Section 2

Evidence of Evolution

Reading Preview

Key Concepts

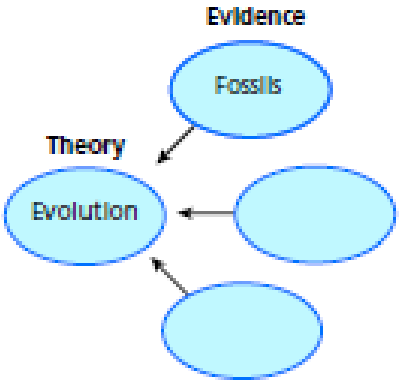
- What evidence supports the theory of evolution?
- How do scientists infer evolutionary relationships among organisms?
- How do new species form?

Key Terms

- homologous structures
- branching tree

Target Reading Skill

Identifying Supporting Evidence Evidence consists of facts that can be confirmed by testing or observation. As you read, identify the evidence that supports the theory of evolution. Write the evidence in a graphic organizer like the one below.



Lab zone Discover Activity

How Can You Classify Species?

1. Collect six to eight different pens. Each pen will represent a different species of similar organisms.
2. Choose a trait that varies among your pen species, such as size or ink color. Using this trait, try to divide the pen species into two groups.
3. Now choose another trait. Divide each group into two smaller groups.

Think It Over

Classifying Which of the pen species share the most characteristics? What might the similarities suggest about how the pen species evolved?

Does natural selection occur today? Evidence indicates that the answer is yes. Consider, for example, what happens when chemicals called pesticides are used to kill harmful insects such as the cockroaches below. When a pesticide is first used in a building, it kills almost all the insects. But a few insects have traits that protect them from the pesticide. These insects survive.

The surviving insects reproduce. Some of their offspring inherit the pesticide protection. The surviving offspring, in turn, reproduce. Every time the pesticide is used, the only insects that survive are those that are resistant to the harmful effects of the pesticide. After many years, most of the cockroaches in the building are resistant to the pesticide. Therefore, the pesticide is no longer effective in controlling the insects. The development of pesticide resistance is one type of evidence that supports Darwin's theory of evolution.

Figure 7
Pesticide Resistance
Many insects, including cockroaches such as these, are no longer killed by some pesticides. Increased pesticide resistance is evidence that natural selection is happening.

Interpreting the Evidence

Since Darwin's time, scientists have found a great deal of evidence that supports the theory of evolution. **Fossils, patterns of early development, and similar body structures all provide evidence that organisms have changed over time.**

Fossils By examining fossils, scientists can infer the structures of ancient organisms. Fossils show that, in many cases, organisms that lived in the past were very different than organisms alive today. You will learn more about the importance of fossils in the next section.

Similarities in Early Development Scientists also make inferences about evolutionary relationships by comparing the early development of different organisms. Suppose you were asked to compare an adult fish, salamander, chicken, and opossum. You would probably say they look quite different from each other. However, during early development, these four organisms are similar, as you can see in Figure 8. For example, during the early stages of development all four organisms have a tail and a row of tiny slits along their throats. These similarities suggest that these vertebrate species are related and share a common ancestor.

