

Fossils**Guided Reading and Study****Target Reading Skill**

This is one possible way to complete the graphic organizer. Accept all logical answers.

What You Know: 1. Fossils come from ancient organisms. 2. Fossils are found in hardened rock. **What You Learned:** 1. Molds and casts are types of fossils. 2. Organisms are also preserved in amber.

1. fossils
2. a. Evidence of how life has changed over time b. How Earth's surface has changed c. What past environments were like
3. True
4. False
5. sedimentary rock
6. The soft parts often decay quickly or are eaten by animals.
7. False
8. a, b
9. petrified
10. True
11. A carbon film is a type of fossil that is an extremely thin coating of carbon on rock.
12. False
13. a, b, d
14. Fossil footprints give clues about the animal's size and behavior, whether it walked on two legs or four legs, or if it lived alone.
15. a. In tar b. In amber, or hardened by tree sap c. By freezing
16. paleontologists
17. True
18. fossil record
19. a, b, d
20. False
21. c
22. A scientific theory is a well-tested concept that explains a wide range of observations.
23. evolution
24. True
25. extinct

Fossils**Review and Reinforce**

1. minerals
2. Mold
3. Cast
4. carbon
5. activities
6. Preserved remains
7. A mold is an empty space in rock in the shape of an organism or part of an organism. If water carrying dissolved minerals and sediment seeps into the mold and deposits those minerals and sediments, the result is a cast in the shape of the organism.
8. Fossil footprints can provide clues about the dinosaur's size and behavior.
9. The fossil record provides evidence that many different organisms have existed at different times. The fossil record also shows that groups of organisms have changed over time.
10. evolution
11. sedimentary rock
12. extinct
13. paleontologist
14. fossils
15. scientific theory

Fossils**Enrich**

1. Trace fossils are fossils that provide evidence of activities of ancient organisms.
2. The soil must have been moist to hold the shape of the print.
3. The prints became trace fossils when the sediment hardened into rock.
4. The dinosaur came from the upper left; the mammal came from the left.
5. The dinosaur began at a walk and then started to run, as evidenced by the sudden difference in stride length.
6. The dinosaur's prints lead away from the meeting.
7. Answers may vary. A typical answer might describe how the dinosaur saw the mammal; attacked, killed, and devoured the mammal; and then walked away.

The Relative Age of Rocks Guided Reading and Study

Use Target Reading Skills This is one possible way to complete the graphic organizer. Accept all logical answers. **What does the position of rock layers reveal?** The position of rock layers shows that the oldest layers—and the oldest fossils—are at the bottom. **How do geologists determine the relative age of a rock?** By applying the law of superposition **How are fossils used to date rocks?** The age of an index fossil tells the relative age of the rock layer in which it occurs.

- b
- a
- oldest; younger
- False
- a. Lava hardens on Earth's surface. b. Rock layers below extrusions are always older. c. Magma pushes into rock, then cools and hardens. d. An intrusion is always younger than the rock layers around and beneath it. e. Forces inside Earth cause the rock to move on opposite sides of a fault. f. A fault is always younger than the rock it cuts through. g. The extrusion
- An unconformity is a gap in the geologic record where new rock layers form above a much older rock surface.
- Sedimentary rocks form in horizontal layers. Folding tilts the rock layers. The surface is eroded. New sediment is deposited, forming new rock layers. The unconformity is the boundary where the new rock layers meet the old, eroded surface.
- index
- a, d

The Relative Age of Rocks Review and Reinforce

- Layer C is the youngest because the law of superposition says that a layer is younger than the layers below it.
- The extrusion is younger because extrusions are always younger than the rock layers below them.
- The fault is younger than layer A because rock layers are always older than the faults they contain.
- The fossil might be an index fossil. Geologists can use index fossils to match rock layers at locations that are far apart.
- b
- h
- g
- e
- c
- d
- a
- f

The Relative Age of Rocks Enrich

- Sedimentary rock layers form when sediment is deposited in flat layers, one on top of the other. Over years, the sediment hardens and changes into sedimentary rock.
- They weathered and eroded away.
- When the first sedimentary layers eroded away, new layers formed on top of the eroded surface. The boundary where the eroded and new layers make contact is an unconformity.
- The Grand Canyon formed when the Colorado River cut down through the rock layers.
- The rock layers are older because they formed before the river cut the canyon.

