

Chapter Resources

Geologic Time

Includes:

Reproducible Student Pages

ASSESSMENT

- ✓ Chapter Tests
- ✓ Chapter Review

HANDS-ON ACTIVITIES

- ✓ Lab Worksheets for each Student Edition Activity
- ✓ Laboratory Activities
- ✓ Foldables—Reading and Study Skills activity sheet

MEETING INDIVIDUAL NEEDS

- ✓ Directed Reading for Content Mastery
- ✓ Directed Reading for Content Mastery in Spanish
- ✓ Reinforcement
- ✓ Enrichment
- ✓ Note-taking Worksheets

TRANSPARENCY ACTIVITIES

- ✓ Section Focus Transparency Activities
- ✓ Teaching Transparency Activity
- ✓ Assessment Transparency Activity

Teacher Support and Planning

- ✓ Content Outline for Teaching
- ✓ Spanish Resources
- ✓ Teacher Guide and Answers



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Photo Credits

Section Focus Transparency 1: Ron Watts/CORBIS; **Section Focus Transparency 2:** Museum of Paleontology, University of CA, Berkeley; **Section Focus Transparency 3:** Jeremy Stafford-Deitsch/ENP



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Reproducible Student Pages

Reproducible Student Pages

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Hands-On Activities



Dating Rock Layers with Fossils

Procedure

1. In the space below, draw three rock layers.
2. Number the layers 1 to 3, bottom to top.
3. Layer 1 contains fossil A. Layer 2 contains fossils A and B. Layer 3 contains fossil C.
4. Fossil A lived from the Cambrian through the Ordovician. Fossil B lived from the Ordovician through the Silurian. Fossil C lived in the Silurian and Devonian.

Data and Observations

Drawing of rock layers:

Table 1

Period	Fossil		
	A	B	C
Permian			
Pennsylvanian			
Mississippian			
Devonian			↑
Silurian		↑	↑
Ordovician	↑	↑	
Cambrian	↑		

Analysis

1. Which layers were you able to date to a specific period?

2. Why isn't it possible to determine during which specific period the other layers formed?

TRY AT HOME


**Mini
LAB**

Calculating the Age of the Atlantic Ocean

Procedure

1. On a **world map** or **globe**, measure the distance in kilometers between a point on the east coast of South America and a point on the west coast of Africa.
2. Measure in SI several times and take the average of your results.
3. Assuming that Africa has been moving away from South America at a rate of 3.5 cm per year, calculate how many years it took to create the Atlantic Ocean.

Data and Observations

Table 1

Measurement	Distance (km)
1	
2	
3	
4	

Calculations:

1. Average distance = _____ km
2. Average distance in cm = _____ cm
3. Time (average distance in cm \div 3.5 cm/yr) = _____ years

Analysis

1. Did the values used to obtain your average value vary much?

2. How close did your age come to the accepted estimate for the beginning of the breakup of Pangaea in the Triassic Period?



Changing Species

Lab Preview

Directions: Answer these questions before you begin the Lab.

1. How many times will you draw cards representing a pair of varimals that will mate and produce offspring?

2. Can you name another variable in your numbered playing cards and explain how that variable could model adaptation within a species?

In this lab, you will observe how adaptation within a species might cause the evolution of a particular trait, leading to the development of a new species.

Real-World Question

How might adaptation within a species cause the evolution of a particular trait?

Materials

deck of playing cards

Goals

- **Model** adaptation within a species.

Procedure

1. **Remove** all of the kings, queens, jacks, and aces from a deck of playing cards.
2. Each remaining card represents an individual in a population of animals called “varimals.” The number on each card represents the height of the individual.
3. **Calculate** the average height of the population of varimals represented by your cards. Record your data in Table 1 of the Data and Observations section.
4. Suppose varimals eat grass, shrubs, and leaves from trees. A drought causes many of these plants to die. All that’s left are a few tall trees. Only varimals at least 6 units tall can reach the leaves on these trees.
5. All the varimals under 6 units leave the area or die from starvation. Discard all of the cards with a number value less than 6. Calculate the new average height of the varimals.
6. Shuffle the deck of remaining cards.
7. **Draw** two cards at a time. Each pair represents a pair of varimals that will mate.
8. The offspring of each pair reaches the average height of its parents. Calculate and record the height of each offspring, and record your data in Table 2 of the Data and Observations section.
9. Discard all parents and offspring under 8 units tall and repeat steps 6–8. Now calculate the new average height of varimals. Include both the parents and offspring in your calculation.



(continued)

Data and Observations

Table 1

Varimal Population Height	
Cards Used for Calculating Height	Average Height of Population
2 through 10	1.
6 through 10	2.
8 through 10 (Includes offspring from Table 2 who are 8 or more units tall.)	3.

Table 2

Varimal Offspring Height	
Parent Cards Drawn	Offspring Height
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Conclude and Apply

1. Describe how the height of the population changed.

2. **Explain** If you hadn't discarded the shortest varimals, would the average height of the population have changed as much?

3. Suppose the offspring grew to the height of one of its parents. How would the results change in each of the following scenarios?

- The height value for the offspring is chosen by coin toss.
- The height value for the offspring is whichever parent is tallest.

4. **Explain** If there had been no variation in height before the droughts occurred, would the species have been able to evolve?



Use the Internet Discovering the Past

Imagine what your state was like millions of years ago. What animals might have been roaming around the spot where you now sit? Can you picture a Tyrannosaurus rex roaming the area that is now your school? The animals and plants that once inhabited your region might have left some clues to their identity—fossils. Scientists use fossils to piece together what Earth looked like in the geologic past. Fossils can help determine whether an area used to be dry land or underwater. Fossils can help uncover clues about how plants and animals have evolved over the course of time. Using the resources of the Internet and by sharing data with your peers, you can start to discover how North America has changed through time.

Real-World Question

How has your area changed over geologic time?

Form a Hypothesis

How might the area where you are now living have looked thousands or millions of years ago? Do you think that the types of animals and plants have changed much over time? Form a hypothesis concerning the change in organisms and geography from long ago to the present day in your area.

Goals

- **Gather** information about fossils found in your area.
- **Communicate** details about fossils found in your area.
- **Synthesize** information from sources about the fossil record and the changes in your area over time.

Data Source

Visit msscience.com for more information about fossils and changes over geologic time and for data collected by other students.

Make a Plan

1. **Determine** the age of the rocks that make up your area. Were they formed during Precambrian time, the Paleozoic Era, the Mesozoic Era, or the Cenozoic Era?
2. Gather information about the plants and animals found in your area during one of the above geologic time intervals. Find specific information on when, where and how the fossil organisms lived. If no fossils are known from your area, find out information about the fossils found nearest your area.

Follow Your Plan

1. Make sure your teacher approves your plan before you start.
2. Go to msscience.com to post your data in the table. Add any additional information you think is important to understanding the fossils found in your area.



(continued)

Data and Observations

Table 1

Fossil Name	Plant or Animal Fossil	Age of Fossil	Detail about Fossil	Location

Analyze Your Data

1. What present-day relatives of prehistoric animals or plants exist in your area?

2. How have the organisms in your area changed over time? Is your hypothesis supported? Why or why not?

3. What other information did you discover about your area's climate or environment from the geologic time period you investigated?

Conclude and Apply

1. **Describe** the plant and animal fossils that have been discovered in your area. What clues did you discover about the environment in which these organisms lived? How do these compare to the environment of your area today?

2. **Infer** from the fossil organisms found in your area what the geography and climate were like during the geologic time period you chose.

Communicating Your Data

Find this lab using the link below.

 msscience.com



Laboratory Activity

Differences in a Species

To use fossil dating efficiently, paleontologists first separate fossils into groups. The most useful group for classification is called a species. A species is a population of individuals that have similar characteristics. Small differences in individuals might result in the development of a new species by a series of gradual changes. These changes can be traced from one geologic time division to another if the fossil record is good.

