

Chapter Quiz

Write your answers on a separate sheet of paper.

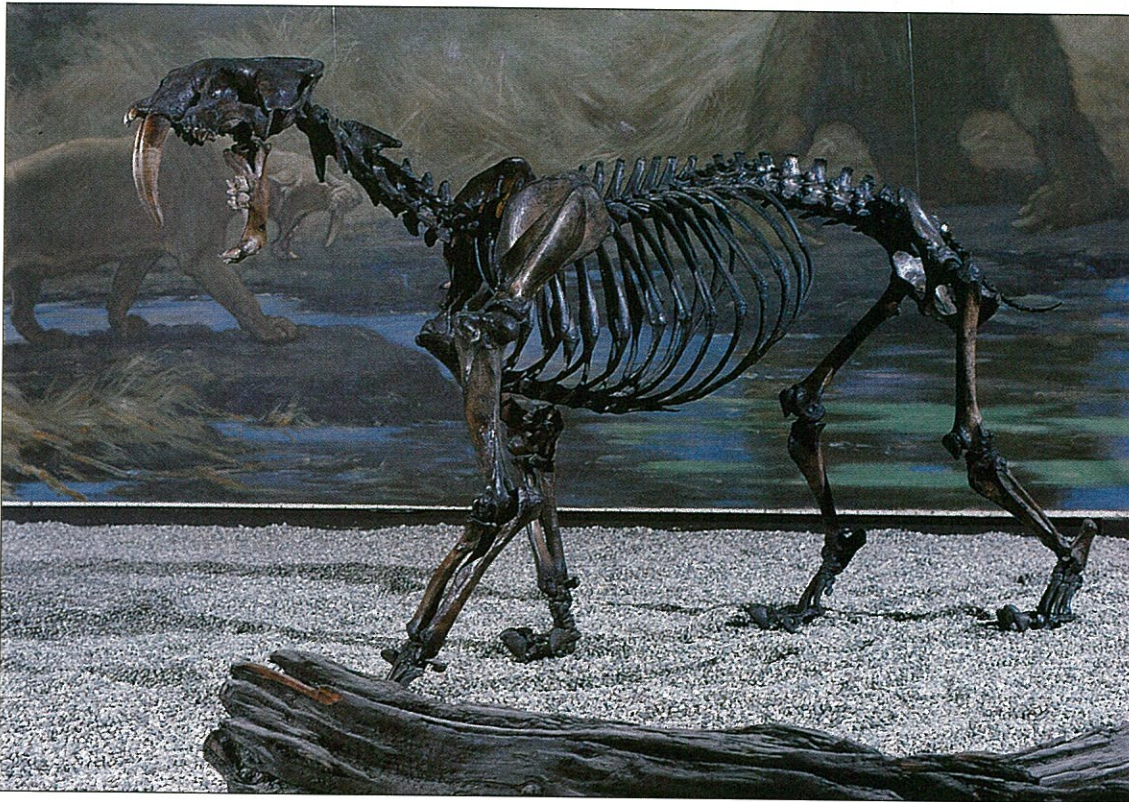
1. What does an organism pass along to its offspring?
2. Does a recessive trait disappear forever?
If not, when may it reappear?
3. Mendel produced pea plants that were hybrid for seed shape. Why did the hybrid plants have round seeds instead of wrinkled seeds?
4. Where are the genes in your cells located?
5. How many chromosomes are in human sex cells?
How many chromosomes are in human body cells?
6. What does a cell make copies of before it divides?
7. Why are harmful mutations usually not passed on to offspring?
8. How do farmers use genetics to produce better livestock?
9. How can the environment affect an organism's traits?
Give two examples.
10. How did scientists produce bacteria that make human insulin?

Test Tip

Before you begin a test, look it over. Try to decide how much time you will need for each question. Set aside enough time for more difficult questions.

Research Project

Choose any plant or animal to research. The organism might be at home or near your school. On a separate sheet of paper, name as many of the organism's traits as you can. Be sure to include its size, shape, and color. Describe how the organism acts. Name three traits that are caused by the organism's genes. Name a trait that is caused by the organism's environment.



