Section 13.4

1 FOCUS

Section Objectives

13.11 **List** the periods that make up the Cenozoic era.
13.12 **Describe** the land formations created during the Cenozoic era.
13.13 **Describe** the plant life and animal life that became prominent in the Cenozoic era.
13.14 **Describe** the conditions that helped mammals become dominant in the Cenozoic era.

Reading Focus

Build Vocabulary

L2

Flowcharts Have students create flowcharts showing how early plants eventually developed into angiosperms and how mammals changed over time. Recommend that students use this section, as well as previous sections in this chapter. *(Sample answer: aquatic plants that can only survive in water → gymnosperms that must live near a large body of water → angiosperms that do not need to live near a large body of water.)*

Reading Strategy

L2

Angiosperms: developed flowers and covered seeds
Mammals: warm-blooded, insulating body hair, more efficient heart and lungs, increase in size and brain capacity, specialized teeth and limbs

2 INSTRUCT

Cenozoic North America

Build Reading Literacy

L1

Refer to **p. 216D** in **Chapter 8**, which provides the guidelines for comparing and contrasting.

Compare and Contrast After students have read Cenozoic North America, ask: **How were the landscapes of the east and west coasts of North America similar?** *(Both were above sea level.)* **How were the landscapes of the east and west coast of North America different?** *(The west coast was tectonically active. The east coast was not tectonically active.)* **Verbal**

13.4 Cenozoic Era: Age of Mammals

Reading Focus

Key Concepts

- What time period is defined by the Cenozoic era?
- Which land formations were created during the Cenozoic era?
- What types of life forms became prominent in the Cenozoic?
- What adaptations enabled mammals to diversify?

Vocabulary

- mammal
- angiosperm

Reading Strategy

Identifying Details Copy the table below. As you read, list the adaptations of each life form.

Angiosperms	Mammals

The Cenozoic era, or "era of recent life," encompasses the past 65 million years of Earth history. It is the "post-dinosaur" era, the time of mammals, including humans. It is during this span that the physical landscapes and life forms of our modern world came into being. The Cenozoic era represents a much smaller fraction of geologic time than either the Paleozoic or the Mesozoic. The Cenozoic era is shorter than the other eras, but it possesses a rich history because the completeness of the geologic record improves as time approaches the present. The rock formations of this time span are more widespread and less disturbed than those of any preceding time.

The Cenozoic era is divided into two periods of very unequal duration, the Tertiary period and the Quaternary period. The Tertiary period embraces about 63 million years, practically all of the Cenozoic era. The Quaternary period represents only the last 2 million years of geologic time.

Cenozoic North America

Most of North America was above sea level throughout the Cenozoic era. However, the eastern and western margins of the continent experienced contrasting events because of their different relationships with plate boundaries. The Atlantic and Gulf coastal regions were far removed from an active plate boundary, so they were tectonically stable. In contrast, western North America was the leading edge of the North American plate.

Plate interactions during the Cenozoic caused many events of mountain building, volcanism, and earthquakes in the West.

Cenozoic Life

Mammals replaced reptiles as the dominant land animals in the Cenozoic. The Cenozoic is often called the "age of mammals" because land animals came to dominate land life. It could also be called the "age of flowering plants" because the angiosperms enjoyed a similar status in the plant world. **Angiosperms—flowering plants with covered seeds—replaced gymnosperms as the dominant land plants.** Marine invertebrates took on a modern look.

The advances in seed fertilization and dispersal allowed angiosperms to experience a rapid development and expansion as the Mesozoic drew to a close. As the Cenozoic era began, angiosperms were already the dominant land plants.

Development of the flowering plants strongly influenced the evolution of both birds and mammals. Birds that feed on seeds and fruits, for example, evolved rapidly during the Cenozoic in close association with the flowering plants. During the middle Tertiary, grasses developed rapidly and spread over the plains. This fostered the emergence of herbivorous mammals that were mainly grazers. In turn, the development and spread of grazing animals established the setting for the evolution of the carnivorous mammals that preyed upon them.

Q & A

Q *What are the La Brea tar pits?*

A The La Brea tar pits, located in downtown Los Angeles, are famous because they contain rich and very well preserved fossils, as shown in Figure 15. These organisms roamed southern California from 40,000 to 8000 years ago. The collection of fossils includes 59 species of mammals and more than 130 species of birds. Hundreds of invertebrate and plant fossils are also preserved.

Mammals Replace Reptiles

Back in the Mesozoic, an important evolutionary event was the appearance of primitive mammals in the late Triassic, about the same time the dinosaurs emerged. Yet throughout the period of dinosaur dominance, mammals remained as small and primitive. By the close of the Mesozoic era, dinosaurs and other reptiles no longer dominated the land. It was only after these large reptiles became extinct that mammals became the dominant land animals. The transition is a major example in the fossil record of the replacement of one large group by another.

