



## New Jersey Center for Teaching and Learning Progressive Science Initiative

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## **6<sup>th</sup> Grade PSI**

# **Evidence of Common Ancestry and Diversity**

[www.njctl.org](http://www.njctl.org)

# **Table of Contents: Evidence of Common Ancestry and Diversity**

*Click on the topic to go to that section*

- **Fossils**
- **Fossilization**
- **Dating Fossils**
- **Evidence of Evolution**

# Fossils

[Return to Table of Contents](#)

# Timelines

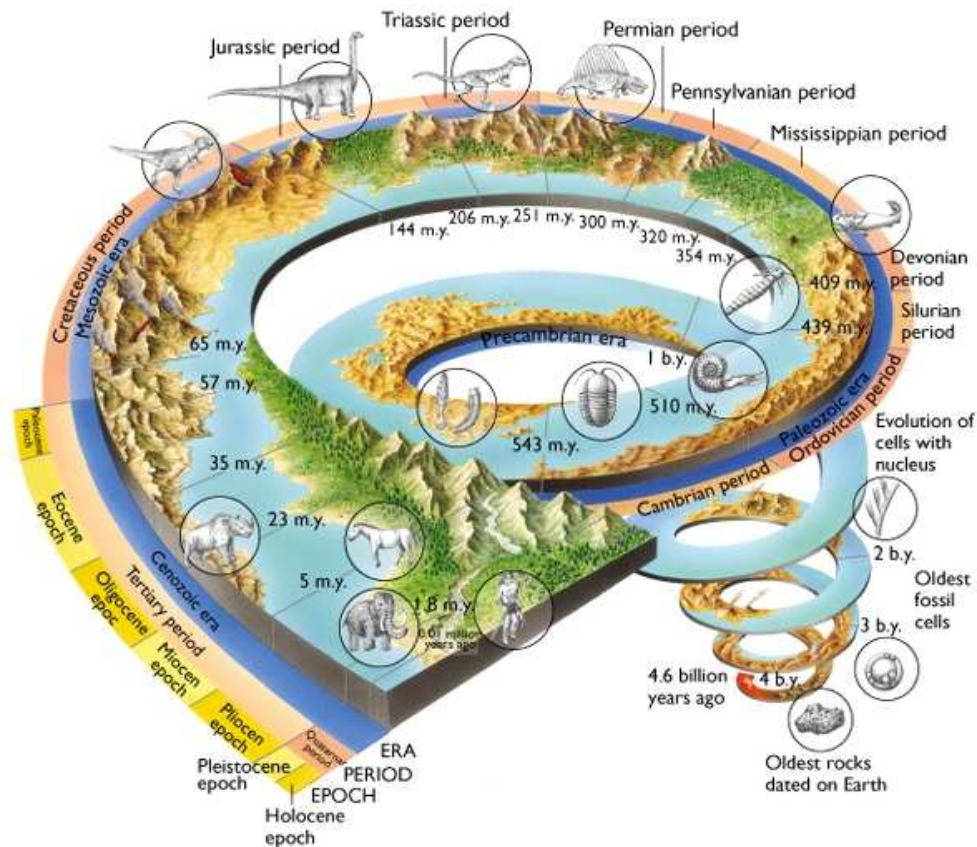
What is a timeline? What do they show?

Draw a timeline below that shows 5 important events in your life.

A large, empty, rounded rectangular box with a green border, intended for drawing a timeline. The box is centered on the page and occupies most of the lower half of the slide.