Strategy

You will describe the variations present within a species.

You will describe a species in terms of one characteristic.

Materials

meterstick

graph paper

pencils (colored)

Procedure

1. The species you will study is *Homo sapiens*, or yourself. You and your classmates are all members of this species. Remember that all living things grow at different rates. It is possible that you will find some big differences in your study, but everyone still belongs to the same species.
2. Record all characteristics of the species that you can. Record which of the characteristics you could measure and compare for all members of the species.
3. Measure and record in Table 1 the height of yourself and each of your classmates. Round off the height to the nearest tenth of a meter (0.1 m).
4. Measure the heights of a class of younger students. Record this data in Table 2.

Data and Observations

1. Characteristics: _____

Table 1

Name	Height (m)	Name	Height (m)	Name	Height (m)

Laboratory Activity 1 (continued)

Table 2

Name	Height (m)	Name	Height (m)	Name	Height (m)

Use a separate sheet of paper to graph the Frequency (number of persons having the same height) on the vertical axis against the Height (m) on the horizontal axis. Use one color for your own class and a second color for the younger class.

Questions and Conclusions

1. On what characteristics can you classify this group as a single species?

2. Where do most of the members of your class fall in regard to height?

3. Where do most of the members of the younger class fall in regard to height?

4. What change has taken place over time?

5. How is this activity like fossil dating?

6. How is this activity different from fossil dating? (Hint: Think in terms of the time spans involved.)

Strategy Check

_____ Can you describe the variations present within a species?

_____ Can you describe a species in terms of a range of a characteristic?

LAB
2 Laboratory
Activity

Looking at the Geologic Time Scale

As you have learned, Earth's history can be divided in geologic time segments called eras, periods, and epochs. These time periods are useful for placing events such as the disappearance of the dinosaurs and the appearance of humans in perspective relative to the history of life on Earth. The time segments are not as equal as they sound, however. In earlier eras, life processes on Earth appear to have been developing quite slowly, whereas later eras saw enormous changes over relatively short segments of geologic time. In this Laboratory Activity you will compare and contrast various segments of Earth's history by constructing a geologic time line.

Strategy

You will make a graph to compare the durations of Earth's geologic eras.

You will measure and construct a time line that shows Earth's geologic eras.

You will identify time relationships among events in Earth's geologic history.

You will record and illustrate significant events during the Mesozoic and Cenozoic Eras on a time line.

Materials

4–4.5 m of adding machine tape

meter stick

colored pencils

Procedure

Part A

1. Figure 1 shows approximately how long ago each major division of Earth's geologic time scale began. Use the information to calculate how long each of these divisions lasted. Record that information in the last column of Figure 1.
2. Using that information, make a bar graph on the grid in the Data and Observations section to show how long each division lasted.

Part B

3. You will use a piece of adding machine tape to make a geologic time line. Distance will represent time, with 1 cm representing 10 million years.
4. Using the meter stick, draw a straight line through the middle of the tape from one end to the other.
5. Starting at the left end of the tape, measure a distance that represents the length of Precambrian Time. Refer back to the time duration you calculated in Figure 1. Make a vertical line at the correct point.
6. From that vertical line, measure a distance that represents the length of the Paleozoic Era. Refer back to the time duration you calculated in Figure 1. Make a vertical line at the correct point. To the left of that line label the division on your time line *Precambrian Time*.
7. Repeat step 6 for the Mesozoic Era and the Cenozoic Era.
8. Lightly color each division on your time line a different color.
9. Divide the Mesozoic Era and the Cenozoic Era into the Periods and Epochs shown in Figure 2.
10. Then, using information from your text (such as the mass extinction) and the additional information in Figure 2, mark in the correct positions on your time line for significant events that occurred during the Mesozoic and Paleozoic Eras. Illustrate each of these events with a small drawing.

Laboratory Activity 2 (continued)

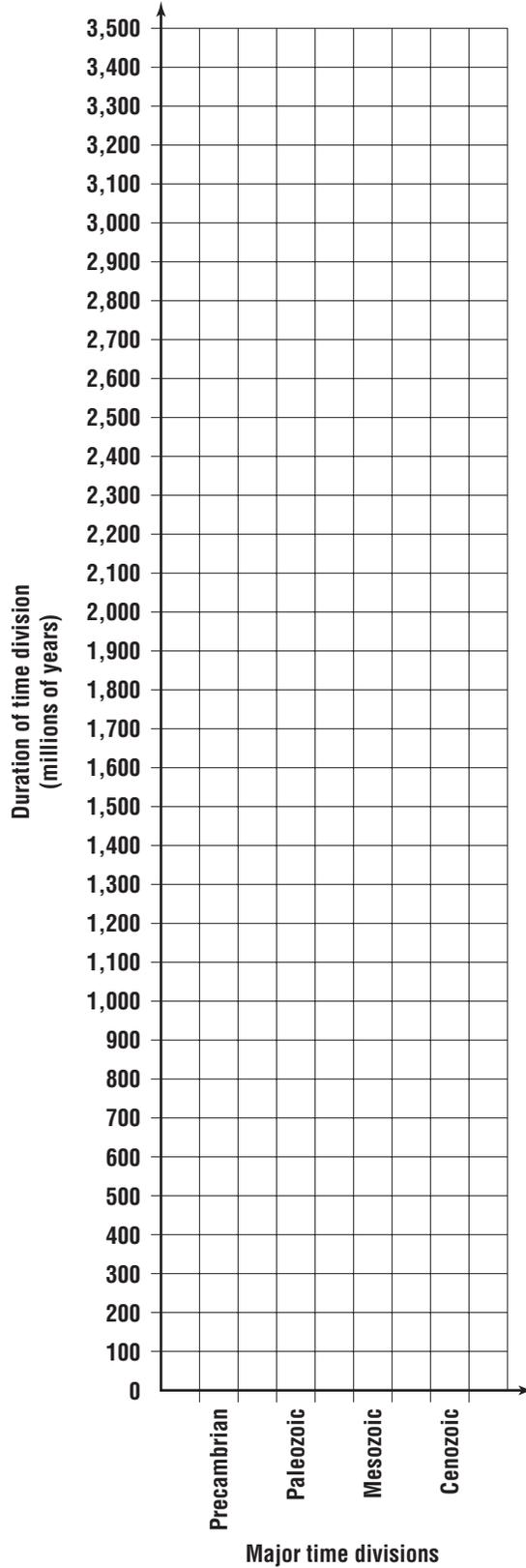
Data and Observations

Figure 1

Major geologic time division	When time division began	Length of time division lasted
Precambrian time	4.0 billion years ago	
Paleozoic era	544 million years ago	
Mesozoic era	245 million years ago	
Cenozoic era	65 million years ago	

Figure 2

Division	Time period (millions of years ago)	Event(s)
Triassic period	248–213	breakup of Pangaea
Jurassic period	213–145	first birds
Cretaceous period	145–65	Rocky Mountains form; first flowering plants
Paleocene epoch	65–55.5	first hooved mammals
Eocene epoch	55.5–33.7	first whales
Oligocene epoch	33.7–23.8	early formation of European Alps
Miocene epoch	23.8–5.3	first dogs and bears
Pliocene epoch	5.3–1.8	first Ice Age; first hominoids
Pleistocene epoch	1.8–0.008	modern humans
Holocene epoch	0.0008–present	Sea levels rose as climate warmed; first civilizations

Laboratory Activity 2 (continued)**Graph**

Laboratory Activity 2 (continued)**Questions and Conclusions**

1. Based on your graph in Part A, which time division is the longest? The shortest?

2. About how many times longer than the Mesozoic Era was the Paleozoic Era?

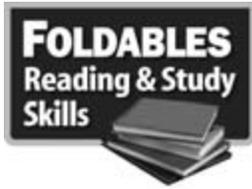
3. In which era do you live today? In which epoch?

