Section 30–3

1 FOCUS

Objectives

30.3.1 ***Describe*** what an amphibian is.
30.3.2 ***Summarize*** events in the evolution of amphibians.
30.3.3 ***Explain*** how amphibians are adapted for life on land.
30.3.4 ***Describe*** essential life functions in amphibians.
30.3.5 ***Name*** the main groups of living amphibians.

Guide for Reading

Vocabulary Preview

Explain that *nictitating* comes from the Latin word *nictare,* meaning "to wink." *Tympanic* comes from the Latin word *tympanum,* meaning "drum." Ask: **Where do you think the nictitating and tympanic membranes are located in an amphibian?** *(Nictitating membrane is in the eye, and tympanic membrane is in the ear.)*

Reading Strategy

Suggest to students that while reading the section, they also list ways in which amphibians are adapted to live on land.

2 INSTRUCT

What Is an Amphibian?

Build Science Skills

Observing Display a variety of live amphibians for students to observe, or take students to a zoo, an aquarium, or a pet store. As students observe the amphibians, instruct them to specifically look for ways in which the amphibians are adapted for life on land. Remind students that adaptations are not only structural but behavioral as well. Students should record all of their observations. L2

30–3 Amphibians

Guide for Reading

Key Concepts
- What is an amphibian?
- How are amphibians adapted for life on land?
- What are the main groups of living amphibians?

Vocabulary
cloaca
nictitating membrane
tympanic membrane

Reading Strategy: Making Comparisons
As you read, write down similarities and differences between fishes and amphibians. Consider such characteristics as body structure, habitat, and method of reproduction.

Amphibians have survived for hundreds of millions of years, typically living in places where fresh water is plentiful. With over 4000 living species, amphibians are the only modern descendants of an ancient group that gave rise to all other land vertebrates.

What Is an Amphibian?

The word *amphibian* means "double life," emphasizing that these animals live both in water and on land. The larvae are fishlike aquatic animals that respire using gills. In contrast, the adults of most species of amphibians are terrestrial animals that respire using lungs and skin.

An amphibian is a vertebrate that, with some exceptions, lives in water as a larva and on land as an adult, breathes with lungs as an adult, has moist skin that contains mucous glands, and lacks scales and claws. In a sense, amphibians are to the animal kingdom what mosses and ferns are to the plant kingdom: They are descendants of ancestral organisms that evolved some—but not all—of the adaptations necessary for living entirely on land.

Evolution of Amphibians

The first amphibians to climb onto land probably resembled lobe-finned fishes similar to the modern coelacanth. However, the amphibians had legs, as in **Figure 30–21.** They appeared in the late Devonian Period, about 360 million years ago.

The transition from water to land involved more than just having legs and clambering out of the water. Vertebrates colonizing land habitats faced the same challenges that had to be overcome by invertebrates. Terrestrial vertebrates have to breathe air, protect themselves and their eggs from drying out, and support themselves against the pull of gravity.

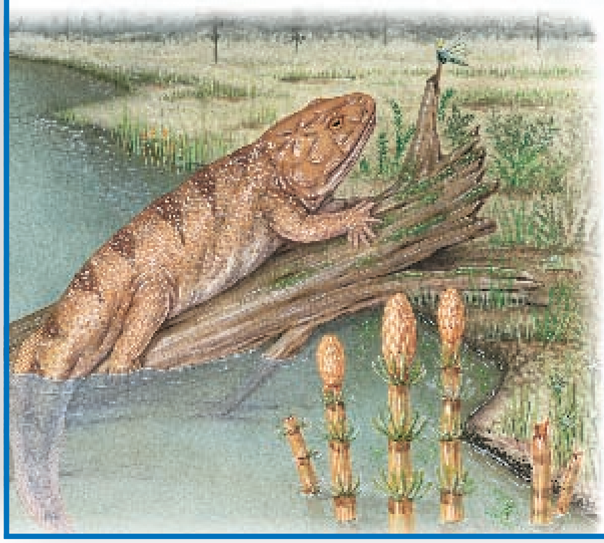
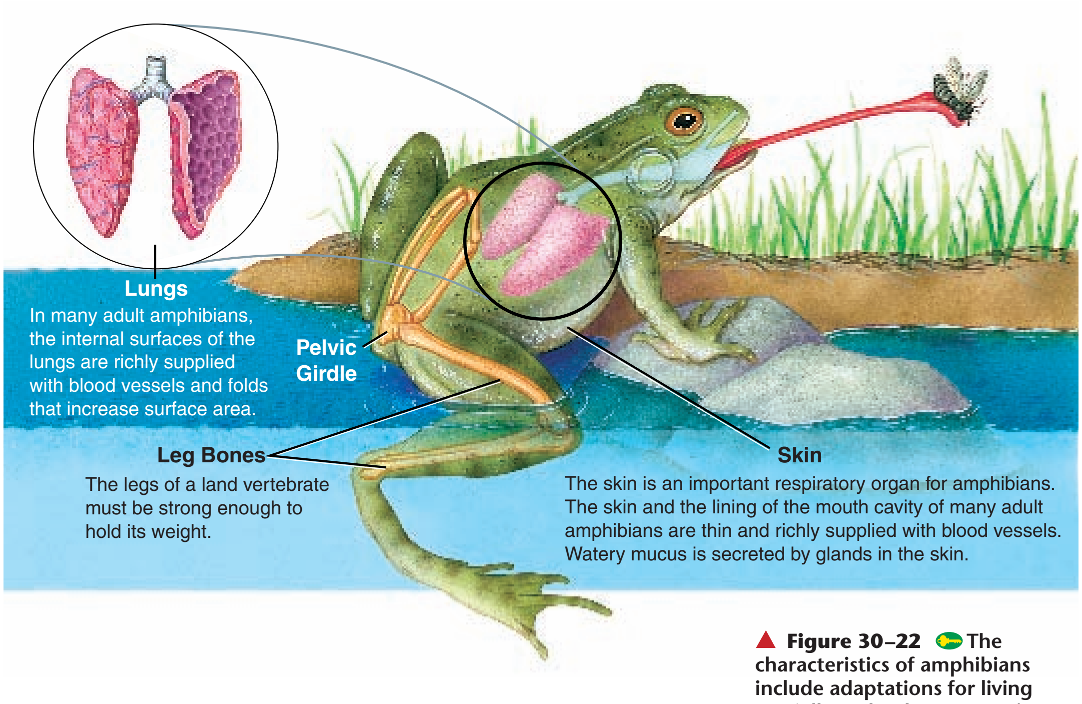