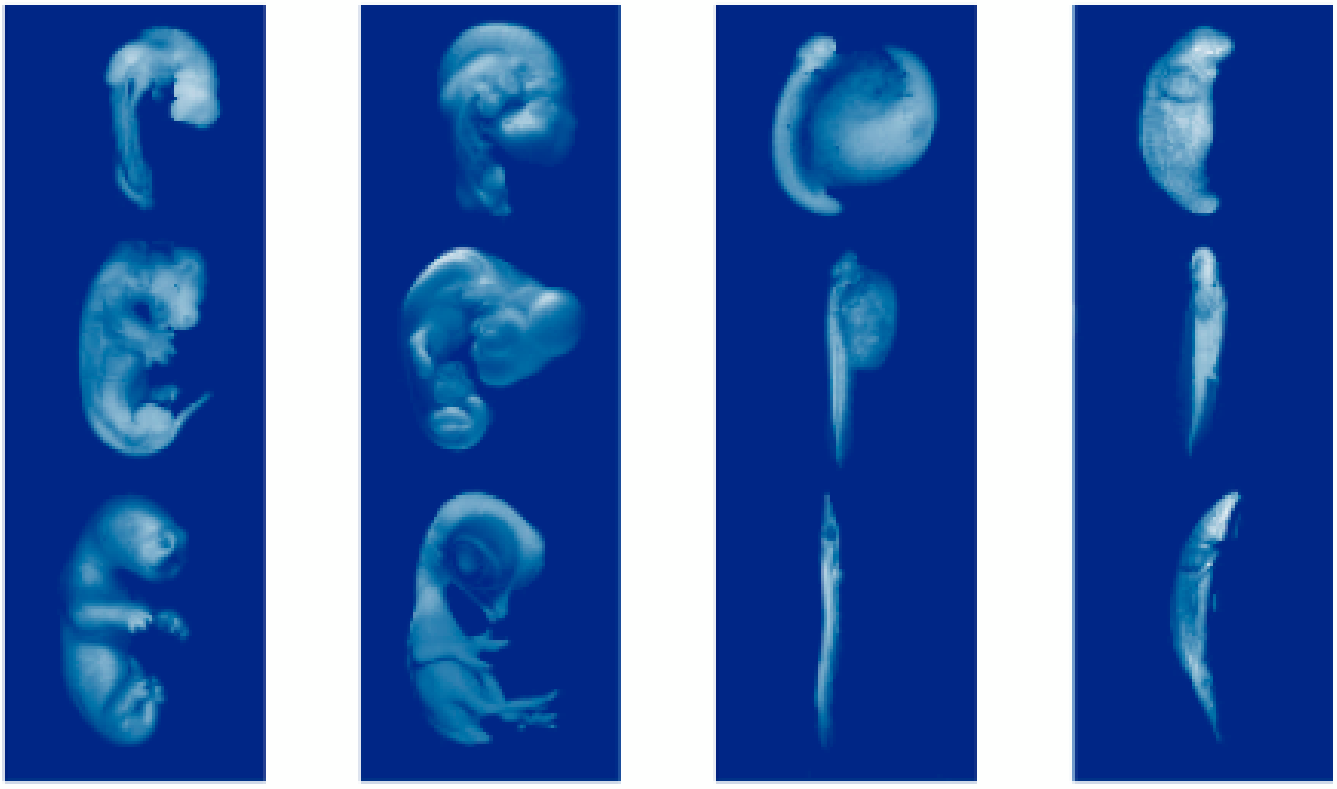


FIGURE 8
Similarities in Development
These animals look similar during their early development.
Comparing and Contrasting *What are some similarities you observe? What are some differences?*

