SECTION 1 Change Over Time

California Science Standards

7.3.c, 7.3.d

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- How are organisms different from one another?
- How do scientists know that species change over time?
- How can you tell if species are related?

What Are Adaptations?

STUDY TIP

Learn New Words As you read this section, circle the words you don't understand. When you figure out what they mean, write the words and their definitions in your notebook.

The pictures below show three different kinds of frogs. These frogs all have some things in common. For example, they all have long back legs to help them move. However, as you can see in the pictures, there are also many differences between the frogs. Each frog has some physical features that can help it survive.

The red-eyed tree frog has green skin. It hides in the leaves of trees during the day. It comes out at night.

The skin of the smokey jungle frog looks like leaves. It can hide on the forest floor.

The strawberry poison frog has brightly-colored skin. Its bright coloring warns predators that it is poisonous.

TAKE A LOOK

1. Explain How does the coloring of the strawberry poison frog help it survive?

A feature that helps an organism survive and reproduce in its environment is called an **adaptation**. Some adaptations, such as striped skin or a long neck, are physical features. Other adaptations are behaviors that help an organism find food, protect itself, or reproduce.

Critical Thinking

2. Infer Give an example of a behavior that could help an organism survive.

Living things with the same features may be members of the same species. A **species** is a group of organisms that can mate with one another to produce fertile offspring. *Fertile* offspring are offspring that can reproduce. For example, all smokey jungle frogs are members of one species. Therefore, smokey jungle frogs can mate with each other to produce offspring. The offspring can also reproduce.

A group of individuals of the same species living in the same place is a *population*. For example, all of the smokey jungle frogs living in a certain jungle are a population.

CHANGE OVER TIME

Scientists estimate that there has been life on Earth for over 3 billion years. Earth has changed a great deal during its history. Living things have changed in this time too. Since life first appeared on Earth, many species have died out and many new species have appeared.

Scientists observe that species change over time. They also observe that the inherited characteristics in populations change over time. Scientists think that as populations change, new species form. New species descend from older species. The process in which populations change over time is called **evolution**. ☑

READING CHECK

3. Define What is evolution?

What Is the Evidence That Organisms Have Changed?

Much of the evidence that organisms have changed over time is buried in sedimentary rock. *Sedimentary rock* forms when pieces of sand, dust, or soil are deposited in flat layers. Sedimentary rocks may contain fossils. These fossils provide evidence that organisms have changed over Earth's history.

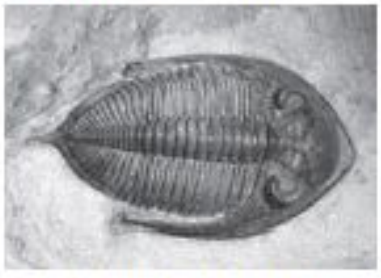
FOSSILS

Fossils are the remains or imprints of once-living organisms. Some fossils formed from whole organisms or from parts of organisms. Some fossils are signs, such as footprints, that an organism once existed. ☑

Fossils can form when layers of sediment cover a dead organism. Minerals in the sediment may seep into the organism and replace its body with stone. Fossils can also form when an organism dies and leaves an imprint of itself in sediment. Over time, the sediment can become rock and the imprint can be preserved as a fossil.

READING CHECK

4. Identify What are two kinds of fossils?



Some fossils, like this trilobite, form from the bodies of organisms. The trilobite was an ancient marine animal.

Some fossils, like these ferns, form when an organism leaves an imprint in sediment. Over time, the sediment becomes rock and the imprint is preserved as a fossil.

TAKE A LOOK

5. Compare Which of the fossils looks most like an organism that lives today? Give the modern organism that the fossil looks like.

CALIFORNIA STANDARDS CHECK

7.3.c Students know how independent lines of evidence from geology, fossils, and comparative anatomy provide the bases for the theory of evolution.

Word Help: evidence information showing whether an idea or belief is true or valid

6. Explain How do fossils give evidence that organisms have changed over time?

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THE FOSSIL RECORD

Comparing fossils provides evidence that organisms have changed over time. Rocks from different times in Earth's history contain fossils of different organisms. Fossils in newer layers of rock tend to be similar to present-day organisms. Fossils from older layers are less similar to present-day organisms. By studying fossils, scientists have made a timeline of life known as the **fossil record.**

How Do Scientists Compare Organisms?

Scientists observe that all living things have some features in common. They also observe that all living things inherit features in a similar way. Therefore, scientists think that all living species are descended from a common ancestor. Scientists compare features of fossils and of living organisms to determine whether ancient species are related to modern species.

COMPARING STRUCTURES

When scientists study the anatomy, or structures, of different organisms, they find that some organisms share traits. These organisms may share a common ancestor. For example, the figure below shows that humans, cats, dolphins, and bats have similar structures in their front limbs. These similarities suggest that humans, cats, dolphins, and bats have a common ancestor.