Figure 30–21 Evolving in the swamplike tropical ecosystems of the Devonian Period, amphibians were the first chordates to live at least part of their lives on land. **Most amphibians live in water as larvae and on land as adults.**

SECTION RESOURCES

Print:
- ***Laboratory Manual A,*** Chapter 30 Lab
- ***Laboratory Manual B,*** Chapter 30 Lab
- ***Teaching Resources,*** Lesson Plan 30–3, Adapted Section Summary 30–3, Adapted Worksheets 30–3, Section Summary 30–3, Worksheets 30–3, Section Review 30–3
- ***Reading and Study Workbook A,*** Section 30–3
- ***Adapted Reading and Study Workbook B,*** Section 30–3
- ***Lab Worksheets,*** Chapter 30 Exploration
- ***Issues and Decision Making,*** 33

Technology:
- ***iText,*** Section 30–3
- ***Animated Biological Concepts DVD,*** 37 Frog Anatomy
- ***Transparencies Plus,*** Section 30–3



▲ **Figure 30–22 The characteristics of amphibians include adaptations for living partially on land.** For example, lungs enable adult amphibians to obtain oxygen from air.

Early amphibians evolved several adaptations that helped them live at least part of their lives out of water. Bones in the limbs and limb girdles of amphibians became stronger, permitting more efficient movement. Lungs and breathing tubes enabled amphibians to breathe air. The sternum, or breastbone, formed a bony shield to support and protect internal organs, especially the lungs. Some of these adaptations are shown in **Figure 30–22.**

Soon after they first appeared, amphibians underwent a major adaptive radiation. Some of these ancient amphibians were huge. One early amphibian, *Eogyrinus,* is thought to have been about 5 meters long. Amphibians became the dominant form of animal life in the warm, swampy fern forests of the Carboniferous Period, about 360 to 290 million years ago. In fact, they were so numerous that the Carboniferous Period is sometimes called the Age of Amphibians. These animals gave rise to the ancestors of living amphibians and of vertebrates that live completely on land.

The great success of amphibians didn't last, however. Climate changes caused many of their low, swampy habitats to disappear. Most amphibian groups became extinct by the end of the Permian Period, about 245 million years ago. Only three orders of small amphibians survive today—frogs and toads, salamanders, and caecilians (see-SIL-ee-unz).

CHECKPOINT *Which geological period is called the Age of Amphibians?*

Word Origins

Carboniferous is a combination of two root words—*carbone* and *fer. Carbone* is a French word for coal; *fer* is a Latin suffix meaning "bearing or producing." *Carboniferous* is an adjective describing the coal-making period of the Paleozoic Era. **If *cone* refers to a reproductive structure of a tree, what do you think the word *coniferous* means?**

Evolution of Amphibians

Use Visuals

Figure 30–22 Have students describe how the adaptations shown in the illustration make it possible for amphibians to live successfully on land. Ask: **What is the advantage of moist skin?** *(It protects the amphibian from drying out.)* Continue in the same manner for the other adaptations shown. Then, ask: **How did these adaptations help amphibians become the dominant land vertebrate during the Carboniferous Period?** *(They were the only vertebrates adapted to live on land. They had few predators, favorable climate conditions, and plenty of food and shelter.)* L2

Word Origins

Coniferous is an adjective that describes trees that bear or produce cones. L2

UNIVERSAL ACCESS

English Language Learners
Students can use flashcards to review amphibian form and function and Vocabulary terms. Have students write the body structure on one side of the flashcard. On the other side of the flashcard, students should write its function and where it is located. Students can also explain how it helps the amphibian survive on land. L1

Advanced Learners
Students might enjoy writing an instruction manual that describes how a water-dwelling vertebrate may come to live successfully on land. They should include step-by-step instructions that explain how to overcome the special challenges of living on land, such as movement, reproduction, breathing air, supporting themselves against gravity, and protecting themselves from drying out. L3

Answer to . . .