Finding Clues to Rock Layers Chapter Skills Lab

For answers, see the Teacher's Edition.

Radioactive Dating Guided Reading and Study

Use Target Reading Skills

This is one possible way to complete the graphic organizer. Accept all logical answers. **Detail:** The absolute age of rocks **Detail:** The age of organic remains, such as those of frozen mammals **Detail:** The age of rock layers

1. element
2. False
3. The atoms of an unstable element break down to form atoms of another element.
4. b
5. They use the rate of decay to calculate the rock's age.
6. c, d
7. True
8. **a.** The amount of a radioactive element in a rock **b.** The amount of the stable element into which the radioactive element decays
9. True
10. **a.** Argon-40 **b.** Ancient rocks **c.** 1.3 billion years **d.** Nitrogen-14 **e.** Remains of organisms **f.** 5,730 years **g.** Potassium-40 could be used to date the rock. The half-life of carbon-14 is too short to date a rock that old.
11. True
12. True
13. No. Sedimentary rocks are made from particles of other rocks of all different ages. Radioactive dating would provide the age of the particles, not of the sedimentary rock.
14. They date the igneous intrusions and extrusions near the sedimentary rock layers.

Radioactive Dating Review and Reinforce

1. They cannot use radioactive dating because sedimentary rock layers are made of particles from other rocks. Dating would provide the ages of those particles, not of the rock.
2. They can use radioactive dating because extrusions and intrusions are made of igneous rock.
3. Rock layer C is at least 80 million years old because it is older than the intrusion that cuts partway across it.
4. element
5. half-life
6. atoms
7. radioactive decay

Radioactive Dating Enrich

1. Potassium-40, 100%; argon-40, 0%
2. 1.3 billion years
3. Each amounts to 50%.
4. More argon-40
5. Potassium-40, 12.5%; argon-40, 87.5%
6. No. A geologist would not have to wait because the potassium-40 immediately begins to decay into argon-40 when the rock is formed.

The Geologic Time Scale Guided Reading and Study

Use Target Reading Skills Check students' answers against the figure The Geologic Time Scale in the textbook.

1. **a.** Earth forms. **b.** Earliest organisms appear. **c.** Simple organisms develop. **d.** More complex organisms appear. **e.** Humans appear.
2. False
3. The geologic time scale is a record of the life forms and geologic events in Earth's history.
4. life
5. Precambrian Time
6. **a.** eras **b.** periods

The Geologic Time Scale Review and Reinforce

1. 3
2. 1
3. 4
4. 2
5. Geologists subdivide eras into periods.
6. Geologists use the geologic time scale to show Earth's history because the time span of Earth's past is so great.
7. They studied rock layers and index fossils worldwide. With that information, they placed Earth's rock layers in order by relative age.
8. The divisions of the geologic time scale depend on events in the history of life on Earth.
9. eras
10. geologic time scale

The Geologic Time Scale

Enrich

1. Yes. The bottom slanted rock layers formed in Precambrian Time, which was before the Paleozoic Era.

2. Carboniferous Period

3. Cambrian Period

4. Permian Period

5. No. The rock layers end with the Permian Period, which is before the Mesozoic Era began.

6. Neither the Ordovician nor the Silurian periods are represented by rock layers. It could be that no sediment was deposited during those periods or that layers formed but were later eroded away.

Early Earth

Guided Reading and Study

Use Target Reading Skills This is one possible way to complete the graphic organizer. Accept all logical answers.

a. Hydrogen and helium **b.** Carbon dioxide and water vapor **c.** None; only water vapor **d.**

Formed from rainwater **e.** None; Earth's crust still partly molten **f.** Large landmasses formed as rock cooled and hardened

1. Radioactive dating

2. 4.6 billion

3. Earth began as a ball of dust, rock, and ice in space.

4. True

5. Precambrian Time

6. a, d

7. a

8. False

9. **a.** carbon dioxide **b.** Water vapor **c.** oceans **d.** oxygen **e.** increase **f.** Possible answer: Without life on Earth, no oxygen would be produced in the process of photosynthesis. Oxygen would not be a part of Earth's atmosphere.

Early Earth

Review and Reinforce

1. F

2. E

3. D

4. A

5. C

6. B

7. They were single-celled organisms that were probably similar to present-day bacteria.

8. When Earth was very young, it collided with a large object. The collision threw a large amount of material from both bodies into orbit around Earth. This material combined to form the moon.