Mammals are distinct from reptiles in important ways. Mammalian young are born alive rather than in eggs, and mammals maintain a steady body temperature—they are "warm-blooded."Because mammals are warm-blooded, they could survive in cold regions and search for food during any season or time of day. Other adaptations included the development of insulating body hair and more efficient heart and lungs. **These adaptations allow mammals to lead more active lives than reptiles.**

Figure 15 Fossils being excavated from the La Brea tar pits in 1914. **Inferring** ***What kinds of fossils were found in the La Brea tar pits?***

Cenozoic Life

Build Science Skills

L2

Relating Cause and Effect During the Cenozoic, evolutionary developments of one group quickly led to developments in other groups. Ask: **How did the development of angiosperms and grasses cause changes in other forms of life?** *(Development of plants with fruits and flowers led to the development of groups of birds and mammals that ate them. The increasing abundance of grasses resulted in the development of grazing mammals that ate the grasses, and this led to the development of carnivores that ate the grazing mammals.)* **Verbal, Logical**

Integrate Biology

L2

Seed Dispersal Ask: **What do the following fruits have in common: peach, apple, orange, pumpkin, and strawberry?** *(Many answers are acceptable, but emphasize that they all contain one or more seeds. Point out that strawberry seeds are on the outside.)* Plants make fruits to protect and disperse their seeds, and many animals eat fruits. However, few animals actually eat and digest the seeds. Many animals simply eat around the seeds, leaving the seeds on the ground when they finish their meal. However, even animals that eat the fruit whole will then excrete the seeds intact. This is because the digestive systems of most animals are incapable of digesting seeds. Whether an animal never eats the seed or eats the seeds but cannot digest them, the end result is that the seeds are dropped in a new location, usually far from the parent plant. **Verbal**

Customize for Inclusion Students

Learning Disabled Have students create their own version of the information in the geologic time scale, using a format that is comfortable for them. This format could be similar to Figure 2 on p. 365, in the form of a concept map, in a single straight line, or in any other orientation the student chooses. Help students put the information they need to know about each geologic time period on their graphic organizer, and let them use what they create during their exam.

Answer to . . .

Figure 15 *A wide variety of fossils, including mammals, birds, invertebrates, and plants were found.*

3 ASSESS

Evaluate Understanding L2

Have students work in small groups to determine the answers to the Section Assessment questions.

Reteach L1

Use Figure 2 on p.365 to reteach the main ideas of this section. Have students add information to their version of the geologic time scale about angiosperms and major continental events during the Cenozoic era.

Connecting Concepts

Plants and animals are tied to each other for food and reproductive purposes. Angiosperms became a prominent source of food for animals. Animals became a means to disperse seeds more efficiently for plants.

Go Online NSTA SCILINKS

Download a worksheet on environmental disruptions for students to complete, and find additional teacher support from NSTA SciLinks.

Answer to . . .

Reading Checkpoint *Mammals are warm-blooded, so they could survive in cold regions. They also developed insulating body hair and more efficient hearts and lungs.*

Go Online NSTA SCILINKS

For: Links on environmental disruptions
Visit: www.SciLinks.org
Web Code: cjn-4134

With the demise of most Mesozoic reptiles, Cenozoic mammals diversified rapidly. The many forms that exist today evolved from small primitive mammals that were characterized by short legs, flat five-toed feet, and small brains. Their development and specialization took four principal directions: (1) increase in size, (2) increase in brain capacity, (3) specialization of teeth to better accommodate a particular diet, and (4) specialization of limbs to better equip the animal for life in a particular environment.

Reading Checkpoint ***What adaptations caused mammals to be successful?***

Large Mammals and Extinction Some groups of mammals became very large. For example, by the Oligocene epoch a hornless rhinoceros that stood nearly 5 meters high had evolved. It is the largest land mammal known to have existed. Many large forms of mammals were common as recently as 11,000 years ago. However, a wave of late Pleistocene extinctions rapidly eliminated these animals from the landscape.

In North America, the mastodon and mammoth, both huge relatives of the elephant, became extinct. In addition, saber-toothed cats, giant beavers, large ground sloths, horses, camels, giant bison, and others died out. The reason for this recent wave of extinctions puzzles scientists. These animals had survived several major glacial advances and interglacial periods, so it is difficult to say that climatic change caused the extinctions. Some scientists believe that early humans hurried the decline of these mammals by selectively hunting large forms. Although this hypothesis is preferred by many, it is not yet accepted by all.

Section 13.4 Assessment

Reviewing Concepts

1. What proportion of the Cenozoic era do each of the two periods make up?
2. How were the mountains of western North America created?
3. What adaptations caused angiosperms to surpass the success of gymnosperms?
4. How did the extinctions at the end of the Mesozoic era allow mammals to be successful?

Critical Thinking

5. **Making Generalizations** How did mobility play a role in the evolutionary success of plants and animals?
6. **Inferring** Although the Quaternary period encompasses much less time than any of the other periods you've studied, a vast majority of fossils and remains found are from this period. Why?