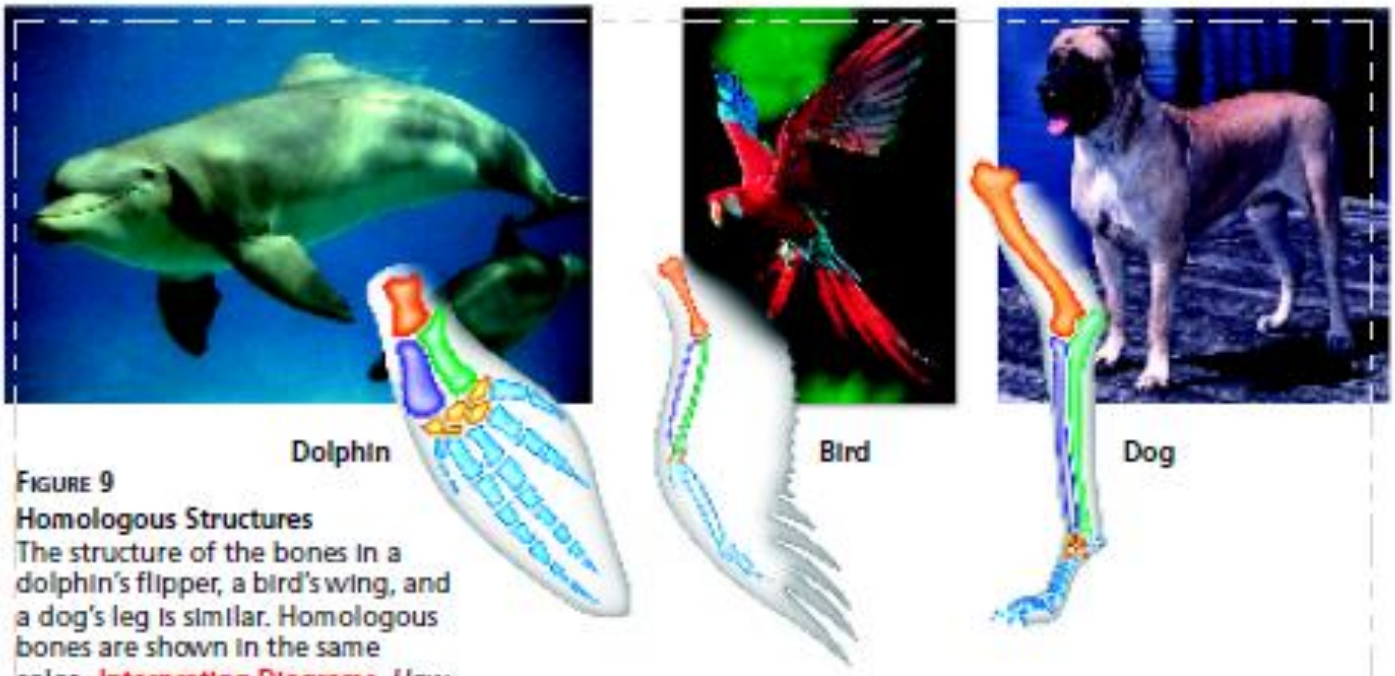


FIGURE 9
Homologous Structures
The structure of the bones in a dolphin's flipper, a bird's wing, and a dog's leg is similar. Homologous bones are shown in the same color. Interpreting Diagrams *How are all three orange bones similar?*

Similarities in Body Structure Long ago, scientists began to compare the body structures of living species to look for clues about evolution. In fact, this is how Darwin came to understand that evolution had occurred on the Galápagos Islands. An organism's body structure is its basic body plan, such as how its bones are arranged. Fishes, amphibians, reptiles, birds, and mammals, for example, all have a similar body structure—an internal skeleton with a backbone. This is why scientists classify all five groups of animals together as vertebrates. All of these groups probably inherited a similar structure from an early vertebrate ancestor that they shared.

Look closely at the structure of the bones in the bird's wing, dolphin's flipper, and dog's leg that are shown in Figure 9. Notice that the bones in the forelimbs of these three animals are arranged in a similar way. These similarities provide evidence that these three organisms all evolved from a common ancestor. Similar structures that related species have inherited from a common ancestor are known as **homologous structures** (hoh MAHL uh gus).

Sometimes scientists find fossils that support the evidence provided by homologous structures. For example, scientists have recently found fossils of ancient whalelike creatures. The fossils show that the ancestors of today's whales had legs and walked on land. This evidence supports other evidence that whales and humans share a common ancestor.

Reading Checkpoint **In what way are the body structures of fishes, amphibians, reptiles, and mammals similar?**

Lab zone Skills Activity

Drawing Conclusions

Look at the drawing below of the bones in a crocodile's leg. Compare this drawing to Figure 9. Do you think that crocodiles share a common ancestor with birds, dolphins, and dogs? Support your answer with evidence.

Crocodile

Inferring Species Relationships

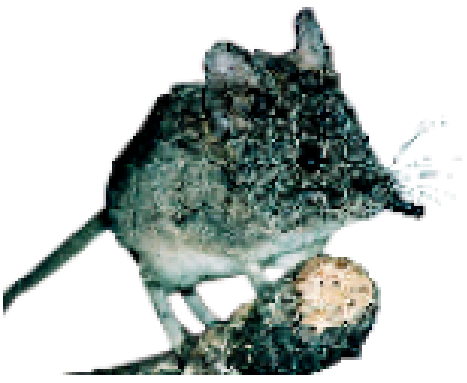
Fossils, early development patterns, and body structure provide evidence that evolution has occurred. Scientists have also used these kinds of evidence to infer how organisms are related to one another. Not too long ago, fossils, embryos, and body structures were the only tools that scientists had to determine how species were related. Today, scientists can also compare the DNA and protein sequences of different species. **Scientists have combined the evidence from DNA, protein structure, fossils, early development, and body structure to determine the evolutionary relationships among species.**

Similarities in DNA Why do some species have similar body structures and development patterns? Scientists infer that the species inherited many of the same genes from a common ancestor. Recently, scientists have begun to compare the genes of different species to determine how closely related the species are.

Recall that genes are made of DNA. By comparing the sequence of nitrogen bases in the DNA of different species, scientists can infer how closely related the two species are. The more similar the DNA sequences, the more closely related the species are. For example, DNA analysis has shown that elephants and tiny elephant shrews, shown in Figure 10, are closely related.

The DNA bases along a gene specify what type of protein will be produced. Therefore, scientists can also compare the order of amino acids in a protein to see how closely related two species are.

Combining Evidence In most cases, evidence from DNA and protein structure has confirmed conclusions based on fossils, embryos, and body structure. For example, recent DNA comparisons show that dogs are more similar to wolves than they are to coyotes. Scientists had already reached this conclusion based on similarities in the structure and development of these three species.