CHECKPOINT *Carboniferous Period*

30–3 (continued)

Form and Function in Amphibians

Build Science Skills

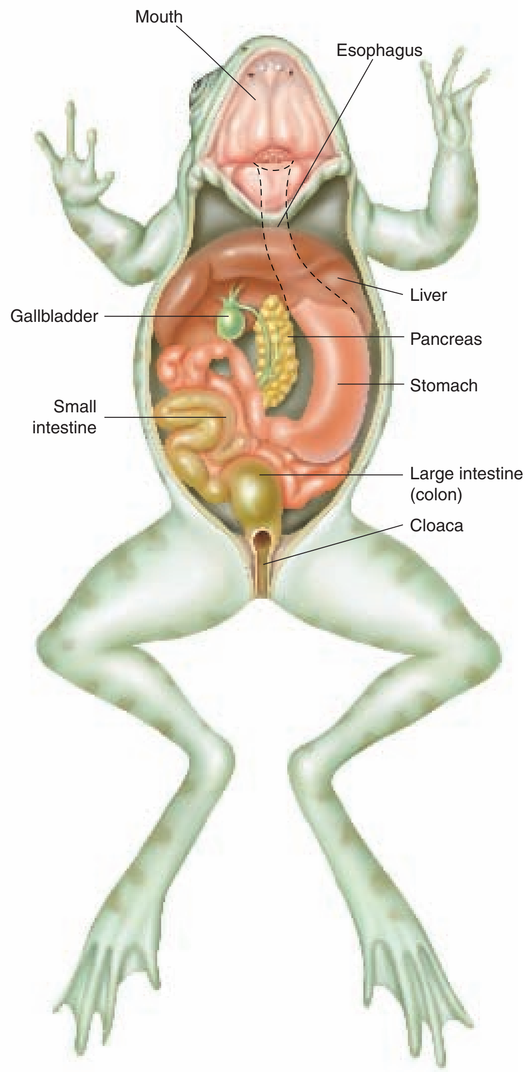
Comparing and Contrasting As students study this subsection, encourage them to compare the form and function of amphibians with that of fishes. They might wish to organize their ideas in a Venn diagram or create a table. Challenge students to identify differences that are specific adaptations to a terrestrial environment and to an aquatic environment. *(Lungs vs. gills, nictitating membrane vs. no eyelids)* L1 L2

Demonstration

You might wish to dissect a frog so that the class can observe its internal anatomy. Point out the parts of the digestive system, the lungs, and the heart. Encourage students to draw labeled diagrams of the internal structures that they observe. As an alternative, provide a three-dimensional frog model or diagrams of frog anatomy. L2

Use Visuals

Figure 30–23 Have students trace the path of food as it travels through the frog's digestive system. Begin with the frog catching a fly with its tongue. Then, call randomly on students to tell where the food will travel next and what will happen to it there. After completing the path, ask: **How does the digestive system in a tadpole differ from an adult frog's?** *(Tadpoles have longer intestines to help digest plant material.)* L1 L2



▲ **Figure 30–23** This illustration shows the organs of a frog's digestive system. **Comparing and Contrasting** *Which digestive organs are found in both frogs and fishes?*

Form and Function in Amphibians

Although the class Amphibia is relatively small, it is diverse enough to make it difficult to identify a typical species. As you examine essential life functions in amphibians, you will focus on the structures found in frogs.

Feeding The double lives of amphibians are reflected in the feeding habits of frogs. Tadpoles are typically filter feeders or herbivores that graze on algae. Like other herbivores, the tadpoles eat almost constantly. Their intestines, whose long, coiled structure helps break down hard-to-digest plant material, are usually filled with food. However, when tadpoles change into adults, their feeding apparatus and digestive tract are transformed to strictly meat-eating structures, complete with a much shorter intestine.

Adult amphibians are almost entirely carnivorous. They will eat practically anything they can catch and swallow. Legless amphibians can only snap their jaws open and shut to catch prey. In contrast, many salamanders and frogs have long, sticky tongues specialized to capture insects.

Trace the path of food in a frog's digestive system in **Figure 30–23.** From the mouth, food slides down the esophagus into the stomach. The breakdown of food begins in the stomach and continues in the small intestine, where digestive enzymes are manufactured and food is absorbed. Tubes connect the intestine with organs such as the liver, pancreas, and gallbladder that secrete substances that aid in digestion. The small intestine leads to the large intestine, or colon. At the end of the large intestine is a muscular cavity called the **cloaca** (kloh-AY-kuh), through which digestive wastes, urine, and eggs or sperm leave the body.

Respiration In most larval amphibians, gas exchange occurs through the skin as well as the gills. Lungs typically replace gills when an amphibian becomes an adult, although some gas exchange continues through the skin and the lining of the mouth cavity. In frogs, toads, and many other adult amphibians, the lungs are reasonably well developed. In other amphibians, such as salamanders, the lungs are not as well developed. In fact, many terrestrial salamanders have no lungs at all! Lungless salamanders exchange gases through the thin lining of the mouth cavity as well as through the skin.

