Chapter Introduction

Lesson 1  Fossil Evidence of Evolution

Lesson 2  The Theory of Evolution by Natural Selection

Lesson 3  Biological Evidence of Evolution

Chapter Wrap-Up
How do species adapt to changing environments over time?
What do you think?

Before you begin, decide if you agree or disagree with each of these statements. As you view this presentation, see if you change your mind about any of the statements.
Do you agree or disagree?

1. Original tissues can be preserved as fossils.

2. Organisms become extinct only in mass extinction events.

3. Environmental change causes variations in populations.
Do you agree or disagree?

4. Variations can lead to adaptations.

5. Living species contain no evidence that they are related to each other.

6. Plants and animals share similar genes.
Fossil Evidence of Evolution

Key Concepts

• How do fossils form?
• How do scientists date fossils?
• How are fossils evidence of biological evolution?
Fossil Evidence of Evolution

Vocabulary

- fossil record
- mold
- cast
- trace fossil
- geologic time scale
- extinction
- biological evolution
The Fossil Record

• The **fossil record** is made up of all the fossils ever discovered on Earth.

• The fossil record provides evidence that species have changed over time.

• Based on fossil evidence, scientists can recreate the physical appearance of species that are no longer alive on Earth.
Fossil Formation

After an animal dies, any soft tissues animals do not eat break down.

**SCIENCE USE v. COMMON USE**

tissue

*Science Use* similar cells that work together and perform a function

*Common Use* a piece of soft, absorbent paper
Only the dead animal’s hard parts, such as bones, shells, and teeth, remain. Under rare conditions, these parts become fossils.

<table>
<thead>
<tr>
<th>How Fossils Form</th>
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<tbody>
<tr>
<td><strong>Mineralization</strong></td>
</tr>
<tr>
<td>Rock-forming minerals in water filled in the small spaces in the tissue of these pieces of petrified wood. Water also replaced some of the wood’s tissue. Mineralization can preserve the internal structures of an organism.</td>
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</tbody>
</table>
Fossil Formation (cont.)

- The impression of an organism in a rock is called a **mold**.

- A **cast** is a fossil copy of an organism in a rock.
Fossil Formation (cont.)

A **trace fossil** is the preserved evidence of the activity of an organism.

**WORD ORIGIN**

fossil
from Latin *fossilis*, means “to obtain by digging”
Fossil Formation (cont.)

In rare cases, the original tissues of an organism can be preserved.

**KEY CONCEPT CHECK**

List the different ways fossils can form.
Determining a Fossil’s Age

• Instead of dating fossils directly, scientists date the rocks the fossils are embedded inside.

• In relative-age dating, scientists determine the relative order in which rock layers were deposited.
Relative-age dating helps scientists determine the relative order in which species have appeared on Earth over time.

**KEY CONCEPT CHECK**

How does relative-age dating help scientists learn about fossils?
Determining a Fossil’s Age (cont.)

• Scientists take advantage of radioactive decay, a natural clocklike process in rocks, to learn a rock’s absolute age, or its age in years.

• To measure the age of sedimentary rock layers, scientists calculate the ages of igneous layers above and below them.
If the age of the igneous layers is known, it is possible to estimate the age of the sedimentary layers—and the fossils they contain—between them.
Fossils over Time

• The **geologic time scale** is a chart that divides Earth’s history into different time units.

• Earth’s history is divided into four eons—the longest time units in the geologic time scale.
The Geologic Time Scale

- **Precambrian**
  - Hadean
  - Archean
  - Proterozoic

- **Phanerozoic**
  - Paleozoic
    - Cambrian
  - Ordovician
  - Silurian
  - Devonian
  - Carboniferous
  - Permian
  - Triassic
  - Jurassic
  - Cretaceous
  - Tertiary
  - Quaternary

- **Eons**
  - 4,560 Mya
  - 3,850 Mya
  - 2,500 Mya
  - 542 Mya

- **Eras**
  - 488 Mya
  - 444 Mya
  - 416 Mya
  - 359 Mya
  - 299 Mya
  - 251 Mya
  - 201 Mya

- **Periods**
  - 145.5 Mya
  - 65.5 Mya
  - 26 Mya
  - 0
Extinctions

- **Extinction** occurs when the last individual organism of a species dies.
- A mass extinction occurs when many species become extinct within a few million years or less.
- Extinctions can occur when environments change.
The fossil record contains evidence that five mass extinction events have occurred during the Phanerozoic eon.
Extinctions (cont.)

- The fossil record contains evidence of the appearance of many new species over time.

- **Biological evolution** is the change over time in populations of related organisms.
The fossil record is evidence that horses descended from organisms for which only fossils exist today.
Extinctions (cont.)

**Key Concept Check**

How are fossils evidence of biological evolution?
Fossils can consist of the hard parts or soft parts of organisms. Fossils can be an impression of an organism or consist of original tissues.

Scientists determine the age of a fossil through relative-age dating or absolute-age dating.
Scientists use fossils as evidence that species have changed over time.
Which refers to a chart that divides Earth’s history into different time units?

