**5.2**

Amphibians and reptiles are adapted for life on land.

**BEFORE, you learned**
- Fish are vertebrates that live in water
- Fish gills remove oxygen from water
- Most young fish develop inside eggs laid in the water

**NOW, you will learn**
- About amphibians, vertebrates that can live on land for part of their lives
- About reptiles, vertebrates that can live on land for their whole lives
- About the body temperature of amphibians and reptiles

**VOCABULARY**
- amphibian p. 167
- reptile p. 168
- ectotherm p. 170

**EXPLORE Moving on Land**

**What good are legs?**

**PROCEDURE**
1. Measure and record your height in meters.
2. Jump as far as you can, and have your partner record the distance.
3. Divide the distance you jumped by your height.
4. Some frogs can jump a distance that's equal to 10 times their body length. Calculate the distance you would be able to jump if you were a frog.

**MATERIALS**
- meter stick

**WHAT DO YOU THINK?**
How might the ability to jump help a frog survive on land?

**Vertebrates adapted to live on land.**

Most of the groups of invertebrates and all of the vertebrates you have read about so far live in water. Organisms such as plants and insects became very diverse after adapting to live on land. Some vertebrate animals adapted to live on land as well. In this section you will learn about the first vertebrates to live on land, a group called the amphibians, and the group that came next, the reptiles.

Amphibians living today include frogs, toads, and salamanders. Reptiles include turtles, snakes, lizards, and crocodiles. Some people find it hard to tell animals from these two groups apart, but there are some important characteristics that distinguish them.

More than 350 million years ago, Earth was already inhabited by many species of vertebrate animals. All of them were fish. They
lived in salt water and fresh water, consumed other organisms as food, and obtained oxygen using specialized organs called gills.

Recall the pond you imagined in Chapter 3, when you learned that plants adapted to land. Now imagine the same pond a hundred million years later. The pond is crowded with invertebrates and fish, all competing for oxygen and food.

Suppose a period of dry weather makes the pond start to dry up. Many animals die, and food and oxygen become scarce. On the banks of the pond it might be less crowded. Invertebrates living there are sources of food. Air on land contains more oxygen than water does. Fish that could survive on land would be better off than the fish in the pond in this situation.

However, the gills of fish work only when they are wet. Fins can function to make a fish move through water, but they are not good for moving on land. Water provides more support for the body than air. Plus, fish sensory organs are specialized for detecting sounds and smells in water, not in air.

It took millions of years and many generations before different adaptations occurred and amphibians became a distinct group. These early amphibians were able to survive on land. Today there are fish that can breathe air and fish that can walk for short distances on land. There are also some modern amphibian species that have adapted to life only in water.

CHECK YOUR READING How are amphibians different from fish?
Some of the eggs hatch and become tadpoles. Tadpoles swim and breathe like fish. The young wood frog climbs out of the water. From now on, it will live on land and breathe with lungs.

A female adult wood frog deposits a mass of eggs in a pool of fresh water. Some of the eggs hatch and become tadpoles. Tadpoles swim and breathe like fish.

The wood frog will grow until fall and slow its activity in winter. In spring females lay eggs and the cycle repeats.

The tadpole’s legs develop, and its tail shrinks. Many changes occur inside the tadpole’s body as well.

What visible changes occur in a wood frog tadpole’s body as it transforms into an adult wood frog?
Amphibians have moist skin and lay eggs without shells.

As adults, most **amphibians** have these characteristics:

- They have two pairs of legs, or a total of four limbs.
- They lay their eggs in water.
- They obtain oxygen through their smooth, moist skin.
  Many also have respiratory organs called lungs.
- Their sensory organs are adapted for sensing on land.

Most amphibians live in moist environments. Their skin is a respiratory organ that functions only when it is wet. Most species of amphibians live close to water or in damp places. Some are most active at night, when the ground is wet with dew. Others live mostly underground, beneath wet leaves, or under decaying trees.

Amphibians reproduce sexually. In most amphibian species, a female lays eggs in water, a male fertilizes them with sperm, and then the offspring develop and hatch on their own. Yolk inside the eggs provides developing embryos with nutrients. Like fish eggs, amphibian eggs do not have hard shells. This means developing amphibians can get water and oxygen directly from their surroundings.

**Check Your Reading** How is the way most amphibians reproduce similar to the way most fish reproduce?

**Amphibian Life Cycle**

The diagram shows the life cycle of one amphibian, the wood frog. When a young amphibian hatches, it is a larva. In Chapter 4 you learned that a larva is an early stage that is very different from the animal’s adult form. For example, the larvae of frogs and toads are called tadpoles. Tadpoles look and behave like small fish. They breathe with gills, eat mostly algae, and move by pushing against the water with their tails.

After a few weeks, a tadpole’s body begins to change. Inside, the lungs develop and parts of the digestive system transform. The tadpole begins to have some of the external features of a frog. It develops legs, its tail shrinks, and its head changes shape.