Comparing Structures The front limb bones of humans, cats, dolphins, and bats show some similarities. This suggests that all of these species share a common ancestor.

TAKE A LOOK

7. Color Color the bones in each front limb to show which bones are similar. Use a different color for each bone.

Scientists can study the structures in modern organisms and compare them to structures in fossils. In this way, scientists can gather evidence that living organisms are related to organisms that lived long ago.

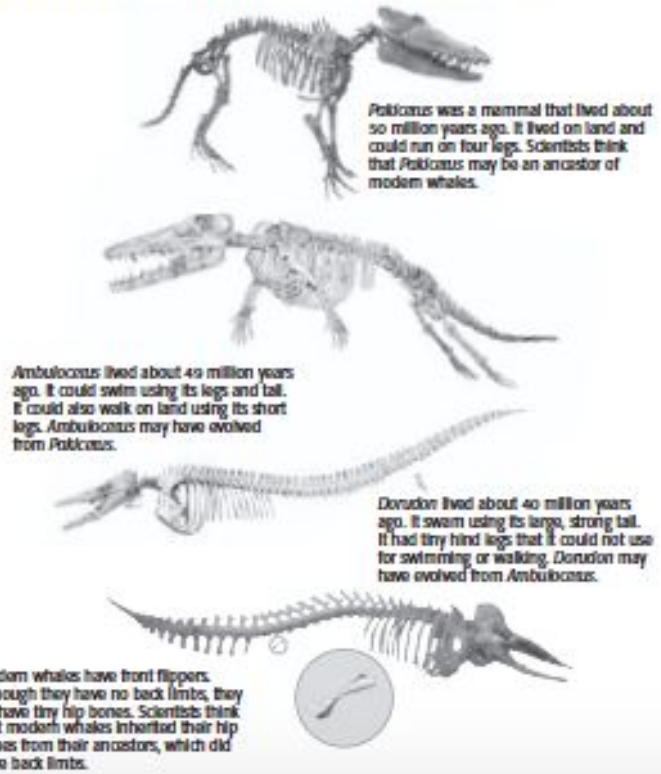
COMPARING CHEMICAL DATA

The genetic information in an organism's DNA determines the organism's traits. RNA and proteins also affect the traits of an organism. Scientists compare these chemicals in organisms. The more alike these chemicals are between any two species, the more recently the two species shared a common ancestor.

Comparing DNA, RNA, and proteins can be very useful in determining whether species are related. However, this method can only be used on organisms that are alive today.

What Is the Evidence That Organisms Are Related?

Examining an organism carefully can give scientists clues about its ancestors. For example, whales look like some fish. However, unlike fish, whales breathe air, give birth to live young, and produce milk. These traits show that whales are mammals. Therefore, scientists think that whales evolved from ancient mammals. By examining fossils from ancient mammals, scientists have been able to determine how modern whales may have evolved.



Pakicetus was a mammal that lived about 50 million years ago. It lived on land and could run on four legs. Scientists think that *Pakicetus* may be an ancestor of modern whales.

Ambulocetus lived about 49 million years ago. It could swim using its legs and tail. It could also walk on land using its short legs. *Ambulocetus* may have evolved from *Pakicetus*.

Dorudon lived about 40 million years ago. It swam using its large, strong tail. It had tiny hind legs that it could not use for swimming or walking. *Dorudon* may have evolved from *Ambulocetus*.

Modern whales have front flippers. Although they have no back limbs, they do have tiny hip bones. Scientists think that modern whales inherited their hip bones from their ancestors, which did have back limbs.

Critical Thinking

8. Infer Why can DNA, RNA, and proteins be used to compare only living organisms?

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READING CHECK

9. Describe Why do scientists think that whales evolved from ancient mammals and not ancient fish?

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TAKE A LOOK

10. Compare Give two ways that modern whales are different from *Pakicetus*, and two ways that they are similar.

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EVIDENCE FROM FOSSILS

Fossils provide several pieces of evidence that some ancient mammals are related to each other and to modern whales. First, fossils of each species share some traits with fossils of an earlier species. Second, fossils of some species show new traits that are also found in fossils of later species. Third, each species had traits that allowed it to survive in a particular time and place in Earth's history.

READING CHECK

11. Identify Give one piece of evidence that indicates ancient mammals are related to each other and to modern whales.

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EVIDENCE FROM MODERN WHALES

Some features of modern whales also suggest that they are related to ancient mammals. For example, modern whales do not have hind limbs. However, they do have tiny hip bones. Scientists think that modern whales inherited these hip bones from the whales' four-legged ancestors. Scientists often use this kind of evidence to determine the relationships between organisms.

How Do Scientists Show the Relationships Between Organisms?

As scientists analyze fossils and living organisms, they develop hypotheses about how species are related. They use *branching diagrams* to show the relationships between species.

TAKE A LOOK

12. Use a Model According to the diagram, which animals are most closely related to whales?

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13. Use a Model According to the diagram, which animals are least closely related to whales?

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