BIO INSIGHTS — FACTS AND FIGURES

Frogs "drink" air
Frogs are unable to inhale and exhale as we do because they do not have the musculature for it. Instead, they fill the mouth cavity with air, close the mouth, and force air back through the open glottis into the lungs. The glottis closes to keep the air inside the lungs. When its lungs are full, the frog keeps expanding and contracting the floor of its mouth. This action brings air into and out of the mouth through the nostrils. Some gas exchange occurs in the mouth tissues at this time. The continual movement of air in and out also clears any "stale" air remaining from the last breath. When the glottis and the mouth open, the lungs empty with a rush. Then, the process begins again.

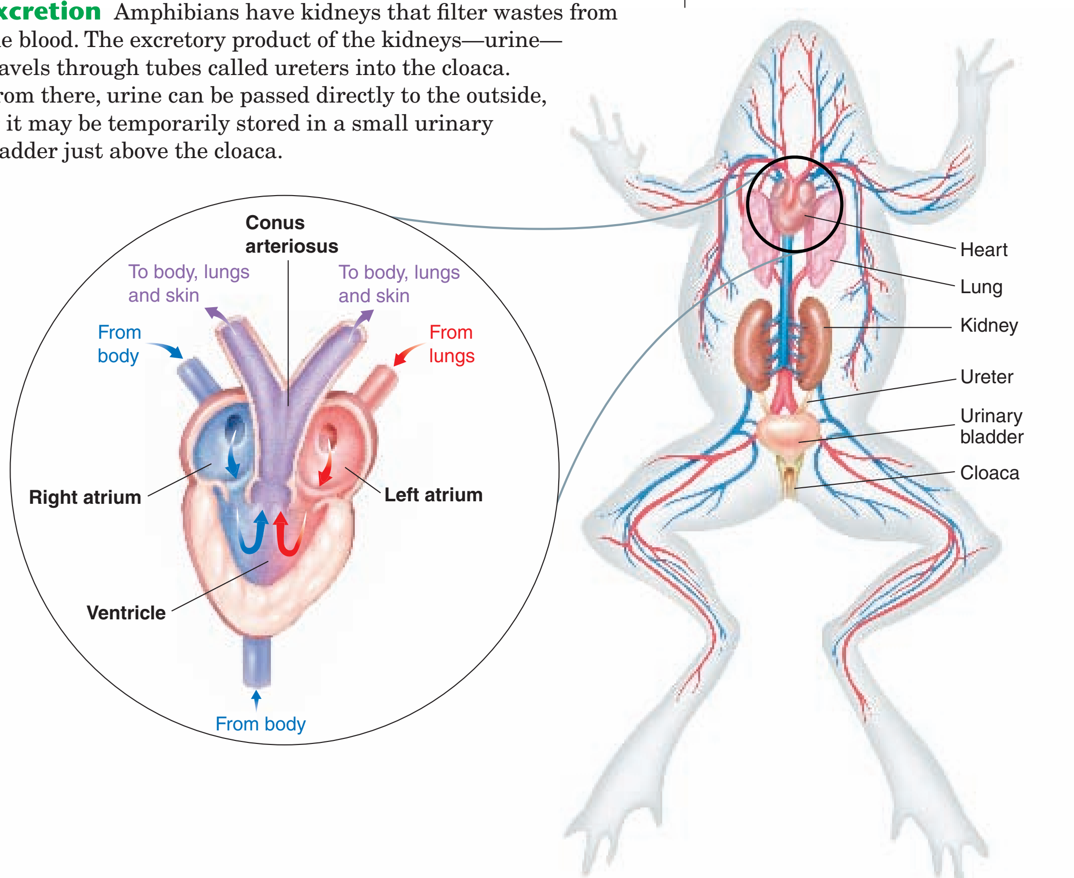
Circulation In frogs and other adult amphibians, the circulatory system forms what is known as a double loop. The first loop carries oxygen-poor blood from the heart to the lungs and skin, and takes oxygen-rich blood from the lungs and skin back to the heart. The second loop transports oxygen-rich blood from the heart to the rest of the body and then carries oxygen-poor blood from the body back to the heart.

The amphibian heart, shown in **Figure 30–24,** has three separate chambers: left atrium, right atrium, and ventricle. Oxygen-poor blood circulates from the body into the right atrium. At the same time, oxygen-rich blood from the lungs and skin enters the left atrium. When the atria contract, they empty their blood into the ventricle. The ventricle then contracts, pumping blood out to a single, large blood vessel that divides and branches off into smaller blood vessels. Because of the pattern in which the blood vessels branch, most oxygen-poor blood goes to the lungs, and most oxygen-rich blood goes to the rest of the body. However, there is some mixing of oxygen-rich and oxygen-poor blood.