4. About how many times longer than modern humans have hooved mammals lived on Earth?

5. What problems did you have in constructing and illustrating your time line? Why did you have those problems?

Strategy Check

- _____ Can you make a graph to compare the durations of Earth's geologic eras?
- _____ Can you measure and construct a time line that shows Earth's geologic eras?
- _____ Can you identify time relationships among events in Earth's geologic history?
- _____ Can you record and illustrate significant events during the Mesozoic and Cenozoic Eras on a time line?



Geologic Time

Directions: Use this page to label your Foldable at the beginning of the chapter.

Paleozoic Era

Mesozoic Era

Cenozoic Era

dinosaurs were dominant

era I live in

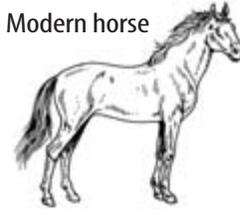
**first fish, reptiles,
amphibians, and land
plants began to appear**

**mammals began to
dominate land**

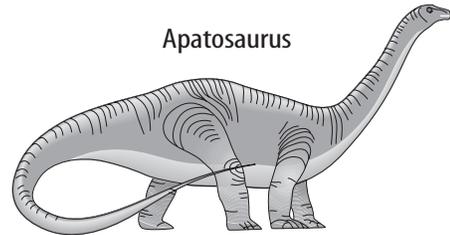
**mountains like the
Appalachian Mountains
were formed**

**Rocky Mountains were
formed**

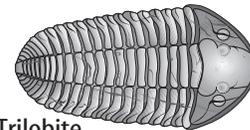
Modern horse



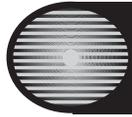
Apatosaurus



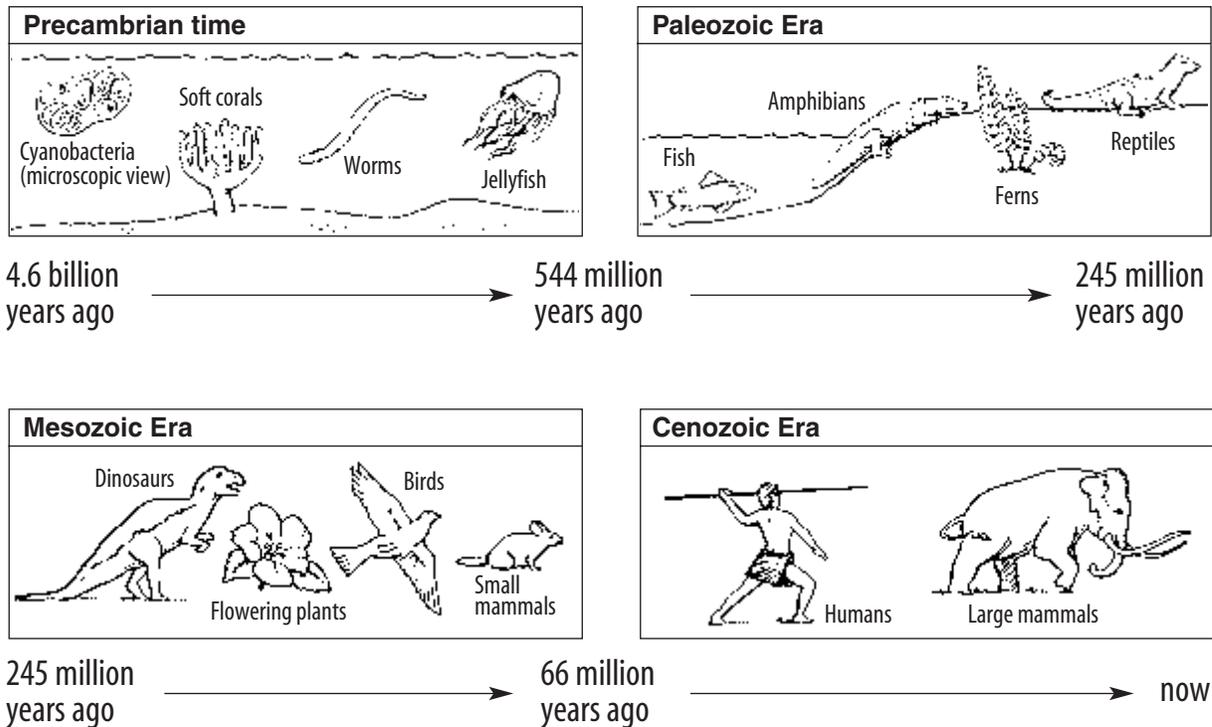
Trilobite



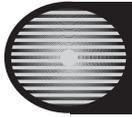
Meeting Individual Needs


**Directed Reading for
Content Mastery**
**Overview
Geologic Time**

Directions: Study the diagram. Then complete the sentences below.



1. Ferns and reptiles appeared in the _____ Era.
2. In the _____ Era, humans and large mammals appeared.
3. Dinosaurs, birds, and flowering plants first appeared in the _____ Era.
4. During _____ time, the earliest life-forms appeared.
5. Small mammals appeared in the _____ Era.
6. The earliest life-form shown above is _____.
7. Reptiles appeared during the same era as ferns, fishes, and _____.
8. Worms and jellyfishes first appeared in _____ time.



Directed Reading for
Content Mastery

Section 1 ■ Life and Geologic Time

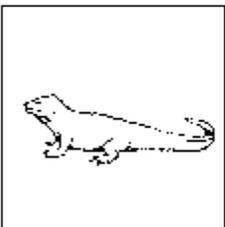
Section 2 ■ Early Earth History

Directions: Circle the term in parentheses that makes each statement correct.

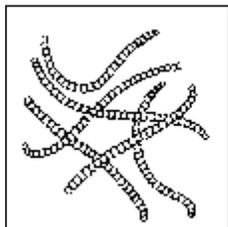
1. The longest subdivisions of geologic time are called (epochs, eons).
2. The division of Earth's history into time units makes up the (geologic time scale, trilobite time scale).
3. A group of organisms that reproduce only with members of their group is a (population, species).
4. The process by which organisms that adapt well to their environment survive and reproduce is called (natural selection, organic evolution).
5. Pangaea formed during the (Paleozoic, Mesozoic) Era.
6. A subdivision of eras, called (epochs, periods), are characterized by the types of life existing worldwide.
7. (Fossils, Plates) help scientists divide Earth's history into time units.
8. The changing of organisms over geologic time is known as (natural selection, organic evolution).
9. The oldest rocks on earth contain (only a few, no) fossils.
10. The Precambrian time is the (longest, shortest) part of Earth's history.
11. Cyanobacteria are (colorless, blue-green) bacteria thought to be one of the earliest forms of life on Earth.

Directions: Write **A, B, C, D,** or **E** beneath the proper illustration to show in which order they first appeared on Earth.