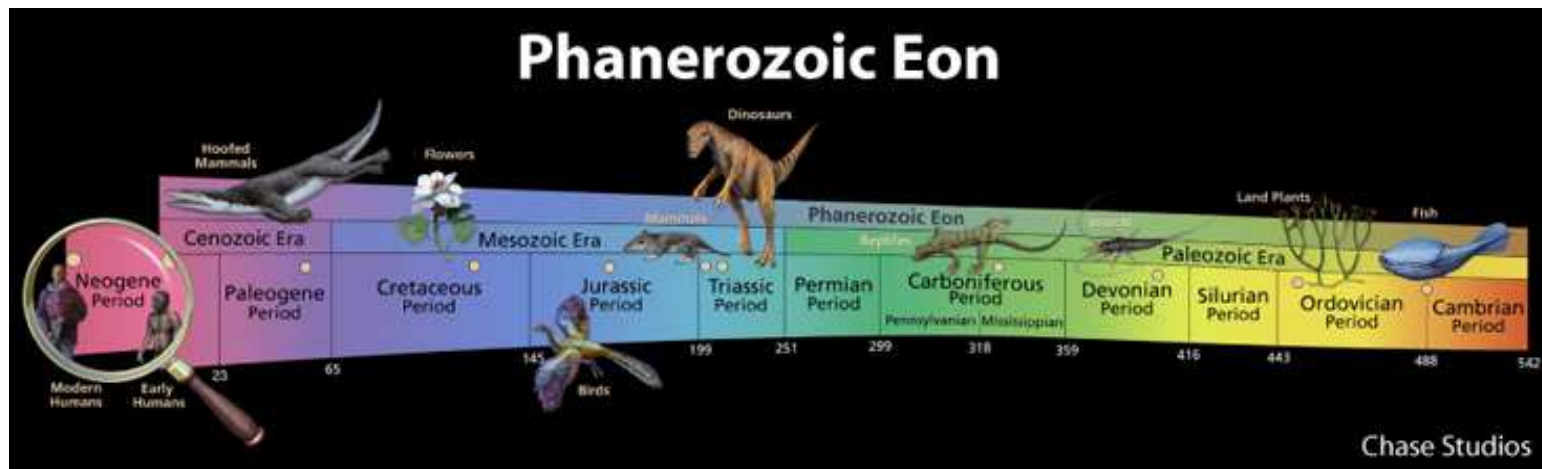
# Geological Time Scale

The geologic time scale is a timeline that spans all of Earth's history. It shows important events that have occurred over the 4.5 billion years of Earth's past.



# The Phanerozoic Eon

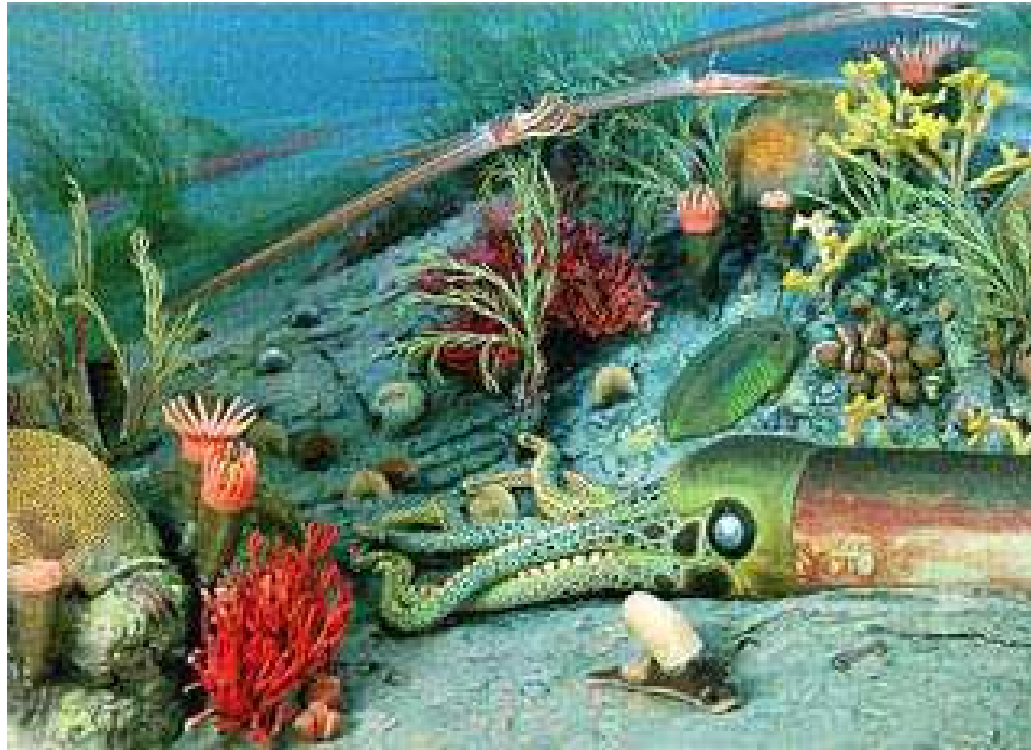
The Phanerozoic Eon covers only the last 10% of Earth's history and is split into three eras, the Cenozoic, Mesozoic and Paleozoic. The organisms from this time period left behind pieces of evidence that gives us clues to their ecosystems and evolution.



Interactive Timeline

## Paleozoic Era

This was the oldest of the three major eras spanning from 541 to 252 million years ago.



The Cambrian explosion was a huge increase in the diversity of multicellular animals. Towards the end of this era, there was a mass extinction that wiped out around 90% of all marine life.