CHECKPOINT *How many chambers are in an amphibian's heart?*

▼ **Figure 30–24** Like all vertebrates, amphibians have a circulatory system and an excretory system. An amphibian's heart has three chambers—two atria and one ventricle. Although some wastes diffuse across the skin, kidneys remove most wastes from the bloodstream. **Applying Concepts** *What excretory product do the kidneys produce?*

Excretion Amphibians have kidneys that filter wastes from the blood. The excretory product of the kidneys—urine—travels through tubes called ureters into the cloaca. From there, urine can be passed directly to the outside, or it may be temporarily stored in a small urinary bladder just above the cloaca.



Make Connections

Physics Explain to students that changes in air pressure help to force air from the frog's mouth into the lungs. Air is a fluid and readily moves from areas of high pressure to areas of lower pressure. You can demonstrate this by blowing up a balloon. Explain that the air you push into the balloon is at a higher pressure than the air inside the balloon, causing the balloon to expand. Then, let the air out of the balloon. Ask: **Why did the air escape from the balloon?** *(The air inside the balloon was at greater pressure because the sides of the balloon were pushing it, so the air moved out.)* L2 L3

Use Visuals

Figure 30–24 Have students trace the path of blood through the frog's heart. Ask: **How many loops are in the frog's circulatory system?** *(Two; one from the heart to the lungs and back, another from the heart to the body and back)* Then, have students review the fish heart in Figure 30–13 on page 776 and compare it to the frog heart. Ask: **How many loops does the fish have?** *(One)* Explain that the tadpole heart is similar in structure and function to the fish heart. In fact, the fish heart is similar to that of most vertebrate embryos. The double-loop system is linked to the development of the lungs. Ask: **Why might the double-loop system be a better adaptation for terrestrial animals?** *(Tissues are supplied with oxygen-rich blood more efficiently because there is no loss of blood pressure. Blood pressure is lost in fishes when blood goes through the gills and then to body tissues.)* L2 L3

TEACHER TO TEACHER

Comparison of chordate circulatory systems can be used to enhance discussion of evolution. Draw on the board a two-chambered and three-chambered heart. Show the path blood takes into, through, and out of each heart. Have students determine reasons why fishes survive with only a two-chambered heart and amphibians survive with a three-chambered heart. When students read about the hearts of birds in Chapter 31, you can do the same with a four-chambered heart. Compare the number of heart chambers to the method by which each chordate obtains oxygen for respiration (gills, skin, lungs).

—*Wendy Peterson*
Biology Teacher
Velva High School
Velva, ND

Answers to . . .

CHECKPOINT *Three*

Figure 30–23 *Mouth, esophagus, liver, gallbladder, pancreas, stomach, intestine*

Figure 30–24 *Urine*

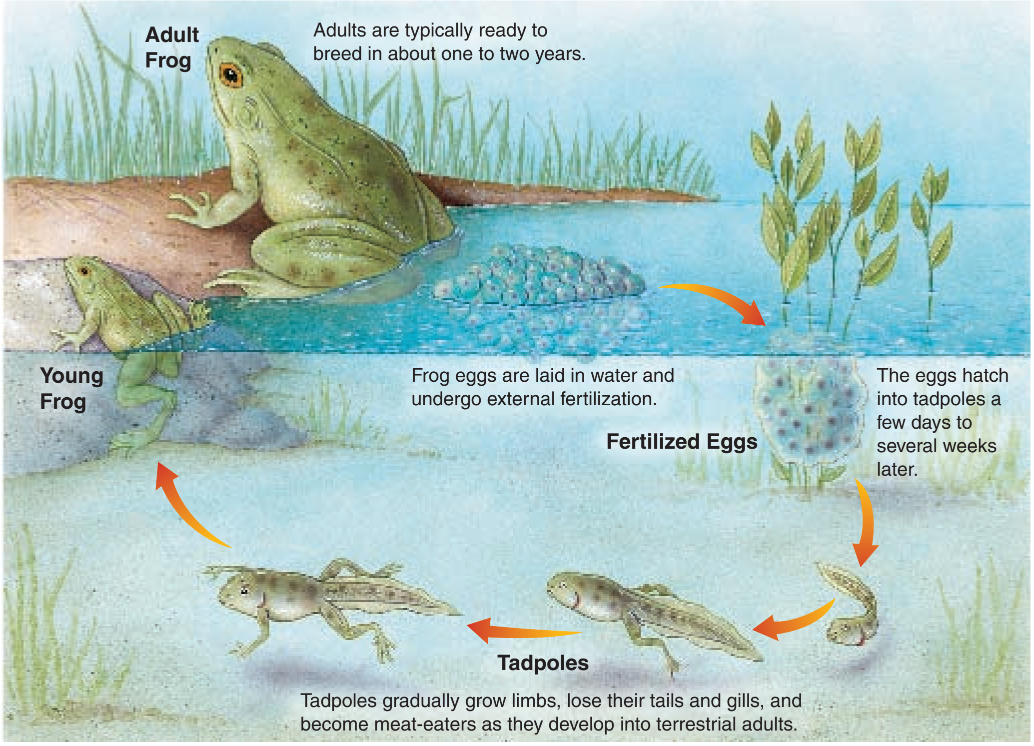
30–3 (continued)