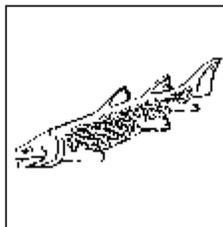
Reptile



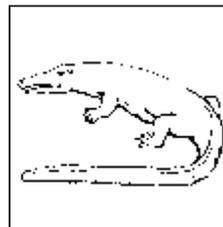
Cyanobacteria



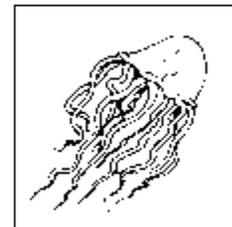
Fish

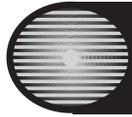


Amphibian



Jellyfish




**Directed Reading for
Content Mastery**
**Section 3 ■ Middle and Recent
Earth History**

Directions: Use the following terms to fill in the chart below.

present

birds

Homo sapiens

Pangaea

Alps and Himalayas

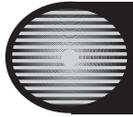
dinosaurs

angiosperms

Era	Time Span	Period	Life-forms	Geologic Events
Mesozoic	245 to 65 million years before present	Triassic	The first small 2. _____ appeared.	6. _____ separated into two large land masses.
		Jurassic	The first 3. _____ appeared.	
		Cretaceous	New plants called 4. _____ evolved.	
Cenozoic	65 million years before present to 1. _____	Tertiary	Dinosaurs became extinct.	7. _____ begin to rise. Ice Age began.
		Quaternary	5. _____ appeared.	Ice ages begin.

Directions: For each of the following, write the letter of the term or phrase that best completes the sentence.

- _____ **8.** The Mesozoic Era is also known as the era of _____.
 a. middle life **b.** new life
- _____ **9.** Birds appeared during the _____ Period.
 a. Triassic **b.** Jurassic

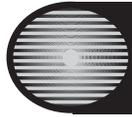


Directed Reading for
Content Mastery

Key Terms Geologic Time

Directions: Draw a line to connect the description on the left to the correct term on the right.

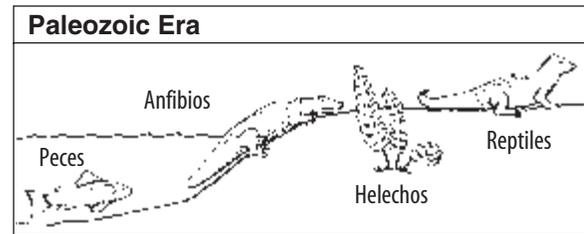
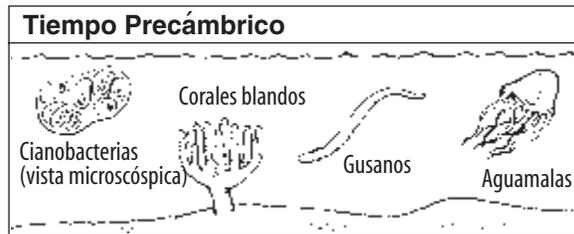
- | | |
|---|---------------------|
| 1. major subdivisions of geological time based on differences in life-forms | Precambrian |
| 2. organisms that lived hundreds of millions of years ago with bodies divided into three sections | geologic time scale |
| 3. the longest geological part of Earth's history | eras |
| 4. one of the earliest life-forms, which gave off oxygen | species |
| 5. flying animals that evolved from dinosaurs | trilobites |
| 6. the single landmass that once contained all Earth's continents | periods |
| 7. smaller units of time in a geologic period | Pangaea |
| 8. the time period where dinosaurs were the dominant life-form | natural selection |
| 9. the division of Earth's history into time units | cyanobacteria |
| 10. the longest subdivisions of geologic time | eons |
| 11. major divisions of an era | birds |
| 12. the change in organisms over time | organic evolution |
| 13. a group of organisms that normally reproduce with other members of their group | Jurassic |
| 14. process by which certain organisms survive and reproduce | epoch |



Lectura dirigida para
Dominio del contenido

Sinopsis El tiempo geológico

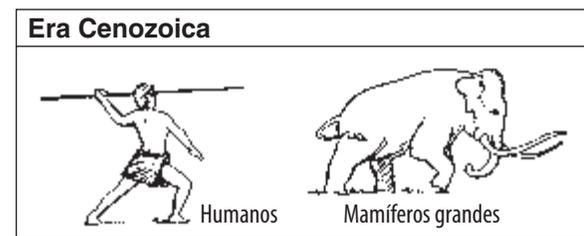
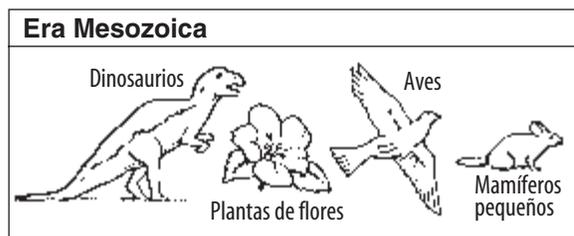
Instrucciones: Estudia el diagrama y completa las oraciones.



hace 4.6
mil millones de años

hace 544
millones de años

hace 245
millones de años

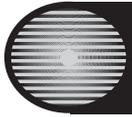


hace 245
millones de años

hace 66
millones de años

presente

1. Los helechos y los reptiles aparecieron en la Era _____.
2. En la Era _____ hicieron su debut los seres humanos y los mamíferos grandes.
3. Dinosaurios, aves y plantas con flores aparecieron en la Era _____.
4. Durante el tiempo _____, aparecieron las formas más primitivas de vida.
5. En la Era _____ aparecieron por primera vez animales pequeños.
6. Las formas de vida más antiguas que se muestran arriba son _____.
7. Los reptiles aparecieron durante la misma era que los helechos, peces y _____.
8. Gusanos y aguamalas aparecieron primero en el tiempo _____.



Lectura dirigida para
Dominio del contenido

Sección 1 ■ La vida y el tiempo geológico

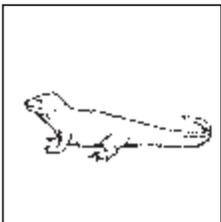
Sección 2 ■ Historia temprana de la Tierra

Instrucciones: Encierra en un círculo el término en paréntesis que completa correctamente cada oración.

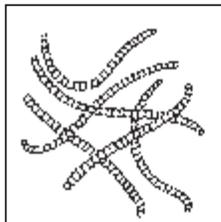
1. La subdivisión más grande del tiempo geológico es el(la) (época, eon).
2. La división de la historia de la Tierra en unidades de tiempo conforma la (escala del tiempo geológico, escala del tiempo trilobítica).
3. Un grupo de organismos que sólo se reproduce con miembros de su grupo es una (población, especie).
4. El proceso por medio del cual los organismos que se adaptan bien a su ambiente, sobreviven y se reproducen se llama (selección natural, evolución orgánica).
5. Pangaea se formó durante la era (Paleozoica, Mesozoica).
6. Una subdivisión de las eras llamada (épocas, períodos), se caracteriza por los tipos de organismos que existían a nivel mundial.
7. Los(as) (fósiles, placas) ayudan a los científicos a dividir la historia de la Tierra en unidades de tiempo.
8. El cambio de los organismos a lo largo del tiempo geológico se conoce como (selección natural, evolución orgánica).
9. Las rocas más antiguas de la Tierra (no) contienen (sólo unos cuantos) fósiles.
10. La Era Precámbrica es la parte (más larga, más corta) de la historia de la Tierra.
11. Las cianobacterias son bacterias (incoloras, azul verdosas) que se cree fueron una de las primeras formas de vida de la Tierra.

Instrucciones: Escribe **A, B, C, D** o **E** bajo la ilustración apropiada para mostrar el orden en que aparecieron los organismos sobre la Tierra.