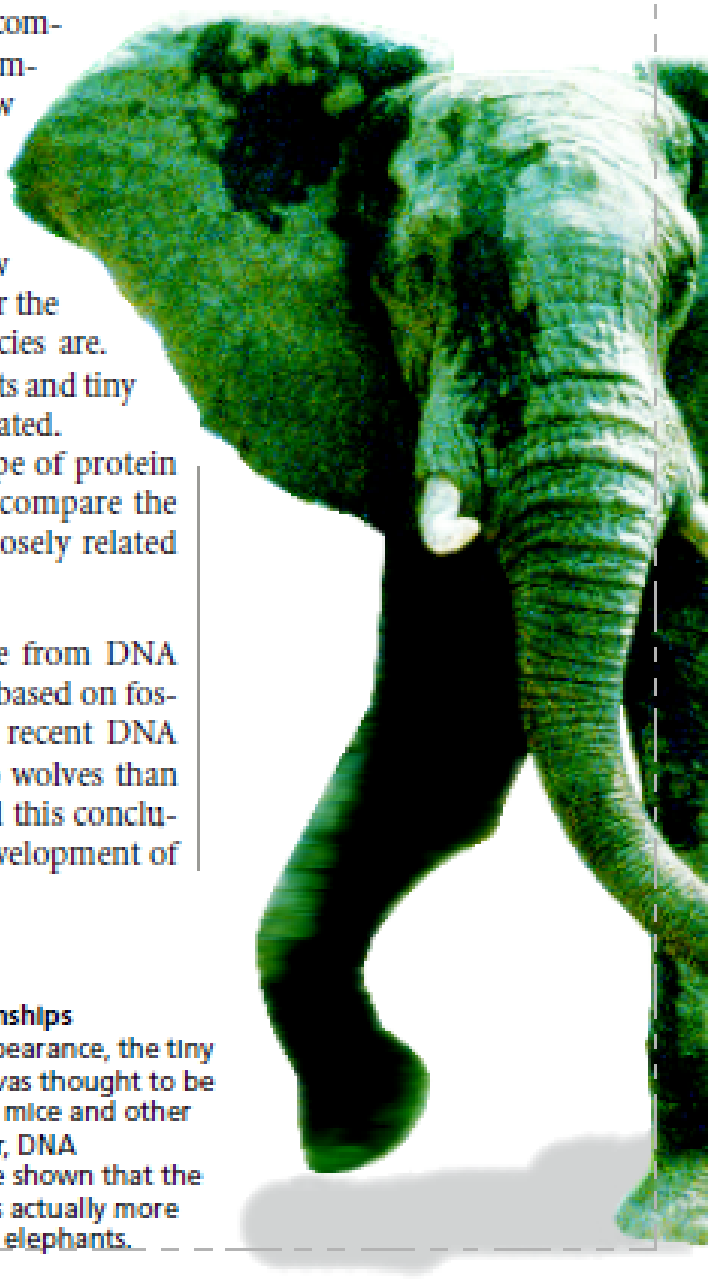


Figure 10
DNA and Relationships
Because of its appearance, the tiny elephant shrew was thought to be closely related to mice and other rodents. However, DNA comparisons have shown that the elephant shrew is actually more closely related to elephants.