Connecting Concepts

Evolutionary Development In what ways were the evolutionary development of plants and animals tied to each other?

Section 13.4 Assessment

1. The Tertiary period makes up about 63 million years of the Cenozoic, while the Quaternary period makes up only about 2 million years of the Cenozoic.
2. Western North America was on the edge of a tectonic plate, causing mountain-building activities when the plate overrode the Pacific plate.
3. Angiosperms developed flowering plants with covered seeds. These advances allowed better seed fertilization and dispersal and improved reproduction by integrating animals into the angiosperms' life cycles.
4. The extinctions of dinosaurs and other reptiles made room for mammals to exploit the resources available and become successful.
5. Mobility allowed some plants and animals to find and use resources that other plants and animals could not reach.
6. There are many more animals populating this period, so there are more fossils. The animals that lived in this period were generally larger and had hard parts that fossilized more easily. In addition, less time has passed since the fossils were created, so they are less likely to be weathered away.

understanding EARTH

Demise of the Dinosaurs

The boundary between the Mesozoic era—"middle life"—and Cenozoic era—"recent life"—about 65 million years ago is of special interest. Around this time, more than half of all plant and animal species died out in a mass extinction. This boundary marks the end of the era in which dinosaurs and other reptiles dominated the landscape and the beginning of the era when mammals become very important.

The extinction of the dinosaurs is generally attributed to the group's inability to adapt to some radical change in the environment's conditions. What event could have caused the rapid extinction of the dinosaurs—one of the most successful groups of land animals ever to have lived?

The most strongly supported hypothesis about the extinction of the dinosaurs states that about 65 million years ago a large meteorite about 10 kilometers in diameter collided with Earth, see Figure 16. The speed of the meteorite impact was believed to be 70,000 kilometers per hour. The force of the impact vaporized the meteorite and trillions of tons of Earth's crust. Huge quantities of dust and other metamorphosed debris were blasted high into the atmosphere.

For months the encircling dust cloud would have greatly restricted the sunlight reaching Earth's surface. Without sunlight for photosynthesis, delicate food chains would have collapsed. By the time the sunlight returned, more than half of the species on Earth, including numerous marine organisms, had become extinct.

What evidence points to such a catastrophic collision 65 million years ago? First, a thin layer of sediment nearly 1 centimeter thick has been discovered worldwide. This sediment contains a high level of the element iridium, which is rare in Earth's crust but is found in high proportions in stony meteorites. Could this layer be the scattered remains of the meteorite that was responsible for the environmental changes that led to the demise of many reptile groups?

Despite its growing support, some scientists disagree with the impact hypothesis. These scientists suggest that huge volcanic eruptions led to the breakdown in the food chain. They cite enormous outpourings of lavas in the Deccan Plateau of northern India about 65 million years ago as support for their thesis. It could be that both volcanism and a catastrophic impact played a role.

Whatever caused the extinction, we now have a greater appreciation of the role of catastrophic events in shaping the history of our planet and the life that occupies it. Could a catastrophic event having similar results occur today? This possibility may explain why an event that occurred 65 million years ago has captured the interest of so many.

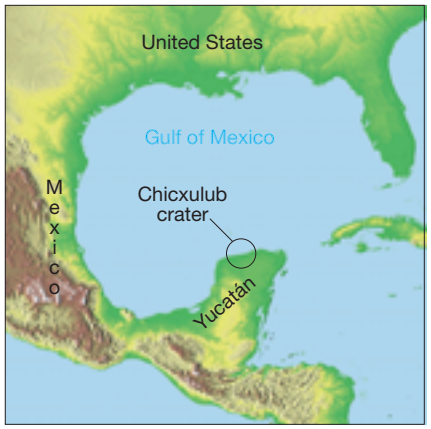

Figure 16 Some researchers believe that the Chicxulub crater is the impact site that resulted in the demise of the dinosaurs.

Facts and Figures

Other support for the impact hypothesis comes from evidence of the largest wave in history, which was 914.4 m tall. Evidence of this wave, a layer of chaotically distributed plant material mixed with deep-sea sediments, exists around the Gulf of Mexico, and dates to 65 million years ago. A type of glass spherules that form only during high velocity impacts and a round crater shape exist on the Yucatán.

understanding EARTH

Demise of the Dinosaur

L2

Teaching Tips

- Take students to their local public or college library to do additional research on this event. Tell students that the time of this mass extinction is called the Cretaceous-Tertiary, or KT boundary. (K is used for Cretaceous to avoid confusion with the other periods beginning with the letter C.)
- It may be helpful for students to know that in 1980 Luis and Walter Alvarez first suggested the impact hypothesis for the extinction of the dinosaurs. Students should be able to find a great deal of information about past meteorite impacts and new ideas to protect Earth from future impacts. Invite students to present what they learn to the rest of the class.

Verbal