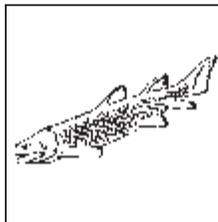
Reptil



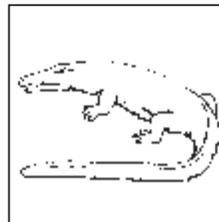
Cianobacteria



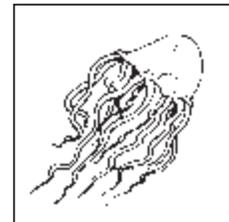
Pez

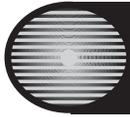


Anfibio



Aguamala





Lectura dirigida para
Dominio del contenido

Sección 3 ■ Historia media y reciente de la Tierra

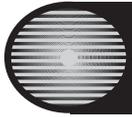
Instrucciones: Usa los siguientes términos para rellenar la tabla.

aves hace 65 millones de años *Homo sapiens* Pangaea
Alpes e Himalayas dinosaurios angiospermas

Era	Lapso de tiempo	Período	Formas de vida	Evento geológico
Mesozoica	245 a 65 millones de años antes del presente	Triásico	Aparecieron los primeros 2. _____ pequeños.	Todos los continentes estaban unidos en una sola masa llamada 6. _____.
		Jurásico	Apareció el(la) primer(a) 3. _____.	
		Cretáceo	Evolucionaron nuevas plantas llamadas 4. _____	
Cenozoica	1. _____ _____ al presente.	Terciario	Se extinguieron los dinosaurios.	Comienzan a elevarse 7. _____ Comienza la glaciación.
		Cuaternario	Apareció 5. _____	

Instrucciones: Para cada uno de los siguientes, escribe la letra del término o frase que complete mejor cada oración.

- _____ 8. La Era Mesozoica también se conoce como la era de _____.
a. vida intermedia b. vida nueva
- _____ 9. Las aves aparecieron durante el Período _____.
a. Triásico b. Jurásico



Lectura dirigida para
Dominio del contenido

Palabras claves El tiempo geológico

Instrucciones: Conecta con una línea cada descripción a la izquierda con el término correcto a la derecha.

- | | |
|---|-----------------------------|
| 1. subdivisiones grandes del tiempo geológico basadas en las diferencias en los seres vivos | Precámbrico |
| 2. organismos que vivieron hace cientos de millones de años y que tenían el cuerpo dividido en tres secciones | escala del tiempo geológico |
| 3. la parte geológica más larga de la historia de la Tierra | eras |
| 4. una de las formas vivientes más tempranas, la cual producía oxígeno | especies |
| 5. animales voladores que evolucionaron a partir de los dinosaurios | trilobitos |
| 6. masa de tierra única que una vez incluyó a todos los continentes | períodos |
| 7. unidad más corta en un período geológico | Pangaea |
| 8. período de tiempo durante el cual los dinosaurios eran la forma de vida dominante | selección natural |
| 9. división de la historia de la Tierra en unidades de tiempo | cianobacterias |
| 10. las subdivisiones más largas tiempo geológico | eones |
| 11. principales divisiones de una era | aves |
| 12. cambio en los organismos a lo largo del tiempo | evolución orgánica |
| 13. grupo de organismos que normalmente sólo se reproducen con miembros del mismo grupo | Jurásico |
| 14. proceso por medio del cual sólo ciertos organismos sobreviven y se reproducen | época |

SECTION
1**Reinforcement****Life and Geologic Time**

Directions: Answer the following questions on the lines provided.

1. What determines the divisions of eras and periods on the geologic time scale?

2. Which of the eras on the geologic time scale is divided into both periods and epochs?

3. Why do scientists study fossils?

4. How do trilobite eyes indicate the environment they lived in?

5. Why are trilobites considered index fossils?

6. What factors in the environment or surroundings would cause a species to change?

7. How might geologic events, such as the movement of tectonic plates, affect the environment in which species live?

8. In what epoch, period, and era do you live?

SECTION
2

Reinforcement

Early Earth History

Directions: List the events and types of organisms below in the order in which they happened or appeared on Earth. The oldest one is Number 1.

- amphibians complex organisms cyanobacteria fish invertebrates
- organisms with hard parts shielding of Earth from ultraviolet rays
- Pangaea reptiles oxygen is major atmospheric gas

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Directions: Answer the following questions on the lines provided.

11. Which of the events in your list above occurred in the Precambrian time? Which occurred in the Paleozoic Era? _____

12. Why is so little known about the Precambrian time? _____

13. Where did most life-forms of the Paleozoic Era live? _____

14. What might have caused the mass extinctions at the end of the Paleozoic Era?

Meeting Individual Needs

SECTION
3

Reinforcement

Middle and Recent Earth History

Directions: Match the descriptions in Column I with the terms in Column II. Write the letter of the correct term in the space provided in the left-hand column.

Column I

- _____ 1. seed plants which first appeared in the Paleozoic Era
- _____ 2. era of “middle life”
- _____ 3. most recent period in the Mesozoic Era
- _____ 4. oldest period in the Mesozoic Era
- _____ 5. northern part of Pangaea
- _____ 6. southern part of Pangaea
- _____ 7. fast-moving dinosaur
- _____ 8. dinosaur thought to nurture hatchlings
- _____ 9. winged animal resembling both dinosaurs and birds
- _____ 10. milk-producing animals; first appeared in the Triassic Period
- _____ 11. flowering plants
- _____ 12. most recent era
- _____ 13. most recent period in the Cenozoic Era
- _____ 14. climate change that allowed flowering plants to increase
- _____ 15. where most marsupials live
- _____ 16. animals with pouches

Column II

- a. Gondwanaland
- b. mammals
- c. Australia
- d. Laurasia
- e. Cretaceous
- f. gymnosperms
- g. angiosperms
- h. Mesozoic
- i. Quaternary
- j. *Maiasaura*
- k. Triassic
- l. Cenozoic
- m. marsupials
- n. tyrannosaurs
- o. cooling
- p. *Archaeopteryx*
- q. *Gallimimus*

Directions: Complete the following statements.

- 17. The bones of cold-blooded animals have _____.
- 18. The bones of dinosaurs resemble those of _____-blooded animals.
- 19. Some dinosaurs may have _____ their young.

SECTION

1

Enrichment

The Earliest Primates

Fossils have allowed scientists to trace the evolution of not just trilobites, but of many species of animals. From the fossils, scientists have learned a tremendous amount about what earlier forms of these animals looked like. One of the problems, though, in studying fossils is that often not all of the fossil skeleton can be found. Therefore, scientists have to draw conclusions about the animal without being able to see and study the animal's entire structure. This particular problem led to some interesting "reconclusions" about primates in 1990.

Primates

Primates are a group of about 200 species of animals that include lemurs, monkeys, apes, and humans. They are grouped together on the basis of similar skeletal and other features. It's believed that they have a common ancestor and developed into separate species over millions of years.

For a long time, paleontologists thought that the oldest primates were the 60-million-year-old creatures they named plesiadapiforms. Plesiadapiform fossils included teeth, jaws, and parts of skulls. From the fossils, scientists concluded that plesiadapiform was a primate. Certainly, its teeth were like those of other primates. They were adapted for grinding, designed for a diet of insects, fruits, and seeds.

Is it a primate?

In 1990, new plesiadapiform bones were dug up in Wyoming. These included the first complete skull and some fingers and wrists which were parts that had never been found before. The paleontologists who studied the finger bones were surprised to find that they did not resemble those of primates. The only living animal with a similar arrangement of finger bones is a small, tree-dwelling mammal of the Borneo and Philippine rain forests, called a colugo. The scientists who examined the intact skull identified it as resembling that of the colugo. The conclusion was the plesiadapiforms were not primates, since colugos are not primates.

Other scientists were studying an animal discovered at the foot of the High Atlas Mountains in Morocco. The creature, called the *Altiatlasius*, lived 60 million years ago. The paleontologists found ten tiny teeth similar to those in one of today's smallest primates, the 57-gram mouse lemur of Madagascar.

The earliest primate?

Another animal, less advanced but much larger than the *Altiatlasius*, has also been found. Many scientists are calling it an earlier primate. It's a house-cat-sized microsypid and may have lived more than 60 million years ago. It's identified as an early primate from its bone structure.