Use Visuals

Figure 30–25 Go through the steps in the metamorphosis of a tadpole to a frog. Ask: **In what ways are tadpoles similar to fishes?** *(Both have gills, tails, lateral line systems, and live in water.)* **In what ways do tadpoles change to live on land?** *(Develop legs, lungs, carnivorous digestive system)* Tell students that tadpoles also have a heart and circulatory system similar to a fish's, but it changes to a double-loop system during metamorphosis. L2

Address Misconceptions

Some students might think that they could get warts from touching a toad. Ask: **Has anyone ever caught a toad? Did you get warts?** *(No)* Explain that although toads have bumpy skin, they do not have warts and cannot pass warts to humans. Remind students that warts are caused by viruses. L1 L2



▲ **Figure 30–25** An amphibian typically begins its life in the water, then moves onto land as an adult. This diagram shows the process of metamorphosis in a frog. **Comparing and Contrasting** *How are tadpoles similar to fish? How are they different?*

Reproduction Amphibian eggs do not have shells and tend to dry out if they are not kept moist. Thus, in most species of amphibians, the female lays eggs in water, then the male fertilizes them externally. In a few species, including most salamanders, eggs are fertilized internally.

When frogs reproduce, the male climbs onto the female's back and squeezes. In response to this stimulus, the female releases as many as 200 eggs that the male then fertilizes. Frog eggs are encased in a sticky, transparent jelly that attaches the egg mass to underwater plants and makes the eggs difficult for predators to grasp. The yolk of the egg nourishes the developing embryos until they hatch into larvae that are commonly called tadpoles. **Figure 30–25** shows the metamorphosis of tadpoles into frogs.

Most amphibians, including common frogs, abandon their eggs after they lay them. A few take great care of both eggs and young. Some amphibians incubate their young in highly unusual places, such as in the mouth, on the back, or even in the stomach! Male midwife toads wrap sticky strings of fertilized eggs around their hind legs and carry them about until the eggs are ready to hatch.

✔ CHECKPOINT *What is the function of the jelly surrounding frog eggs?*

BIO INSIGHTS — FACTS AND FIGURES

Male or female?
It is difficult to tell whether a frog is a male or a female by looking at it. Sex differences in frogs are almost completely internal. Female frogs have a pair of large ovaries that produce and release eggs. The eggs pass down the oviducts into a storage area near the cloaca. Before the eggs are released, the oviduct walls surround them with a jellylike yolk.

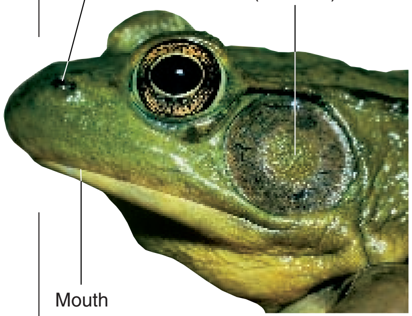
Male frogs have a pair of testes that produce sperm. Sperm passes from the testes through a series of ducts into the cloaca. Some frogs have a seminal vesicle in which sperm are stored.

Movement Amphibian larvae often move very much like fishes, by wiggling their bodies and using a flattened tail for propulsion. Most adult amphibians, like other four-limbed vertebrates, use their front and back legs to move in a variety of ways. Adult salamanders have legs that stick out sideways. These animals walk—or, in some cases, run—by throwing their bodies into S-shaped curves and using their legs to push backward against the ground. Other amphibians, including frogs and toads, have well-developed hind limbs that enable them to jump long distances. Some amphibians, such as tree frogs, have disks on their toes that serve as suction cups for climbing.

Response The brain of an amphibian has the same basic parts as that of a fish. Like fishes, amphibians have well-developed nervous and sensory systems. **Figure 30–26** points out some sense organs in a typical frog. An amphibian's eyes are large and can move around in their sockets. The surface of the eye is protected from damage under water and kept moist on land by a transparent **nictitating** (NIK-tuh-tayt-ing) **membrane.** This movable membrane is located inside the regular eyelid, which can also be closed over the eye. Frogs have keen vision that enables them to spot and respond to moving insects. However, frogs probably do not see color as well as fishes do.

Amphibians hear through **tympanic** (tim-PAN-ik) **membranes,** or eardrums, located on each side of the head. In response to the external stimulus of sound, a tympanic membrane vibrates, sending sound waves deeper within the skull to the middle and inner ear. Many amphibian larvae and adults also have lateral line systems, like those of fishes, that detect water movement.

▼ **Figure 30–26** A frog's eyes and ears are among its most important sensory organs. Transparent eyelids called nictitating membranes protect the eyes underwater and keep them moist in air. Tympanic membranes receive sound vibrations from air as well as water. **Inferring** *What functions does hearing serve in frogs?*



Analyzing Data

Amphibian Population Trends

Over the past several decades, scientists have reported changes in amphibian populations worldwide. In 2000, a team of researchers analyzed data sets contributed by various amphibian population studies conducted in 37 different countries. The results of this analysis are shown in the table. Study the data table and answer the questions.