As a young wood frog’s body changes, its gills stop functioning, and it begins breathing air with its lungs. The frog starts using its tongue to capture and eat small animals. It leaves the water and begins using its legs to move around on land. Some amphibians, such as sirens and bullfrogs, remain in or near water for all of their lives. Others, like wood frogs, most toads, and some salamanders, live in moist land environments as adults.
Reptiles have dry, scaly skin and lay eggs with shells.

Reptiles evolved soon after amphibians and are closely related to them. However, animals in the reptile group have adaptations that allow them to survive in hotter, drier places than amphibians. For many millions of years they were the largest and most diverse vertebrate animal group living on land. Most of the animals classified as reptiles have these characteristics:

- They have two pairs of legs, for a total of four limbs.
- They have tough, dry skin covered by scales.
- They obtain oxygen from air with respiratory organs called lungs.
- Their sensory organs are adapted for sensing on land.
- They lay their eggs, which have shells, on land.

CHECK YOUR READING What characteristics of reptiles are different from the characteristics of amphibians listed on page 167?

Lungs

Reptiles do not get oxygen through their skin the way amphibians do. They are born with lungs that provide their bodies with all the oxygen they need. Lungs are internal organs made up of many small lobes of thin tissue filled with tiny blood vessels. When an animal with lungs inhales, it takes air in through its nostrils or mouth and moves the air into its lungs. There, oxygen is transported across the tissues and into the blood, and carbon dioxide is moved from the blood to the lungs and exhaled.
Dry, Scaly Skin

Reptile skin is hard, dry, and covered with scales made of keratin, a substance much like your fingernails. The thick, waterproof skin of reptiles protects them from the environment and from predators. However, this means that reptiles cannot obtain water through their skin.

Eggs with Shells

The reptile egg is an important adaptation that allows vertebrate animals to survive in hot, dry environments. The eggs of reptiles contain everything an embryo needs: water, nutrients, a system for gas exchange, and a place to store waste. Membranes separate the internal parts of the egg, which is covered by a protective shell.

Reptiles reproduce sexually. The egg cell of the female joins with the sperm cell of the male in the process of fertilization. After fertilization, a protective case, or shell, forms around each egg while it is still inside the female's body. The female selects a place to lay the eggs on land. Many species of reptiles build or dig nests. Some female reptiles, including alligators, guard their nests and care for their offspring after they hatch. Most reptiles, however, leave soon after the eggs are laid. As you can see in the photograph above, when young reptiles hatch, they look like small adults.

CONTRAST How does the egg this gecko hatched from differ from the wood frog eggs shown on page 166?
The body temperatures of amphibians and reptiles change with the environment.

Amphibians and reptiles are **ectotherms**, animals whose body temperatures change with environmental conditions. You are not an ectotherm. Whether the air temperature of your environment is $-4^\circ C$ (25°F) or $43^\circ C$ (110°F), your body temperature remains around $37^\circ C$ (99°F). A tortoise’s body temperature changes with the temperature of the air or water surrounding it. On a cool day, a tortoise’s body will be cooler than it is on a hot one.

Many ectothermic animals can move and respond more quickly when their bodies are warm. Many ectotherms warm themselves in sunlight. You may have seen turtles or snakes sunning themselves. Ectothermic animals transform most of the food they consume directly into energy. Some ectotherms, even large ones such as alligators, or the Galápagos tortoise in the photograph, can survive for a long time without consuming much food.
Although amphibians and reptiles do not have a constant body temperature, their bodies stop functioning well if they become too hot or too cold. Most amphibians and reptiles live in environments where the temperature of the surrounding air or water does not change too much. Others, like wood frogs and painted turtles, have adaptations that allow them to slow their body processes during the winter.

Amphibians and reptiles also have behaviors that allow them to adjust their body temperature in less extreme ways. The sand-diving lizard in the photograph above is able to control how much heat enters its body through the sand by standing on just two of its four feet. Many amphibians and reptiles live near water and use it to cool off their bodies.

KEY CONCEPTS
1. What are three adaptations that allowed the first amphibians to survive on land?
2. What are two adaptations reptiles have that allow them to live their whole life on land?
3. A crocodile has been lying in the sun for hours. When it slides into the cool river, how will its body temperature change? Why?

CRITICAL THINKING
4. Compare and Contrast
   Make a diagram to show how amphibians and reptiles are different and how they are similar.
5. Infer
   Some reptiles, like sea turtles, live almost their whole lives in water. What differences would you expect to see between the bodies of a sea turtle and a land turtle?

CHALLENGE
6. Hypothesize
   For many millions of years, reptiles were the most diverse and successful vertebrate animals on land. Now many of these ancient reptiles are extinct. Give some reasons that might explain the extinction of these reptiles.