This is a skeleton of a saber-toothed tiger that lived millions of years ago. There are no saber-toothed tigers on Earth today. How was this animal like the tigers of today? How was it different?

Learning Objectives

- List the ways scientists learn about theories of evolution.
- Describe Lamarck's theory of evolution.
- Identify the four main parts of Darwin's theory of evolution.
- Compare and contrast natural selection and mutation.
- Explain the role of mutations in the theory of evolution.
- LAB ACTIVITY: Explore how natural selection works.
- SCIENCE IN YOUR LIFE: Relate use of pesticides to natural selection of pests.

Words to Know

evolution	the process of change in a species over time, usually over thousands or millions of years
extinct	no longer existing on Earth
fossil	the remains of an organism that lived long ago
paleontology	the scientific study of fossils
theory	an explanation about something that is supported by data
naturalist	a scientist who studies living things in nature
natural selection	the way organisms that are best suited to their environment survive and pass on their helpful traits to offspring

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Remember

Protists are tiny one-celled creatures.

What Is Evolution?

Most scientists believe that life first appeared on Earth about 3 billion years ago. The organisms were a lot like protists that live in the ocean today.

It is possible that all the plants and animals alive today came from those first creatures. The evidence suggests that humanlike creatures have only been around for about 5 million years. That is really not very long. Remember that the Earth has existed for about 4.6 *billion* years.

Species change over time. For example, the woolly mammoth no longer exists. Yet that species slowly changed into what we know today as the elephant. Dinosaurs do not exist anymore, either. However, some scientists think that the ancestors of today's birds were dinosaurs. This process of change in a species over time, usually over thousands or millions of years, is called **evolution**. To evolve is to change with time. From those first one-celled creatures, evolution may have formed all the organisms alive today.



The woolly mammoth evolved into the elephant.

✓ What happens to species over time?

Putting Together the Puzzle of the Past

Scientists have put together a picture of evolution from many clues. For example, woolly mammoths have been **extinct** for a long time. Something that is extinct is no longer existing on Earth. The species has died out and is gone forever. However, the bones and teeth of dinosaurs and other extinct animals have been found. Scientists have found woolly mammoths in Siberia. Ice had preserved them for 25,000 years. Extinct insects have also been found trapped in hardened tree sap.

The remains of an organism that lived long ago is called a **fossil**. Bones and teeth are fossils. Footprints preserved in rock are also fossils. Fossils show how organisms from the past are different from organisms on Earth today. They also show that today's organisms evolved from these older species.



This fossil is the impression of a plant that lived long ago.

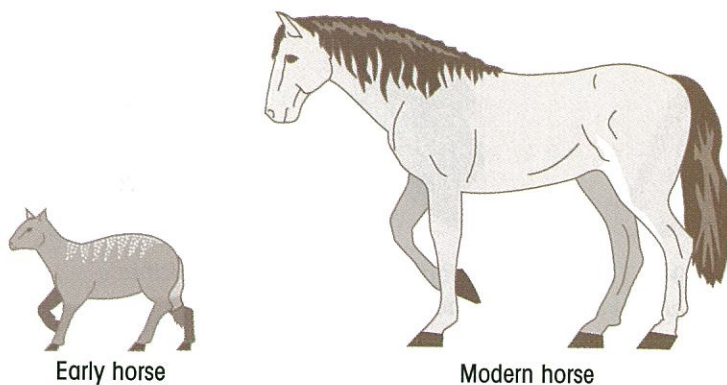


Figure 9-1 *Early horses were the size of large modern dogs.*

The scientific study of fossils is called **paleontology**. By studying fossils, paleontologists learned that early horses were about the size of large modern dogs. These horses had four toes on each front foot and three toes on each back foot. Modern horses have only one toe per foot.

✓ **What are three kinds of fossils?**

DNA and Other Clues to Evolution

In addition to fossils, scientists also look at other clues. They study an organism's DNA to learn about evolution.

Remember

DNA holds the genetic code of an organism.

For example, scientists have found that the DNA in humans is 98 percent the same as the DNA in chimpanzees. This means that our genetic codes are very much alike. Scientists believe that it also means that humans and chimpanzees could have evolved from the same ancestor.