Numbers of Amphibian Populations

Region	Declining	Increasing	No Trend
Western Europe	309	248	29
North America	130	96	14
South America	31	19	1
Australia/NZ	17	6	1
Asia	10	10	1
Eastern Europe	4	5	0
Africa/Middle East	2	2	1

1. **Using Tables and Graphs** How many amphibian populations were studied?
2. **Predicting** If the trends presented in the data table continue, how do you expect amphibian populations in North America to change in the next two decades?
3. **Calculating** What percentage of worldwide amphibian populations is decreasing?
4. **Evaluating** Do you think that regional population data can be used to predict global population trends? Explain your answer.

Build Science Skills

Using Models Challenge student groups to choose one type of amphibian and model its movement. Students can use materials such as pipe cleaners, rubber bands, paper clips, straws, craft sticks, suction cups, or toothpicks to construct their models. Encourage students to do extra research to learn exactly how their amphibian moves. Groups can present their models to the class. L2

Build Science Skills

Applying Concepts Challenge students to consider how a frog's senses help to protect it from predators. Ask: **How would a frog sense a predator?** *(By sight or sound)* **How would a frog defend itself from predators?** *(By jumping or swimming away, by camouflage, or by expelling a poison)* L2

Analyzing Data

Make sure students understand how to interpret information in the table. L2

Answers

1. 936 populations
2. Amphibian populations will decline.
3. 53.7 percent
4. Students might agree or disagree but must give reasons for their answers. Some might think that if population studies from many different regions were combined, predictions could be made about global populations. However, others might think that regions have site-specific conditions, making them unsuitable for global predictions.

BIO INSIGHTS

FACTS AND FIGURES

Amphibians adapt to temperature extremes
Like most fishes, amphibians are ectothermic animals. Unlike fishes, whose body temperature is very close to that of the water in which they live, amphibians absorb solar radiation, which causes their body temperature to be higher than the air temperature.

Amphibians living in areas that freeze during winter enter a dormant state called hibernation. Temperate-zone frogs store fat in the body to use as energy. Then, they bury themselves in the mud in stream banks or at the bottoms of ponds. Their metabolism slows until warmer temperatures arrive. Amphibians living in areas with hot, dry summers enter a dormant state called estivation to keep from drying out. During estivation, amphibians burrow into the mud and coat the inside of the burrow with mucus and dead skin. They remain in this state until the rains come.

Answers to . . .

CHECKPOINT *The jelly attaches the eggs to underwater plants and protects the eggs from predators.*

Figure 30–25 *Both have tails and gills, but tadpoles lack true fins. Also, tadpoles grow limbs and lungs as they become adults.*

Figure 30–26 *To find mates, locate prey, and escape predators*

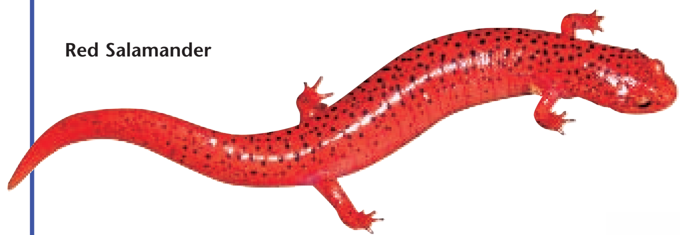
30–3 (continued)

Groups of Amphibians

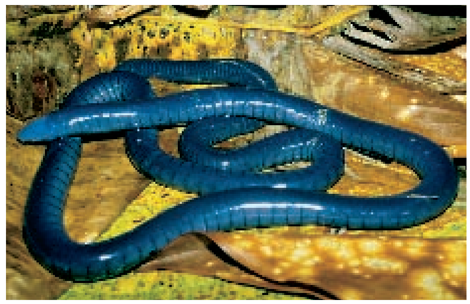
Build Science Skills

Comparing and Contrasting Have students compare and contrast the characteristics of each of the three groups of amphibians. You might ask students to construct a table or other graphic organizer, or you might discuss this orally as a class. Students should focus on the characteristics that make each group an amphibian, as well as the characteristics that define each group.
L1 L2

FIGURE 30–27 DIVERSITY OF AMPHIBIANS


Red Salamander

Living amphibians are classified into three groups: salamanders, frogs and toads, and caecilians. Salamanders usually have long bodies, legs, and tails. Frogs and toads lack tails and can jump. Caecilians have no legs.


Caecilian


Chilean Red-Spotted Toad

Groups of Amphibians

Modern amphibians can be classified into three categories. **The three groups of amphibians alive today are salamanders, frogs and toads, and caecilians.** Representative members are shown in **Figure 30–27.**

Salamanders Members of the order Urodela (yoor-oh-DEE-luh), including salamanders and newts, have long bodies and tails. Most also have four legs. Both adults and larvae are carnivores. The adults usually live in moist woods, where they tunnel under rocks and rotting logs. Some salamanders, such as the mud puppy, keep their gills and live in water all their lives.

Frogs and Toads The most obvious feature that members of the order Anura (uh-NOOR-uh) share is their ability to jump. Frogs tend to have long legs and make lengthy jumps, whereas the relatively short legs of toads limit them to short hops. Frogs are generally more closely tied to water—including ponds and streams—than toads, which often live in moist woods and even in deserts. Adult frogs and toads lack tails.