A. fossil record
B. geologic time scale
C. relative-age dating
D. trace fossil
Which is the preserved evidence of the activity of an organism?

A. cast
B. fossil record
C. mold
D. trace fossil
Which refers to the impression of an organism in a rock?

A. cast
B. fossil
C. mold
D. trace fossil
What do you think **NOW?**

Do you agree or disagree?

1. Original tissues can be preserved as fossils.

2. Organisms become extinct only in mass extinction events.
Lesson 2

Theory of Evolution by Natural Selection

Key Concepts

• Who was Charles Darwin?
• How does Darwin’s theory of evolution by natural selection explain how species change over time?
• How are adaptations evidence of natural selection?
Lesson 2

Theory of Evolution by Natural Selection

Vocabulary

- naturalist
- variation
- natural selection
- adaptation
- camouflage
- mimicry
- selective breeding
Charles Darwin

- A **naturalist** is a person who studies plants and animals by observing them.

- Charles Darwin was an English naturalist who, in the mid-1800s, developed a theory of how evolution works.
Who was Charles Darwin?
Darwin found that each island in the Galápagos had a different environment, and tortoises looked different depending on which island environment they inhabited.
Darwin’s Theory

- A **variation** is a slight difference in an inherited trait of individual members of a species.
- Variations arise naturally in populations, occurring in offspring as a result of sexual reproduction.
- Genetic changes to phenotype can be passed on to future generations.
Darwin’s Theory (cont.)

• **Natural selection** is the process by which populations of organisms with variations that help them survive in their environments live longer, compete better, and reproduce more than those that do not have the variations.

• Natural selection explains how populations change as their environments change.
Natural Selection

1. Reproduction
A population of tortoises produces many offspring that inherit its characteristics.

2. Variation
A tortoise is born with a variation that makes its neck slightly longer.

3. Competition
Due to limited resources, not all offspring will survive. An offspring with a longer neck can eat more cacti than other tortoises. It lives longer and produces more offspring.

4. Selection
Over time, the variation is inherited by more and more offspring. Eventually, all tortoises have longer necks.
What role do variations have in the theory of evolution by natural selection?
Adaptations

• Through natural selection, a helpful variation in one individual can spread to all members of a population.

• An **adaptation** is an inherited trait that increases an organism’s chance of surviving and reproducing in its environment.
Adaptations (cont.)

**WORD ORIGIN**

adaptation
from Latin *adaptare*, means “to fit”
How do variations lead to adaptations?
Adaptations (cont.)

- Structural adaptations involve color, shape, and other physical characteristics.
- Behavioral adaptations involve the way an organism behaves or acts.
- Functional adaptations involve internal body systems that affect biochemistry.
Adaptations (cont.)

- Camouflage and mimicry are adaptations that help species avoid being eaten.
- **Camouflage** is an adaptation that enables a species to blend in with its environment.
- The resemblance of one species to another species is **mimicry**.
Artificial Selection

• The breeding of organisms for desired characteristics is called selective breeding.

• Darwin realized that changes caused by selective breeding were much like changes caused by natural selection.
Charles Darwin developed his theory of evolution partly by observing organisms in their natural environment.

Natural selection occurs when organisms with certain variations live longer, compete better, and reproduce more often than organisms that do not have the variations.
Adaptations occur when a beneficial variation is eventually inherited by all members of a population.
Which refers to the process by which populations of organisms with variations that help them survive in their environments live longer, compete better, and reproduce more than those that do not have the variations?

A. adaptation
B. mimicry
C. natural selection
D. selective breeding
Which is an inherited trait that increases an organism’s chance of surviving and reproducing in its environment?

A. adaptation
B. camouflage
C. natural selection
D. variation
What term refers to the breeding of organisms for desired characteristics?

A. adaptation  
B. variation  
C. natural selection  
D. selective breeding
What do you think NOW?

Do you agree or disagree?

3. Environmental change causes variations in populations.

4. Variations can lead to adaptations.
Biological Evidence of Evolution

Key Concepts

- What evidence from living species supports the theory that species descended from other species over time?
- How are Earth’s organisms related?
Biological Evidence of Evolution

Vocabulary

- comparative anatomy
- homologous structure
- analogous structure
- vestigial structure
- embryology
Evidence for Evolution

- The degree to which species are related depends on how closely in time they diverged, or split, from their common ancestor.

- Although the fossil record is incomplete, it contains many examples of fossil sequences showing close ancestral relationships.
The fossil record indicates that different species of horses often overlapped with each other.
Evidence for Evolution  (cont.)

- **Comparative anatomy** is the study of similarities and differences among structures of living species.

- **Homologous structures** are body parts of organisms that are similar in structure and position but different in function.
The forelimbs of these species are different sizes, but their placement and structure suggest common ancestry.
Evidence for Evolution (cont.)

Key Concept Check

How do homologous structures provide evidence for evolution?
Body parts that perform a similar function but differ in structure are analogous structures.
**Vestigial structures** are body parts that have lost their original function through evolution.