Scientists also compare the bones of different living animals for clues about evolution. For example, the bones in a lion's foreleg, a bat's wing, and a dolphin's flipper are very similar. Scientists say this is because these animals have a common ancestor.



Figure 9-2 *The lion's foreleg, bat's wing, and dolphin's flipper all have similar bone structures.*

✓ Why do scientists study an organism's DNA?

Lesson Review

1. What process may have formed all the organisms alive today?
2. Why do scientists search for fossils?
3. **CRITICAL THINKING** Scientists have found DNA in the fossils of some extinct organisms. What can they learn by comparing this DNA to the DNA of living organisms?

Words to Know

theory	an explanation about something that is supported by data
naturalist	a scientist who studies living things in nature
natural selection	the way organisms that are best suited to their environment survive and pass on their helpful traits to offspring

An Early Theory

In 1809, the French biologist Jean Baptiste Lamarck came up with a **theory** of evolution. A theory is an explanation about something that is supported by data. Lamarck suggested that organisms develop traits by using or not using parts of the body. If a part of the body is used a lot, it becomes larger and stronger. If it is not used, it becomes smaller and weaker. Lamarck also believed that the traits an organism developed during its lifetime could be passed on from parents to offspring. A species evolves by inheriting traits such as these.

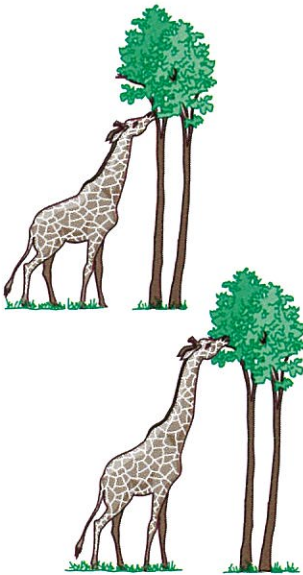
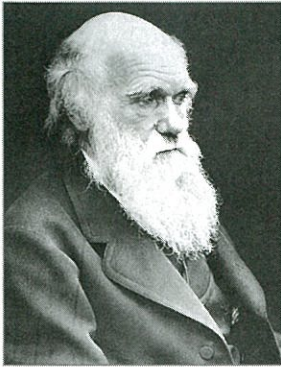


Figure 9-3 *Lamarck mistakenly believed that giraffes grew longer necks by stretching to reach leaves.*

Lamarck used the giraffe as a model for his theory. He assumed that early giraffes had short necks and ate grass. Then the environment changed, and the grass died. The giraffes began to eat leaves on trees instead. They stretched their necks to reach the leaves on high branches. This made their necks grow longer. The new trait was passed on.

Lamarck did not have much evidence to support his theory. Eventually it was proven wrong. Although his explanation for evolution was wrong, Lamarck was the first person to propose that new species evolved from older species.

✓ What was Lamarck's theory of evolution?



Charles Darwin
(1809–1882)

Darwin and Natural Selection

Charles Darwin was an English scientist who played an important role in developing the modern theory of evolution.

In 1831, when Darwin was only 22 years old, he sailed around the world. Darwin was the ship's **naturalist**. A naturalist is a scientist who studies living things in nature.

Darwin's job was to list and describe all the plants and animals he saw on the trip. His observations led him to his theory of evolution.