9. In photosynthesis, oxygen is released as a waste product. Oxygen released into the air was changed into ozone, which blocks out ultraviolet rays of the sun. Organisms could live on land because the ozone protected them from these harmful rays.

10. Scientists used radioactive dating to show that the oldest moon rocks are about 4.6 billion years old. Because Earth is slightly older than the moon, Earth must be roughly 4.6 billion years old.

11. comet

12. continental drift

Early Earth

Enrich

1. It can make its own food.

2. Oxygen

3. Most oxygen was taken up by iron in the oceans and settled to the ocean bottom along with the iron.

4. Animals and other types of organisms use oxygen to get energy from food.

Eras of Earth's History

Guided Reading and Study

Use **Target Reading Skills** This is one possible way to complete the graphic organizer. Accept all logical answers. **What geologic events happened during Precambrian Time?** Earth formed, ocean formed, first sedimentary rocks appeared **When did dinosaurs appear on Earth?** Triassic period of Mesozoic Era **What caused the mass extinction at the end of the Cretaceous Period?** An object from space struck Earth and blocked the sunlight

1. A great number of different kinds of organisms evolved.
2. a. plants b. amphibians c. reptiles d. mass extinction e. Plant life on land provided food for animals.
3. True
4. vertebrate
5. Jawless fishes were the first vertebrates to evolve.
6. It is a period in which many types of living things become extinct at the same time.
7. Earth's climate changed.
8. The continents moved together to form a great landmass, or supercontinent, called Pangaea. Pangaea had a harsh, dry climate where many organisms could not survive.
9. True
10. d
11. Mammals
12. Jurassic
13. a, d
14. An object from space, probably an asteroid, struck Earth and caused dust and heavy clouds to block sunlight for years. Without sunlight, plants died and plant-eating animals starved.
15. Mammals had a hard time competing with dinosaurs for food and places to live.
16. True
17. It changed from a warm, mild climate to a cool climate.
18. Tertiary

Eras of Earth's History

Review and Reinforce

1. Paleozoic
2. Paleozoic
3. Cenozoic
4. Mesozoic
5. Cenozoic
6. Paleozoic
7. Paleozoic
8. Mesozoic (or Cenozoic)
9. Mesozoic
10. Mesozoic
11. The Cambrian Explosion occurred at the beginning of the Paleozoic Period, when a great number of different kinds of organisms evolved in a relatively short time period.
12. The probable cause of the mass extinction at the end of the Paleozoic Era was a climate change that occurred when Pangaea formed. The probable cause of the mass extinction at the end of the Mesozoic Era was that an asteroid struck Earth.
13. Dinosaurs or Reptiles
14. The extinction of the dinosaurs created an opportunity for mammals.
15. Ice ages occurred as thick continental glaciers advanced and retreated over parts of Europe and North America.
16. b
17. c
18. a
19. d

Eras of Earth's History

Enrich

1. Evidence includes the fossil record, which shows many organisms died out 65 million years ago, an impact crater near the Yucatán Peninsula, and a layer of rock around Earth that is enriched with iridium.
2. Evidence includes the fossil record, which shows many organisms died out 65 million years ago, a huge area of volcanic rock on the Indian subcontinent from 65 million years ago, and a layer of rock around Earth that is enriched with iridium.
3. In each theory, a dust cloud blocks the energy of the sun from reaching Earth's surface for months or longer. This causes plants, which use energy from the sun to make food, to die, and then animals die.

4. Answers may vary. A typical answer might suggest that there is no evidence that could prove absolutely that one or the other of these theories is true.

5. Answers may vary. A typical answer might suggest that the asteroid theory makes more sense because volcanic eruptions in recent times have not caused similar extinctions.

As Time Goes By Chapter Skills Lab

For answers, see the Teacher's Edition.