Caecilians The least known of the amphibians are the caecilians, members of the order Apoda (ay-POH-duh). Caecilians are legless animals that live in water or burrow in moist soil or sediment, feeding on small invertebrates such as termites. Many have fishlike scales embedded in their skin—which demonstrates that some amphibians don't fit the general definition.

BIOLOGY UPDATE

Incidence of deformed frogs rising
Since 1995, when middle-school students found many deformed frogs in a Minnesota pond, the reported number of deformed frogs has been increasing. While it is normal for about 1 percent of a population of frogs to have some deformities, these increasing numbers are alarming because frogs are bioindicators of the environment. They are more susceptible to subtle changes in the environment than are many other species.

Researchers have been working to find the cause of these deformities. Several hypotheses include chemical contamination, infection with a parasitic worm, exposure to the sun's ultraviolet rays, and physical trauma. Some researchers think that the deformities are caused by the interaction of more than one factor at the same time in a specific place.

Ecology of Amphibians

Amphibians must live near water, and they are common in moist, warm places such as tropical rain forest biomes. In contrast, because most amphibians cannot tolerate dry conditions, comparatively few live in desert biomes. Desert amphibians have adaptations that enable them to take advantage of water when it is available. For example, some toads stay inactive in sealed burrows for months, then emerge when a heavy rain falls.

Many amphibians make an ideal meal for predators such as birds and mammals. However, amphibians have adaptations that protect them from predators. For example, many species have skin colors and markings that enable them to blend in with their surroundings. Most adult amphibians, such as the toad in **Figure 30–28,** have skin glands that ooze an unpleasant-tasting and poisonous substance, or toxin.

Recently, scientists have noticed an alarming trend in amphibian populations worldwide. For the past several decades, the numbers of living species have been decreasing. The golden toad of Costa Rica, for example, seems to be extinct. In North America, the numbers of boreal toads have dwindled. Even the leopard frog and its relatives, once common worldwide, are getting harder to find.

Scientists do not yet know what is causing the global amphibian population to decline. It is possible that amphibians are susceptible to a wide variety of environmental threats, such as decreasing habitat, depletion of the ozone layer, acid rain, water pollution, fungal infections, introduced aquatic predators, and an increasing human population.

To better understand this phenomenon, biologists worldwide have been focusing their efforts and sharing data about amphibian populations. In the late 1990s, a group of scientists set up monitoring programs that cover the entire area of North America. One such program relies mostly on the efforts of volunteers, who are trained to recognize the specific call of various species such as cricket frogs, bullfrogs, or spring peepers.

▲ **Figure 30–28** Some amphibians that release toxins, such as this European fire-bellied toad, have bodies that are brightly colored and have bold patterns. The colors and patterns serve as a warning to potential predators. **Using Analogies** *How is the underside of this frog comparable to a dog showing its teeth?*

30–3 Section Assessment

1. **Key Concept** List the characteristics of amphibians.
2. **Key Concept** What adaptations helped amphibians evolve into land animals?
3. **Key Concept** List the three groups of amphibians.
4. What characteristics usually restrict amphibian reproduction to moist environments?
5. How are scientists attempting to deal with the problem of declining amphibian populations?
6. **Critical Thinking Formulating Hypotheses** Most caecilian species are totally blind as adults. How do you think this characteristic has evolved?

Thinking Visually

Cycle Diagrams
Construct a cycle diagram that identifies and describes the stages in the life cycle of a typical amphibian. For information about cycle diagrams, see Appendix A at the back of the book.

Ecology of Amphibians

Make Connections

Environmental Science Explain that amphibians are good indicators of changes in the environment. Challenge students to identify amphibian characteristics that would make them susceptible to environmental changes. *(Moist skin, small body, unshelled eggs, reliance on both land and water)* L2

3 ASSESS

Evaluate Understanding

Call on students to give amphibian characteristics that are adaptations to life on land and describe how amphibians are still dependent on water.

Reteach

Give students a frog diagram and instruct them to label the adaptations that enable the frog to live on land.

Thinking Visually

Cycle diagrams should follow the life cycle diagram in Figure 30–25 on page 786. Students should include not only the stages of the life cycle—eggs, tadpoles, adults—but also a description of each stage.

iText Interactive Textbook

If your class subscribes to the iText, use it to review the Key Concepts in Section 30–3.

30–3 Section Assessment

1. Vertebrates that live in water as larvae and on land as adults, breathe with lungs as adults, have moist skin with mucous glands, and lack scales and claws.
2. Strong bones; sternum that supports and protects internal organs; and lungs
3. Salamanders, frogs and toads, caecilians
4. Shell-less eggs and aquatic larvae
5. By monitoring populations of amphibians worldwide and sharing their data
6. Sample Answer: As caecilians became adapted to burrowing, those with smaller and smaller eyes suffered less damage and infection from the eyes scraping against the burrow walls. Thus, natural selection favored these variants.

Answer to . . .

Figure 30–28 *Both are warnings to potential predators.*