1. If the microsypid is proved to be a primate, what conclusion about primates might be changed?

2. Why do you think the *Altiatlasius* was so named?

3. What does the reading tell you about scientific inquiries?

SECTION 2

Enrichment

Extinction and Paleozoic Life

When the birth rate of a species is lower than its death rate for a prolonged period of time, extinction might occur. Extinction means that a species dies out forever. Scientists believe extinction occurs because the species is not able to adapt to a changing environment. For example, if a certain kind of fish lives in fresh water but for some reason the water becomes brackish, or part saltwater, then the species of fish will either adapt or die out completely. Scientists say that of all the species that have ever lived, more than 99 percent are extinct.

Background Extinction

Most extinctions occur over a period of time. This is called *background extinction*. Scientists say that as many as 95 percent of extinctions are background extinctions. There are many causes of background extinction including small changes in climate or habitat, competition or war between species, and depletion or using up of resources needed by the species.

Mass Extinction

Another thing that can happen is a mass extinction. A mass extinction is a sudden, worldwide decrease in species. There have been five mass extinctions in the history of the world. For an extinction to be considered a mass extinction, it must:

- be global
- impact a number of species
- take place within a relatively short period of time

During the Paleozoic Era, there were six distinct periods of time: Cambrian, Ordovician, Silurian, Devonian, Carboniferous, and Permian. During the Ordovician period of time, a mass extinction occurred. Scientists say it is the second largest mass extinction in history. More than 100 families of marine invertebrates disappeared during the extinction.

Directions: Use resources from the library to help you answer the following questions.

1. Which kinds of animals lived during the six time periods of the Paleozoic Era?

2. Besides the Ordovician Mass Extinction, were there any other mass extinctions during the Paleozoic Era?

3. Did any Paleozoic Era animal life survive? Explain.

4. Why do you think most extinctions occur as background extinctions?

SECTION

3

Enrichment

Autumn Leaves

It's remarkable to find 17 million-year-old fossil leaves. It's more remarkable to find 17 million-year-old leaves themselves. But such leaves have been found. According to the scientist who reported this discovery, Edward Golenberg, about 17 million years ago a storm tore autumn leaves from trees growing near a lake in what is now northern Idaho. The leaves, some green and some red, settled into the cold, oxygen-free sediment at the bottom of the lake. The absence of oxygen keeps bacteria from growing and causing plants to decay. The leaves were quickly covered with mud. Over time, the lake dried up. The mud turned to rock, and the leaves were sealed away from destruction for millions of years.

Studying the Leaves

Golenberg found that the rock-encased leaves immediately fell apart when the rocks were broken. But he was able to save some parts by placing them in a solution. This allowed scientists to study the genetic material that made up these ancient plants. The appearance of the leaves indicated that they were an extinct species of magnolia. Examination of the genetic material supported this theory.

Ancient Magnolias

This ancient magnolia, like the magnolias of today, is an angiosperm. The seeds of angiosperms are enclosed in a seed case. Insects and birds and sometimes wind carry angiosperm pollen from flower to flower to fertilize the plants. After fertilization, the flowers close and the developing seeds are protected. Gymnosperms, the other kind of seed-producing plant, produce seeds with no seed case. Conifers such as pine and fir trees are typical gymnosperms. The flowers of gymnosperms are barely noticeable, and gymnosperms depend on wind and gravity for pollination.

Which came first?

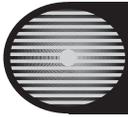
Although some scientists believe that angiosperms evolved from gymnosperms, the question of when and how angiosperms like the ancient magnolias first appeared is still a mystery. To date, no magnolia-like flower fossils have been found.



1. How does Golenberg's discovery differ from most discoveries that reveal information about ancient plants? _____

2. Explain how the leaves remained intact, rather than being decomposed, at the bottom of the lake. _____

3. Do you think trees in autumn looked very different 17 million years ago than they do today? Explain. _____



Note-taking Worksheet

Geologic Time

Section 1 Life and Geologic Time

- A. _____ time—Earth's history is divided into time units that make up a **geologic time scale**.
- Time units on the scale are based on the appearance or disappearance of types of organisms such as _____, index fossils that lived during specific periods of time.
 - Geologic time is divided into four major _____.
 - _____—longest subdivision; based on abundance of fossils
 - _____—marked by significant worldwide changes in the types of fossils present in rock
 - _____—based on types of life existing worldwide at a particular time
 - _____—characterized by differences in life-forms, but differences can be regional rather than global
 - Geologic time can be subdivided only if fossils are present in rock records.
- B. _____ **evolution**—Organisms have changed over time, most likely because of environmental changes.
- Species**—organisms that normally _____ only with other members of their group
 - Darwin's theory of **natural** _____—organisms more adapted to an environment are more likely to reproduce
 - Natural selection within a species occurs only if characteristics present in some numbers increase their _____.
 - _____ selection—breeding individuals with desired characteristics; humans use this type of selection when breeding domestic animals
 - _____ species can evolve from natural selection.
- C. Trilobites—have an exoskeleton with three lobes; lived in oceans for more than 200 million years
- Trilobite _____ position changed as the species adapted to various environments.
 - Trilobite bodies and _____ changed in response to changing environments.

Note-taking Worksheet (continued)

3. Continental collisions formed the giant landmass _____ near the end of the Paleozoic _____. These collisions may have dropped _____, causing the extinction of trilobites.

Section 2 Early Earth History

A. _____ time—from 4 billion to about 544 million years ago

1. Very few _____ remain from this time.
 - a. Many Precambrian rocks were deeply buried, causing the fossils in them to be changed by _____ and pressure.
 - b. Most Precambrian organisms lacked _____ parts.
2. **Cyanobacteria** are blue-green _____.
 - a. One of the _____ life forms to appear
 - b. Added _____ to the atmosphere through photosynthesis
3. _____ and Ediacaran animals appeared late in Precambrian time.

B. The _____ Era—about 544 million years ago to about 245 million years ago

1. Many organisms with _____ and vertebrates evolved in the warm, shallow seas.
2. _____ evolved to survive in water and on land.
 - a. Might have evolved from _____
 - b. Could obtain oxygen from _____ or from lungs.
3. _____ evolved from amphibians to survive farther from water
4. Several mountain-building episodes occurred during the Paleozoic Era because of _____ collisions.
5. Most marine and land species became _____ at the end of the Paleozoic Era.

Section 3 Middle and Recent Earth History

A. _____ Era—lasted from 245 to 65 million years ago

1. Pangaea separated into _____ and the climate became drier.
2. _____ evolved; they might have been warm-blooded, traveled in herds, and nurtured their young.

Note-taking Worksheet (continued)

3. _____, which probably evolved from small, meat-eating dinosaurs, appeared during the Jurassic Period.
 4. Small, mouse-like _____, which are warm-blooded vertebrates with hair and milk to feed their young, appeared in the Triassic Period.
 5. _____, plants that produce seeds but not flowers, appeared in the Paleozoic Era.
 6. Flowering plants or _____ appeared during the Cretaceous Period.
 7. A great extinction, perhaps caused by a comet or an asteroid collision, occurred about _____ years ago, marking the end of the Mesozoic Era.
- B.** The _____ Era began about 65 million years ago and continues today.
1. Many _____ formed, perhaps creating cooler climates worldwide.
 2. Mammals continued to evolve
 - a. Many species became _____ as the continents continued to separate.
 - b. *Homo sapiens*, or _____, appeared about 400,000 years ago.

Assessment



Chapter Review

Geologic Time

Part A. Vocabulary Review

Directions: Write the terms in the blanks at the left of their descriptions and then circle the 11 terms in the puzzle.