Key Terms

Across

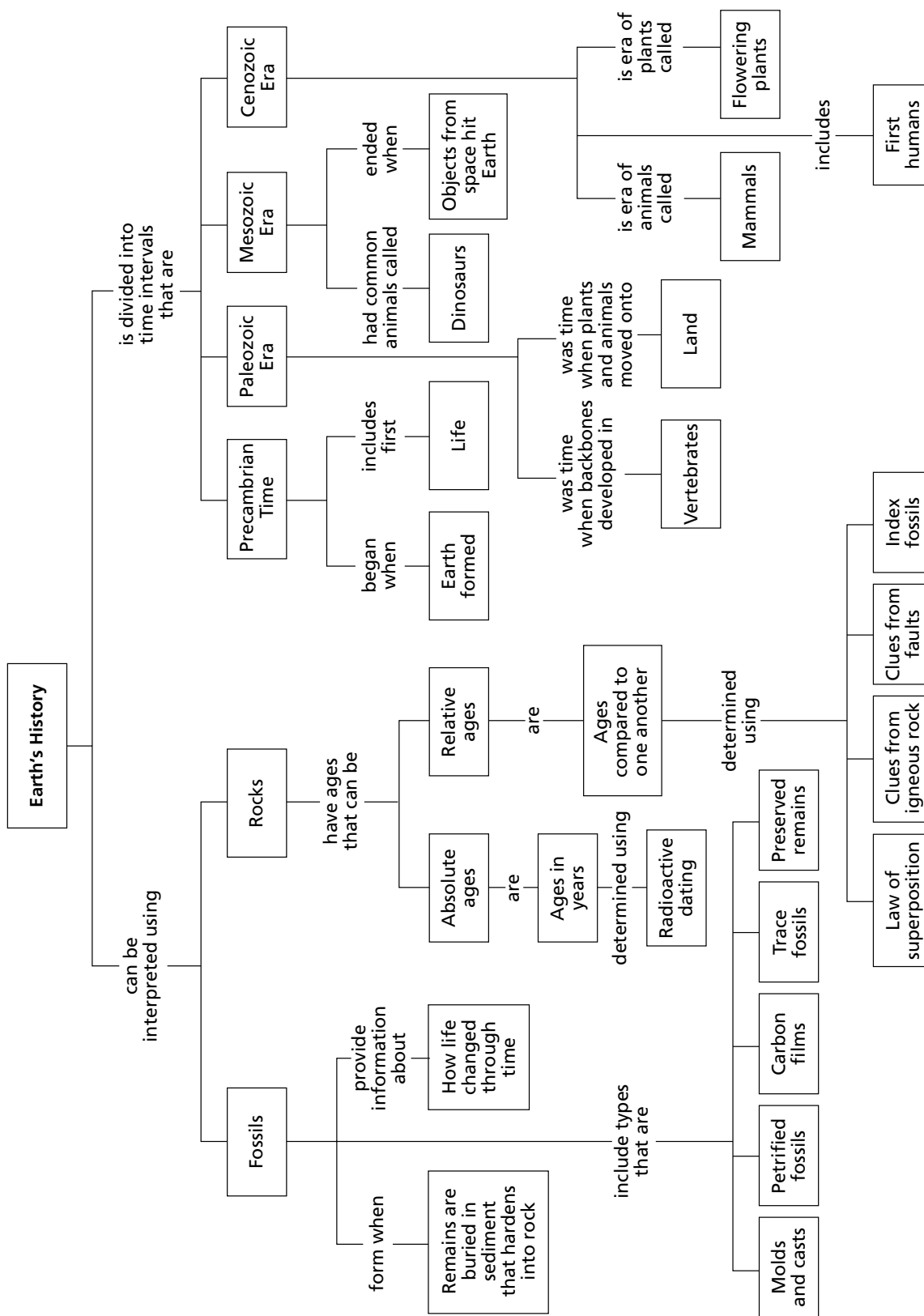
1. amphibian
4. paleontologist
5. invertebrate
8. fossil
9. reptile
10. atoms
11. element

Down

2. mold
3. extinct
4. period
6. relative
7. absolute

Connecting Concepts

This concept map is only one way to represent the main ideas and relationships in this chapter. Accept other logical answers from students.



Laboratory Investigation

Pre-Lab Discussion

1. The law of superposition states that each horizontal layer of sedimentary rock is younger than the layer below it if the layers have not been overturned.
2. Index fossils are fossils of organisms that lived during only one short period of time. Index fossils help scientists date sedimentary rock layers because they are easy to recognize, limited to a particular time period, and occur widely in different areas.

