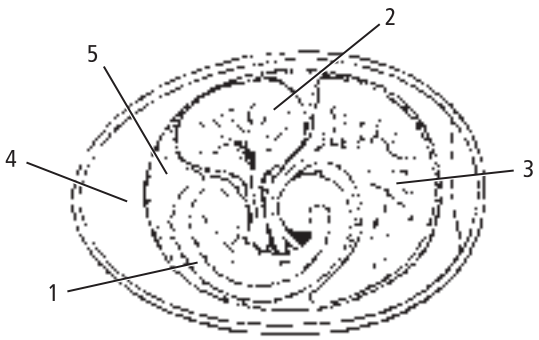
2. Which of these stages are identical between the processes?
- **A.** 1, 5
- **B.** 2, 7
- **C.** 3, 8
- **D.** 4, 7

3. During which stages do immature insects feed?
- **A.** 1, 5
- **B.** 1, 7
- **C.** 2, 6
- **D.** 4, 8

4. How do pseudocoelomates take in gases and excrete metabolic wastes?
- **A.** Their digestive tract is used for gas exchange.
- **B.** Gas exchange occurs through the endoderm tissue.
- **C.** Materials diffuse through their body walls.
- **D.** Materials exchange in the primitive respiratory system.

5. Which is a function of the lateral line system in fishes?
- **A.** detecting chemicals in the water
- **B.** detecting water pressure changes
- **C.** keeping a fish upright and balanced
- **D.** sending signals between fishes

Use the diagram below to answer questions 6 and 7.



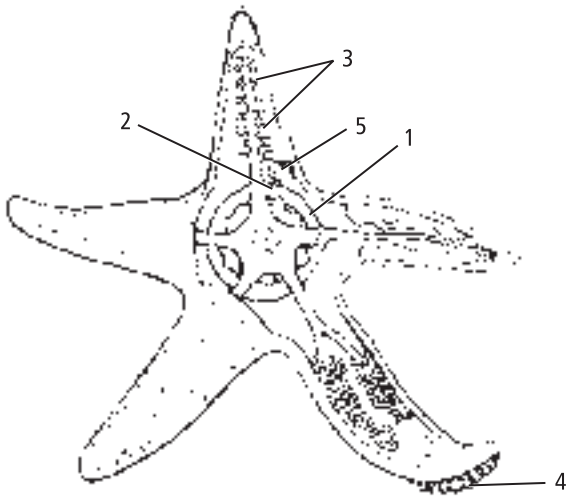
6. Which number represents the fluid-filled membrane that prevents dehydration and cushions the pictured embryo?
- **A.** 1
- **B.** 2
- **C.** 4
- **D.** 5

7. Which number represents the main food supply for the pictured developing reptile embryo?
- **A.** 1
- **B.** 2
- **C.** 3
- **D.** 4

8. Which structures are used in most adult amphibians to take in oxygen and transport it to body cells?
- **A.** gills and a closed circulatory system
- **B.** gills and an open circulatory system
- **C.** lungs and a closed circulatory system
- **D.** 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 they enable 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 scientists use to propose that the lobe-finned fishes are the ancestors of the amphibians.

13. Describe how reptiles regulate their body temperature.

14. Explain why birds need an efficient respiratory system.

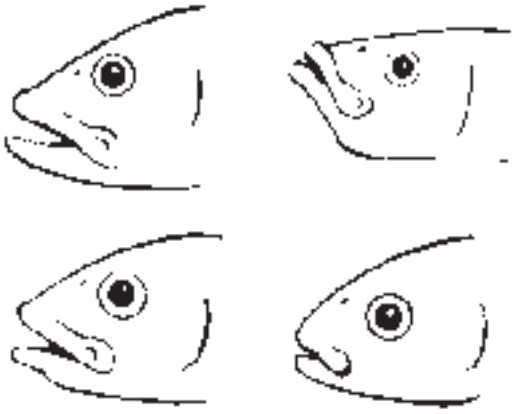
15. Generalize changes a tadpole goes through before becoming a frog.

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 fishes eat.

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
Tennessee Correlations	SPI 3210.5.2	SPI 3210.5.1	CLE 3210.5.1	SPI 3210.5.2	SPI 3210.5.2	CLE 3120.5.2	CLE 3210.5.2	SPI 3210.5.2	CLE 3210.5.2	CLE 3210.5.2	SPI 3210.4.9	CLE 3210.5.4	CLE 3210.5.1	CLE 3210.5.2	CLE 3210.5.1	SPI 3210.5.1	✓3210.TE.4	SPI 3210.5.1