- _____ 1. animals evolved from a species of amphibians
- _____ 2. animals that live on land but return to water to reproduce
- _____ 3. animals without a backbone
- _____ 4. division of Earth's history into smaller units
- _____ 5. among the earliest life-forms on Earth
- _____ 6. group of organisms that normally reproduce only among themselves
- _____ 7. animals with a backbone
- _____ 8. flowering plants
- _____ 9. naked seed plants
- _____ 10. organism used to identify specific geologic time period
- _____ 11. process by which organisms with traits that are suited to a certain environment survive whereas others do not

G E O L O G I C T I M E S C A L E V B
 K D C Z B A J Y Q R E P T I L E S D M
 V F M D K L T A M P H I B I A N S X I
 T X K O R Y A N O C E P O L L T M O N
 B X D G Y M N O S P E R M S R X D R D
 I N V E R T E B R A T E S S Z J C K E
 M B Y F M Y R A N G I O S P E R M S X
 X D F L V P P C Q J D J Q E K Z M L F
 C H X B I B A T K S A R D C F T K V O
 J Y K D Q D V E V C F K F I Q B J C S
 M V E R T E B R A T E S B E R A R T S
 B K A B K X Z I P R B Z T S C S Z K I
 A Z N A T U R A L S E L E C T I O N L

Chapter Review (continued)**Part B. Concept Review**

Directions: Answer the following questions on the lines provided.

1. What units divide the geologic time scale?

2. Describe the life-forms of Precambrian time.

3. What evolutionary change in life-forms marked the beginning of the Paleozoic Era, and what event marked the end of the era? What life-forms dominated the era?

4. How did plate tectonics affect the evolution of life in the Mesozoic Era?

5. During which epoch did humans probably appear?

6. What events occurred that allowed single-celled organisms to evolve into more complex organisms at the end of the Precambrian time?

Transparency Activities

SECTION**1****Section Focus
Transparency Activity****Relatively Speaking . . .**

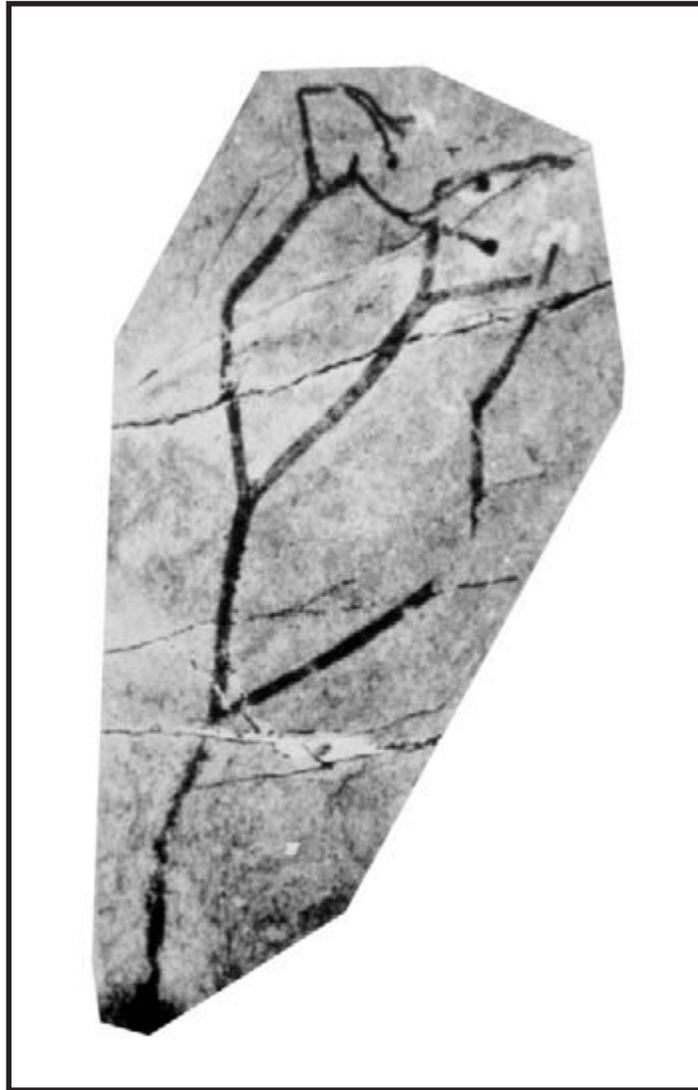
The spectacular bands of multicolored rock at sites like the Vermillion Cliffs are more than just beautiful. They are tools that help us learn about the history of Earth. As you examine the contours of this canyon, think about what these layers tell us.



1. Do you think all the rock in the picture was formed at the same time? Why or why not?
2. If you think the rock formed at different times, which layers are the oldest and which are the youngest?
3. If you were comparing two different fossils, what information might be revealed if you knew their location within the rock layers?

SECTION
2**Section Focus**
Transparency Activity**An Early Plant**

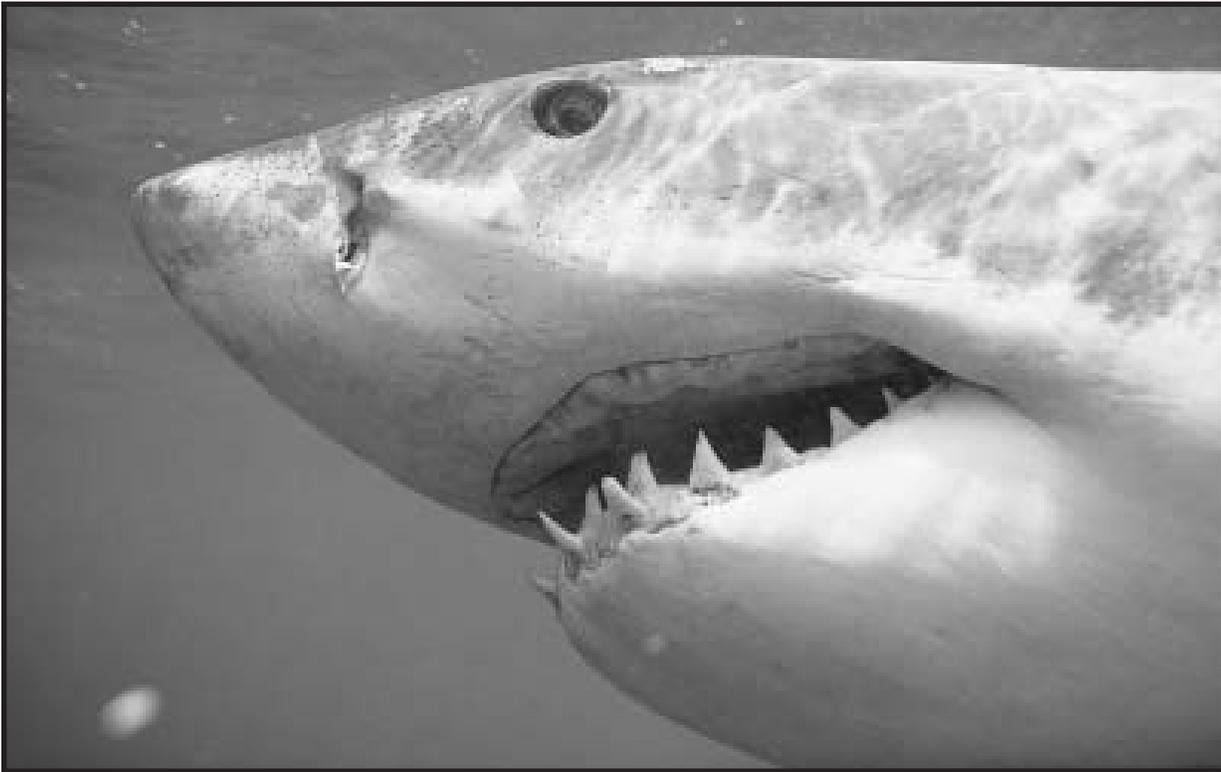
This is a fossil of *Cooksonia*, one of the earliest land plants known to scientists. These fossils are about 420 million years old—that's about 200 million years before the dinosaurs lived!