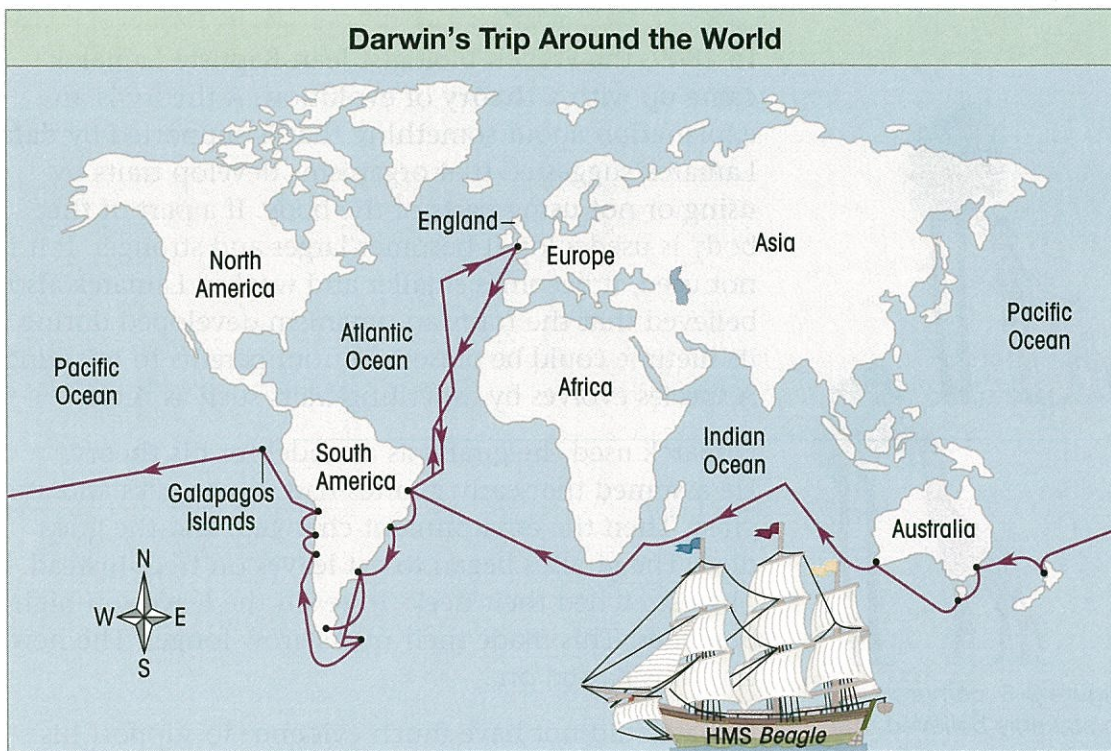


Figure 9-4 *Darwin worked as a naturalist aboard the Beagle on its five-year voyage.*

When Darwin returned to England, he studied his notes. He also studied all the existing theories on the origins of different animals, including humans. Then, in 1858, he wrote a book on his theories. His ideas became the basis of the modern study of evolution.

An important part of Darwin's theory of evolution was **natural selection**. Natural selection is the way organisms that are best suited to their environment survive and pass on their helpful traits to offspring.

Remember that when organisms reproduce by sexual reproduction, the offspring get half of their genes from each parent. Each parent's genes control thousands of traits. So, each offspring has a new combination of genes.

Over time, some gene combinations increase the ability of an organism to survive and reproduce. Other combinations lead to an early death of the organism. Since these individuals die before they can reproduce, their gene combinations are lost.

There are four main ideas that make up Darwin's theory of natural selection.

- 1. Most organisms have more offspring than can survive.** For example, an insect lays many, many eggs in its lifetime. Only a few of these eggs will survive to become full-grown insects. Dandelions release thousands of seeds. Only a few of these seeds will be carried by the wind or animals and land somewhere good for growing into plants.
- 2. Offspring must compete for food and space.** Many of an organism's offspring do not survive and reproduce. That is because there is not enough food and living space for all of them. Only those young organisms that can get food and living space will survive. A seed that lands in a dry, dark place will not grow into a plant. A kitten born in a field where there are five full-grown cats may not catch enough mice to eat and survive. There is too much competition.



Science Fact

The change in one generation may be very small. However, over thousands or millions of generations, a whole new species may be formed.

- 3. Organisms that survive have traits that are best suited to their environment.** Remember that there is not enough food and space for all organisms. To survive, an organism must be able to get food and protect itself from enemies. The strong, fast cats will probably get the mice before the slow, weak ones. Brown rabbits living in the forest are better camouflaged from enemies than white rabbits.
- 4. Natural selection passes along helpful traits to offspring.** Strong, fast cats will live longer than weak, slow ones. So the strong, fast cats are more likely to have offspring. They will pass on their genes to their kittens.

✓ **Why are helpful traits more likely to be passed on to offspring?**

Mutations and Evolution

Scientists today know a lot more about evolution than Darwin did. By studying DNA, they have learned some of the ways that changes in species come about.