Between 50–40 million years ago, this mammal breathed air and walked clumsily on land. It spent a lot of time in water, but swimming was difficult because of its rear legs. Individuals born with variations that made their rear legs smaller lived longer and reproduced more. This mammal is an ancestor of modern whales.

After 10–15 million more years of evolution, the ancestors of modern whales could not walk on land. They were adapted to an aquatic environment. Modern whales have two small vestigial pelvic bones that no longer support legs.
How are vestigial structures evidence of descent from ancestral species?
The science of the development of embryos from fertilization to birth is called **embryology**.

**WORD ORIGIN**

**embryology**

from Greek *embryon*, means “to swell” and from Greek *logia*, means “study of”
All vertebrate embryos exhibit pharyngeal pouches at a certain stage of their development. These features, which develop into neck and face parts, suggest relatedness.
How do pharyngeal pouches provide evidence of relationships among species?
Evidence for Evolution (cont.)

- Molecular biology is the study of gene structure and function.

- Discoveries in molecular biology have confirmed and extended much of the data already collected about the theory of evolution.

- Scientists can study relatedness of organisms by comparing genes and proteins among living species.
How is molecular biology used to determine relationships among species?
• Scientists have found that some stretches of shared DNA mutate at regular, predictable rates.

• Scientists use this “molecular clock” to estimate at what time in the past living species diverged from common ancestors.
Molecular data indicate that whales and porpoises are more closely related to hippopotamuses than they are to any other living species.
New evidence supporting the theory of evolution by natural selection is discovered nearly every day, but scientists debate some of the details.

New fossils that have features of species that lived both before them and after them help scientists study more details about the origin of new species.
Many scientists think that natural selection produces new species slowly and steadily. Other scientists think species exist stably for long periods, and change occurs in short bursts.
By comparing the anatomy of organisms and looking for homologous or analogous structures, scientists can determine if organisms had a common ancestor.
Some organisms have vestigial structures, suggesting that they descended from a species that used the structure for a purpose.
Summary

- Scientists use evidence from developmental and molecular biology to help determine if organisms are related.
What term refers to body parts that perform a similar function but differ in structure?

A. analogous structures
B. homologous structures
C. pharyngeal pouches
D. vestigial pelvis
What is the name for the science of the development of embryos from fertilization to birth?

A. adaptation
B. embryology
C. comparative anatomy
D. molecular biology
Which describes the study of similarities and differences among structures of living species?

A. adaptation
B. embryology
C. comparative anatomy
D. molecular biology
5. Living species contain no evidence that they are related to each other.

6. Plants and animals share similar genes.
Key Concept Summary
Interactive Concept Map
Chapter Review
Standardized Test Practice
Natural selection is a primary mechanism leading to change over time in organisms. Through natural selection, species adapt to changing environments.
Lesson 1: Fossil Evidence of Evolution

• Fossils form in many ways, including mineral replacement, carbonization, and impressions in sediment.

• Scientists can learn the ages of fossils by techniques of relative-age dating and absolute-age dating.

• Though incomplete, the fossil record contains patterns suggesting the biological evolution of related species.
Lesson 2: Theory of Evolution by Natural Selection

• The 19th century naturalist Charles Darwin developed a theory of evolution that is still studied today.

• Darwin’s theory of evolution by natural selection is the process by which populations with variations that help them survive in their environments live longer and reproduce more than those without beneficial variations. Over time, beneficial variations spread through populations, and new species that are adapted to their environments evolve.

• Camouflage, mimicry, and other adaptations are evidence of the close relationships between species and their changing environments.
• Fossils provide only one source of evidence of evolution. Additional evidence comes from living species, including studies in comparative anatomy, embryology, and molecular biology.

• Through evolution by natural selection, all of Earth’s organisms are related. The more recently they share a common ancestor, the more closely they are related.
Which term describes the collection of all the fossils ever discovered on Earth?

A. cast  
B. mold  
C. fossil record  
D. trace fossil
A. cast
B. mold
C. fossil record
D. trace fossil

Which is a fossil copy of an organism in a rock?
What kind of adaptation enables a species to blend in with its environment?

A. camouflage  
B. mimicry  
C. behavioral adaptation  
D. functional adaptation
What kind of adaptations involve internal body systems that affect biochemistry?

A. mimicry
B. variation
C. behavioral adaptations
D. functional adaptations
Which of these is the study of gene structure and function?

A. embryology

B. variation

C. comparative anatomy

D. molecular biology
Which term describes what happens when the last individual organism of a species dies?

A. adaptation
B. extinction
C. biological evolution
D. mass extinction
How many eons is Earth’s history divided into?

A. 2
B. 4
C. 10
D. 25
What describes one species’ resemblance to another species?

A. adaptation
B. camouflage
C. mimicry
D. variation
What type of adaptation involves the way an organism behaves or acts?

A. mimicry
B. variation
C. behavioral adaptation
D. structural adaptation
What term refers to body parts of organisms that are similar in structure and position but different in function?

A. camouflage
B. mimicry
C. analogous structures
D. homologous structures