1. What characteristics of *Cooksonia* are similar to plants that you see every day?
2. Would you guess that plants or animals colonized land first?

SECTION**3****Section Focus
Transparency Activity****Big Smile for the
Camera**

The oldest fossils of sharks date back nearly 400 million years. The ancestors of modern sharks, though, first appeared about 200 million years ago. Below is a great white shark, a creature that hasn't changed much since its family arose during the Jurassic Period. Since that time, the swimming mechanisms of sharks have improved, and so have their feeding abilities.



1. What animals were dominant on land as sharks arose in the oceans?
2. Why are sharks sometimes called living fossils?
3. Can you name any other animals that have survived for such a long time with little change?

SECTION
1

Teaching Transparency
Activity

Geologic Time Scale

		Millions of years ago		
Cenozoic Era	Quaternary Period	Holocene Epoch	0.008	
		Pleistocene Epoch	1.8	
	Tertiary Period	Pliocene Epoch	5.3	← Himalaya rise
		Miocene Epoch	23.8	
		Oligocene Epoch	33.7	
		Eocene Epoch	55.5	
		Paleocene Epoch	65	← Mass extinction
Mesozoic Era	Cretaceous Period	145	← First flowering plants	
	Jurassic Period	213	← First birds	
	Triassic Period	248	← Pangaea breaks apart ← Mass extinction	
Paleozoic Era	Permian Period	286		
	Pennsylvanian Period	325	← First reptiles	
	Mississippian Period	360		
	Devonian Period	410	← First amphibians	
	Silurian Period	440	← First land plants	
	Ordovician Period	505	← First fish	
	Cambrian Period	544	← First trilobites	
Precambrian Time	Proterozoic Eon	2,500		
	Archaean Eon	3,800	← First life	
	Hadean Eon	4,500	← Origin of Earth	

Teaching Transparency Activity (continued)

1. Arrange the following terms in order of the length of time they represent. Place the longest time interval first: *period, era, epoch*.

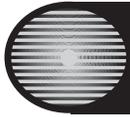
2. Why is the fossil record from Precambrian time so sparse?

3. About how many years separate the beginning of the Devonian Period from the beginning of the Pennsylvanian Period? Which period is more recent?

4. During what era and period did the first amphibians appear?

5. Would researchers be amazed to find a 400-million-year-old fossil of a fish? Why or why not?

6. Would researchers think it unusual to find a bird fossil that dated back to the Permian Period? Why or why not?



Assessment Transparency Activity

Geologic Time

Directions: Carefully review the table and answer the following questions.

Geologic Time Scale		
Era	When was it?	Types of species that appeared
Cenozoic	65 million years ago to today	Humans, larger mammals
Mesozoic	248–65 million years ago	Small mammals, birds, dinosaurs, angiosperms
Paleozoic	544–248 million years ago	Early reptiles, amphibians, fish, gymnosperms
Precambrian	4.5 billion years to 545 million years ago	Worms, jellyfish

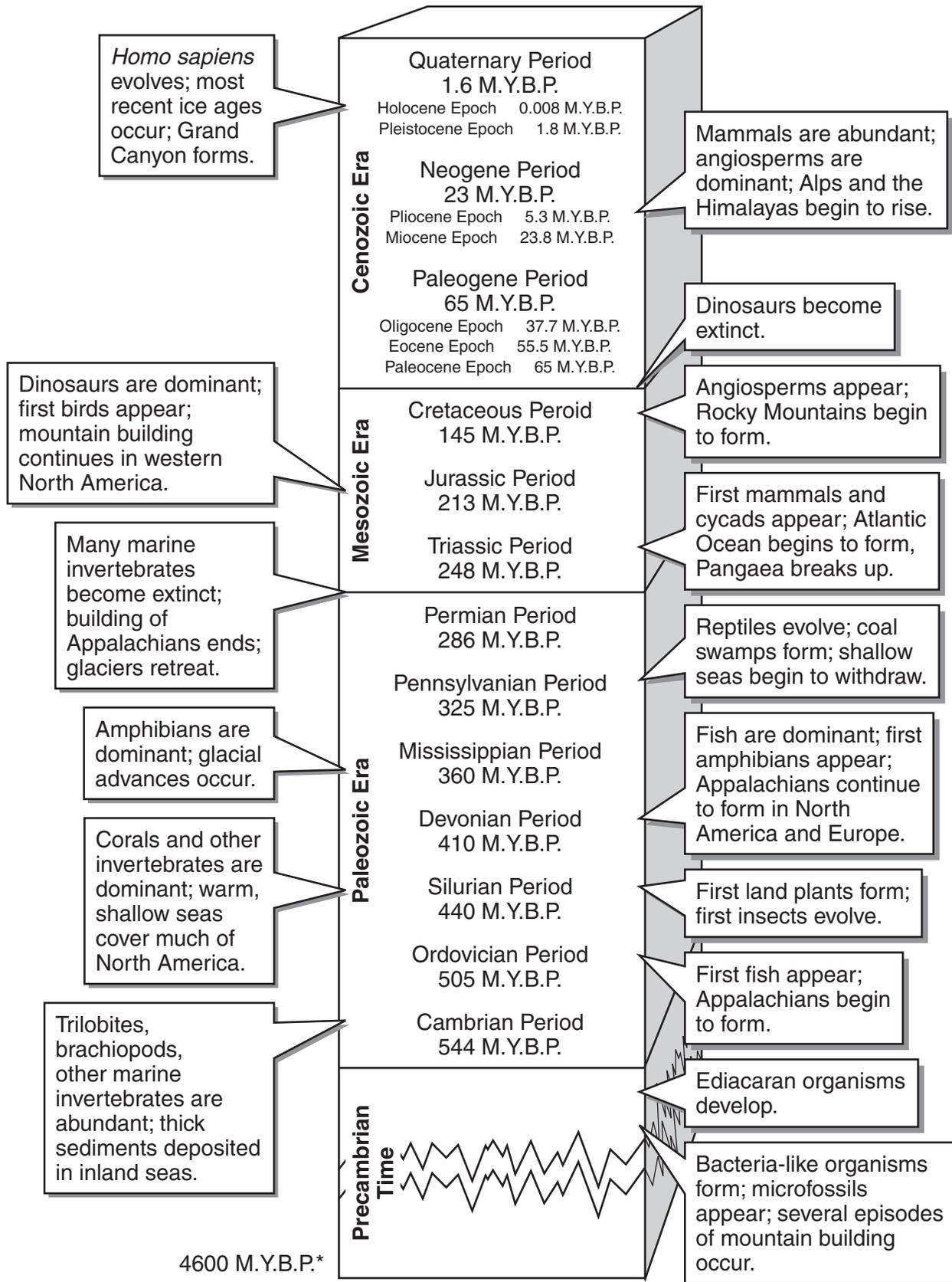
- According to the table, a fossil of a dinosaur would probably be from the _____.

A Cenozoic Era	C Paleozoic Era
B Mesozoic Era	D Precambrian Era
- According to the table, which geologic period occurred more than 800 million years ago?

F Cenozoic Era	H Paleozoic Era
G Mesozoic Era	J Precambrian Era
- According to the table, early ancestors of frogs would have appeared during the _____.

A Cenozoic Era	C Paleozoic Era
B Mesozoic Era	D Precambrian Era

Expanded Geologic Time Scale



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*Millions of years before present that each unit of time began