Mutations, for example, can cause a species to change. Change due to a mutation is different from change due to natural selection. Change by natural selection occurs through new combinations of existing genes. Mutation occurs when a whole new gene is formed. A mutation is a kind of genetic mistake. Many mutations are harmful. Sometimes, however, a mutation introduces a helpful trait to a species.

Remember that the early horses had several toes. This made them slow runners. Perhaps a mutation caused a horse to be born with fewer toes. This horse, and its offspring, could run faster from enemies. These offspring survived better than those with several toes. Over time, the horses with several toes died out.

✓ **How can mutations change the course of evolution?**

Remember

A mutation is a change in the genetic code of an organism.

Lesson Review

1. What kind of traits did Lamarck believe are passed from parents to offspring?
2. Which offspring of an organism are most likely to survive and reproduce?
3. **CRITICAL THINKING** Suppose a brown rabbit has a mutation that makes its fur white. Would that mutation be helpful or harmful in a snowy environment? Explain why.

Great Moments in Science

JUMPING GENES

Barbara McClintock was a biologist. She spent her life studying corn in order to learn more about genes. In the 1940s, McClintock discovered that genes were not found in only one place. They moved around on chromosomes.

McClintock gave talks and wrote reports about her “jumping genes.” No one paid any attention. Forty years later, other scientists finally caught up with her ideas. They, too, found that genes jump on chromosomes. This discovery helped explain how many new combinations of genes are formed. It helped scientists understand how organisms evolve. At the age of 81, McClintock won the Nobel Prize.

CRITICAL THINKING McClintock repeated her experiments many times. How did that make it easier for other scientists to finally accept her idea?



McClintock showed that the colors of corn kernels could change when certain genes moved on the chromosomes.



LAB ACTIVITY

Studying Natural Selection

BACKGROUND

Organisms pass their helpful traits to their offspring. One helpful trait for many animals is having a color that blends into their environment.

PURPOSE

You will see how a helpful trait can be passed on due to natural selection.

MATERIALS

brown and white dots, white cloth, stopwatch

WHAT TO DO

1. Copy the chart to the right.
2. Get 40 brown dots and 40 white dots from your teacher. Each dot represents an animal in the first generation.
3. Spread the cloth on the floor. The cloth represents the environment. Scatter all the dots on the cloth.
4. Pick up as many dots as you can, one at a time, as your partner times you for 30 seconds.
5. Count the number of brown dots and white dots that are left on the cloth. They represent brown animals and white animals that have survived and can now reproduce. Double the number of each color by scattering more dots on the cloth. For example, if there are 10 brown dots and 30 white dots left, add 10 more brown dots and 30 more white dots.
6. Count the number of brown dots and white dots that are now on the cloth. These dots represent animals in the second generation. Enter the numbers in your chart.
7. Repeat steps 4 to 6 to get the third generation.

Generation	Brown Dots	White Dots
1	40	40
2		
3		

DRAW CONCLUSIONS

- How many “animals” of each color were in each generation?
- How does this activity show that natural selection helps pass along certain traits?

SCIENCE IN YOUR LIFE

Changing the Course of Natural Selection

Rey is having a birthday party at his home. It is summer, and the weather is sunny and warm. His guests will play volleyball and eat in the back yard.

However, there are many mosquitoes outside. Rey is worried that the mosquitoes will bite his guests and ruin the party. He decides to spray the yard with a *pesticide*, a poison that kills insects. The pesticide gets rid of most of the mosquitoes. The party is saved.

Rey did not know that by using the pesticide, he could be helping future generations of mosquitoes. Most mosquitoes are killed by the pesticide, but some survive. One of the survivors might have a mutation that makes it *resistant to*, or unharmed by, the pesticide. When it reproduces, its offspring may be resistant, too. If the pesticide is used often, most of the mosquitoes may be resistant after many generations. The same thing can happen with other kinds of pests, such as bacteria and weeds. This is the process of natural selection.

To see how pests can become resistant to pesticides, answer these questions.