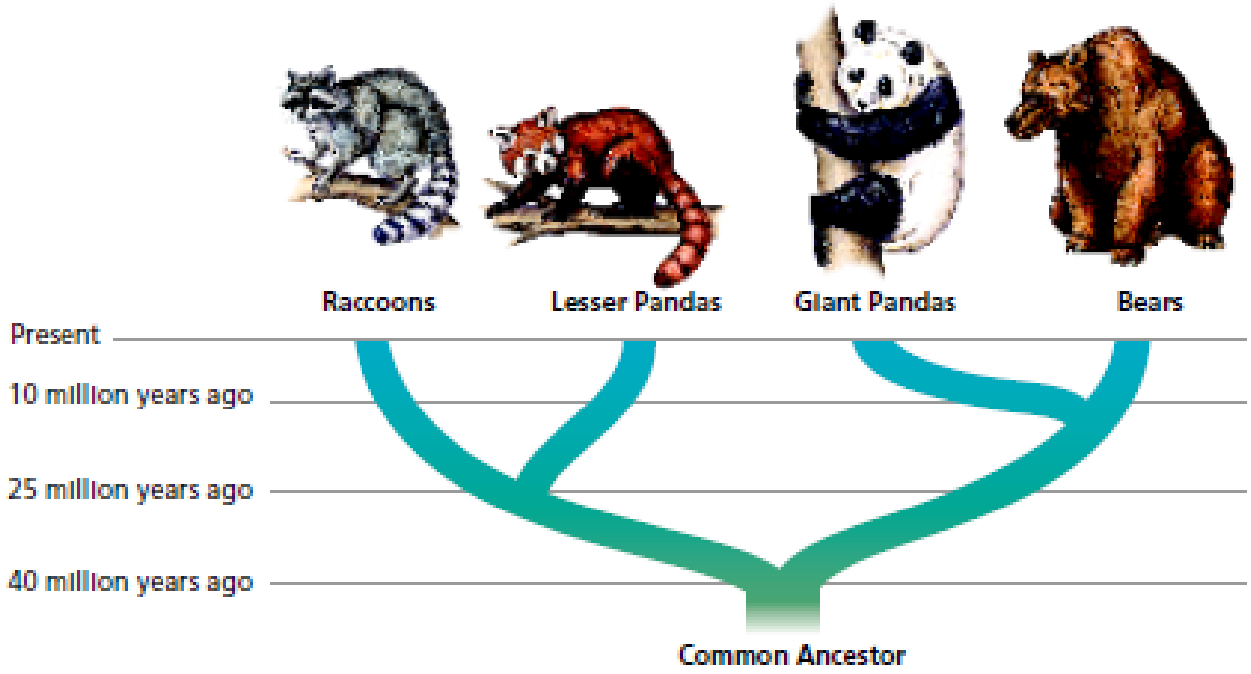


FIGURE 11
A Branching Tree
This branching tree shows how scientists now think that raccoons, lesser pandas, giant pandas, and bears are related.
Interpreting Diagrams *Are giant pandas more closely related to lesser pandas or to bears?*

Sometimes, however, scientists have changed their hypotheses about species relationships. For example, lesser pandas were once thought to be closely related to giant pandas. Recently, however, DNA analysis and other methods have shown that giant pandas and lesser pandas are not closely related. Instead, giant pandas are more closely related to bears, while lesser pandas are more closely related to raccoons.

Branching Trees Scientists use the combined evidence of species relationships to draw branching trees. A **branching tree** is a diagram that shows how scientists think different groups of organisms are related. Figure 11 shows how raccoons, lesser pandas, giant pandas, and bears may be related.

Reading Checkpoint **What is a branching tree?**

How Do New Species Form?

Natural selection explains how variations can lead to changes in a species. But how could an entirely new species form? **A new species can form when a group of individuals remains isolated from the rest of its species long enough to evolve different traits.** Isolation, or complete separation, occurs when some members of a species become cut off from the rest of the species. Group members may be separated by such things as a river, a volcano, or a mountain range.

Abert's squirrel and the Kaibab squirrel both live in forests in the Southwest. As you can see in Figure 12, the populations of the two kinds of squirrel are separated by the Grand Canyon. The Kaibab and Abert's squirrels belong to the same species, but they have slightly different characteristics. For example, the Kaibab squirrel has a black belly, while Abert's squirrel has a white belly. It is possible that one day Abert's squirrel and the Kaibab squirrel will become so different from each other that they will be separate species.

FIGURE 12
Kaibab and Abert's Squirrels
These two kinds of squirrels have been isolated from one another for a long time. Eventually, this isolation may result in two different species.

Section 2 Assessment

Target Reading Skill

Identifying Supporting Evidence Refer to your graphic organizer about the theory of evolution as you answer Question 1 below.

Reviewing Key Concepts

1. a. **Listing** List three kinds of evidence that support the theory of evolution.
   b. **Comparing and Contrasting** What major difference have scientists discovered between today's whales and the fossils of whales' ancient ancestors?
   c. **Drawing Conclusions** How does this difference show that whales and animals with four legs are probably descended from a common ancestor?
2. a. **Identifying** When scientists try to determine how closely related species are, what evidence do they examine?
   b. **Inferring** Of the kinds of evidence you listed above, which are probably the most reliable? Explain your answer.
   c. **Applying Concepts** Insects and birds both have wings. What kinds of evidence might show whether or not insects and birds are closely related? Explain your answer.
3. a. **Reviewing** How can isolation lead to the formation of new species?
   b. **Predicting** A species of snake lives in a forest. A new road separates one group of the snakes from another. Is it likely that these two groups of snakes will become separate species? Why or why not?

Writing in Science

Explaining a Branching Tree Suppose the branching tree in Figure 11 is part of a museum exhibit. Write an explanation of the branching tree for museum visitors. Describe the relationships shown on the tree and identify evidence supporting the relationships.