Analyze and Conclude

1. According to the law of superposition, the layer on the bottom is the oldest because it was deposited first.
2. According to the law of superposition, the layer on the top is the youngest because it was deposited last.
3. Students can conclude when the fossils were deposited in relation to the formation of other rock layers. Depending on whether the same fossils appear in other rock layers, students can conclude whether that fossil would be useful as an index fossil.

Critical Thinking and Applications

1. Answers may include that the thickness of the layers could be affected by pressure of the tube or that if layers are disturbed by the coring process, their order could be mixed. Rough handling of core samples could also damage delicate fossils included in the layers.
2. Faults could tilt sediment layers or displace them along the fault, so that older layers might be found above younger layers.
3. Index fossils can give the relative age of rock layers, even if the rocks are found out of the normal order indicated by superposition. Geologists can use index fossils to match the layers in a disturbed sample with rock layers that have those same fossils but have not been disturbed.
4. A large building should be built on materials that will not compress or shift easily. A core sample should indicate how firm the layers beneath the building site are and whether faults exist.

More to Explore

Student procedures could include making a mold by pressing a layer of clay in the bottom of a container. They could use an existing model or

make a model of the organism or its trace from a material that is harder than clay. To make the mold of the organism, they could use the model to make an impression of the organism or its trace in the clay. They could then make a cast by pouring plaster of paris into the mold. A layer of plaster of paris about 5 cm thick is a good amount for a cast. Spreading a thin layer of petroleum jelly on the mold before pouring the plaster of paris prevents the two layers from sticking together. When the plaster of paris has hardened, students can separate the mold and cast.

Analyze and Conclude

Students might include that both molds and casts can give a good indication of shape, size, texture, and surface features of fossil organisms or traces of such organisms. Accept other comparisons based on students' observations or reflections on the procedure they followed.

Chapter Performance Assessment

1. Layer A is the oldest according to the law of superposition. All the other layers are above it.
2. They probably used radioactive dating, in which they determined the amount of a radioactive element in a rock and compared that with the amount of the stable element into which the radioactive element decays.
3. Sedimentary rock layers cannot be dated absolutely because they are composed of rock particles from many different rocks.
4. Layer D is younger than 250 million years because it is above the extrusion. It is older than 100 million years because intrusions are always younger than the rock layers through which they pass.
5. It could not have been because fishes did not evolve until the Ordovician Period.
6. A trilobite fossil was found in layer C, and a dinosaur fossil was found in layer D. Since trilobites lived only in the Paleozoic Era and dinosaurs lived only in the Mesozoic Era, the mass extinction at the end of the Paleozoic Era occurred at about the time the extrusion occurred. That event affected both plants and animals on land and in the sea.
7. Layer F must have been deposited during the Cenozoic Era because whales did not evolve until that era.

Chapter Test

1. d
2. b
3. c
4. c
5. b
6. c
7. a
8. c
9. a
10. d
11. evolution
12. half-life
13. sedimentary
14. Paleozoic
15. bacteria
16. Mesozoic
17. True
18. carbon-14
19. True
20. relative
21. The figure is called the geologic time scale. Geologists use it because the time span of Earth's past is so great.
22. At the end of the Paleozoic Era
23. At the end of the Cenozoic Era
24. The law of superposition states that in horizontal layers of sedimentary rock, each layer is older than the layer above it and younger than the layer below it. Geologists use this law to determine the relative ages of rocks.
25. A mold is a hollow area in rock in the shape of an organism or a part of an organism. If water carrying dissolved minerals and sediment seeps into the mold and then deposits those minerals and sediments there, the result is a cast.
26. Layer C is more than 120 million years old because a rock layer is always older than a rock layer that lies above it. In this example, the rock layer above layer C is an extrusion that is 120 million years old.
27. The result would be an unconformity.
28. The fossil record shows that different organisms have existed at different times and that groups of organisms have changed over time.
29. Index fossils are fossils of organisms that were widely distributed but lived for only a short period of time. An example is ammonites, a group of hard-shelled animals that evolved in shallow seas more than 500 million years ago and became extinct about 65 million years ago. Index fossils are used to determine the relative ages of rock layers at different locations.
30. A mass extinction occurred at the end of the Cretaceous Period, probably as a result of an asteroid's striking Earth. This mass extinction wiped out the dinosaurs. The extinction of that group created an opportunity for mammals. During the Cenozoic Era, mammals evolved adaptations that allowed them to live on land, in water, and in the air.