1. Suppose there are 1,000 normal mosquitoes and one resistant mosquito in a field. What fraction of the mosquitoes are resistant?
2. The field is sprayed with a pesticide. The resistant mosquito survives, and so do one out of every hundred of the normal mosquitoes. How many normal mosquitoes survive?
3. Each of the survivors produces 100 offspring. How many resistant offspring are there? How many normal offspring are there?
4. As a group, have the mosquitoes become more resistant, less resistant, or stayed about the same?



Chemical poisons can cause the natural selection of pests that are resistant.

Critical Thinking

What would happen to the resistant mosquitoes if a new pesticide was used?

Summary

The theory of evolution explains how species change over time. The current theory of evolution, including the theory of natural selection, was developed by Charles Darwin.

Lesson 9.1

Scientists study fossils for answers about evolution. Scientists also study the DNA and bone structure of living organisms.

Lesson 9.2

Charles Darwin developed his theory of evolution in the mid-1800s. His theory of natural selection explains how helpful traits are passed on to new generations. Mutations help explain how new traits can appear. A helpful mutation will be passed on to offspring.

extinct

evolution

fossil

naturalist

natural selection

paleontology

theory

Vocabulary Review

Match each definition with a term from the list.

1. An explanation about something that is supported by data
2. The way organisms that are best suited to their environment survive and pass on their helpful traits to their offspring
3. No longer existing on Earth
4. The process of change in a species over time, usually over thousands or millions of years
5. The remains of an organism that lived long ago
6. A scientist who studies living things in nature
7. The scientific study of fossils

Chapter Quiz

Write your answers on a separate sheet of paper.

1. What does a species do when it evolves?
2. What can scientists learn by studying fossils?
3. How do scientists use DNA to find out about evolution?
4. How do the limbs of lions, bats, and dolphins show that these animals came from the same ancestor?
5. What did Lamarck believe happens to the traits that an organism develops during its lifetime?
6. What are the four main ideas in Darwin's theory of natural selection?
7. What idea of natural selection is shown by a kitten catching a mouse?
8. What idea of natural selection is shown by a white rabbit in the snow?
9. How is change by natural selection different from change due to a mutation?
10. What kinds of mutations are most likely to cause a species to change?

Test Tip

If you cannot think of an answer, try to remember a picture of something related to that topic. It may help you recall the answer.

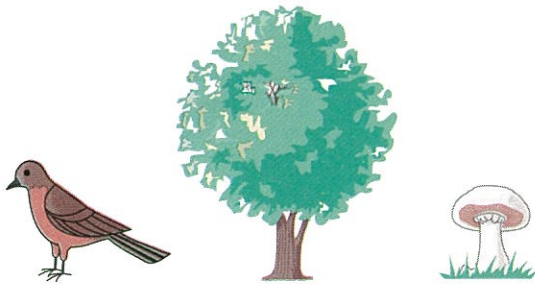
Research Project

Use the Internet or the library to find out about an extinct organism such as the dodo bird, passenger pigeon, or dinosaur. Look for a picture of the organism. Study the picture. Then write a paragraph that describes the organism. What did it look like? When did it live? Where did it live? How was it different from organisms of today?

Unit 2 Review

Choose the letter for the correct answer to each question.

Use the diagram to answer Questions 1 to 3.



1. Which characteristic do the organisms above *not* share?
 - A. growing
 - B. reproducing
 - C. living without water
 - D. responding to the environment
2. The tree can make its own food because each leaf cell has which of the following?
 - A. cytoplasm
 - B. a cell membrane
 - C. a nucleus
 - D. chloroplasts
3. To which kingdom does the mushroom belong?
 - A. Moneran
 - B. Fungus
 - C. Protist
 - D. Animal
4. All animals have which of the following?
 - A. specialized cells
 - B. jointed appendages
 - C. lungs
 - D. a backbone
5. What is the male part of a flower called?
 - A. pistil
 - B. stamen
 - C. stem
 - D. petal
6. What is the threadlike structure in a nucleus that holds thousands of bits of information called?
 - A. gene
 - B. trait
 - C. hybrid
 - D. chromosome
7. Which of the following is an example of a fossil?
 - A. DNA
 - B. a mutation
 - C. a footprint in rock
 - D. a living tree

Critical Thinking

Many biologists think that plants evolved from algae and that animals evolved from protozoa. Why might biologists think that?