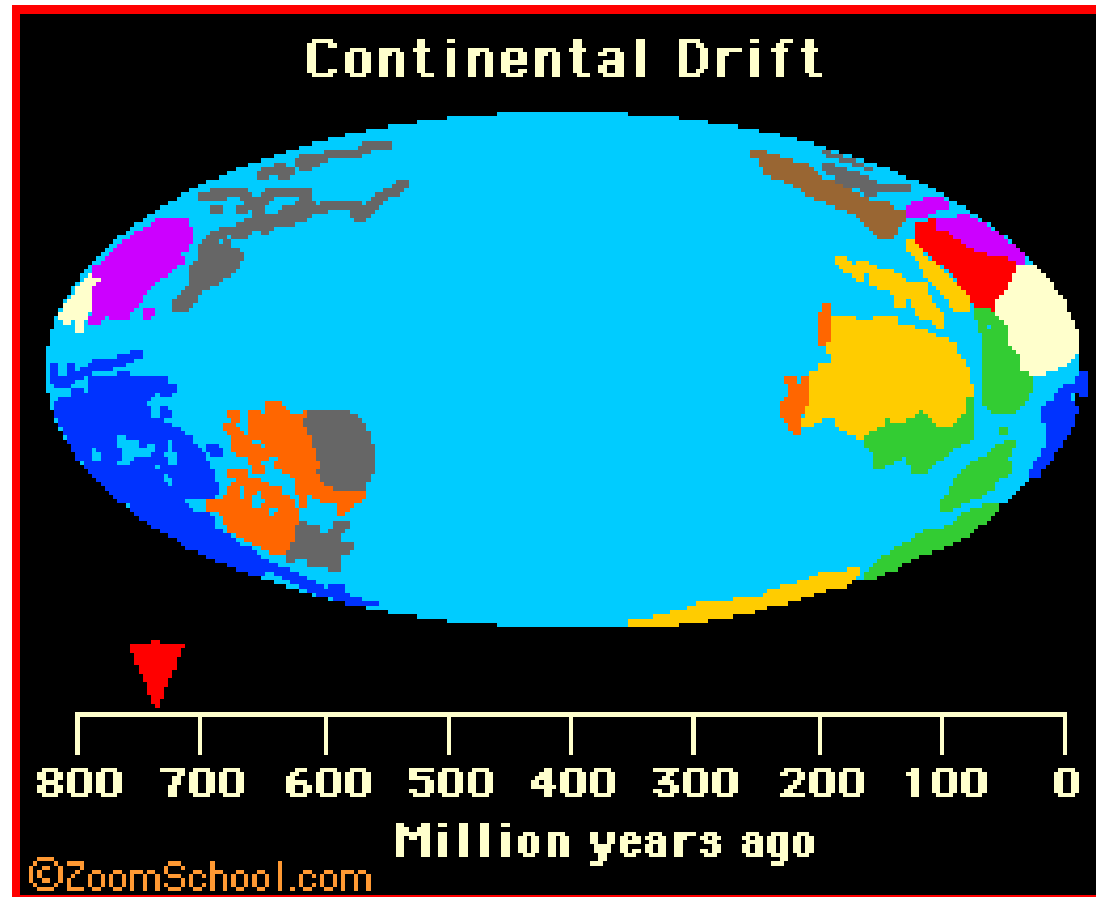
# Mesozoic Era

The middle of Earth's three geologic eras, the Mesozoic era, was known as the Age of Reptiles. Spanning from 248 to 60 million years ago, dinosaurs ruled the land of endless fern forests.



# Mesozoic Era

During this era, the continents were just beginning to move from the super continent of Pangaea into their current locations.



# Cenozoic Era

Spanning 65 million years, the Cenozoic Era is the most recent of the three major divisions in the geologic timeline.

Known as the "Age of Mammals," this era saw the largest land mammals and a great increase in the diversity of mammals due to the absence of large reptiles.



**1 Which of the following are characteristics of the Mesozoic Era? Select all that apply.**

- A Most recent of the three eras
- B Age of the Reptiles
- C Pangaea began to separate
- D Age of Mammals

**1 Which of the following are characteristics of the Mesozoic Era? Select all that apply.**

- A Most recent of the
- B Age of the Rept
- C Pangaea began
- D Age of Mammals

**Answer**

**B & C**

## 2 What is a key characteristic of the Cenozoic Era?

- A Explosion in marine life
- B Age of the Reptiles
- C Oldest of the three eras
- D Age of the Mammals

## 2 What is a key characteristic of the Cenozoic Era?

- A Explosion in marine life
- B Age of the Reptiles
- C Oldest of the three eras
- D Age of the Mammals

Answer

D

**3 Which of the following are characteristics of the Paleozoic Era? Select all that apply.**

A Cambrian Explosion

B Largest land mammals

C Endless fern forests and dinosaurs

D Massive extinction that wiped out 90% of marine life



### 3 Which of the following are characteristics of the Paleozoic Era? Select

- A Cambrian Explosion
- B Largest land mass
- C Endless fern forests
- D Massive extinctions

Answer

A & D

# Evidence

The geologic time scale shows a vast amount of information about life on Earth before humans.

How do we know this information?

What evidence have humans found to prove the existence of life before us?

Write your ideas below:

A large, empty, rounded rectangular box with a green border, intended for writing ideas.

# Fossils



The discovery of fossils has given scientists information about the Earth before humans existed.

# What are fossils?

These are all pictures of different types of fossils. Look closely at them and determine a good definition for a fossil.



A fossil is:

# What are fossils?

Fossils are the preserved remains of prehistoric organisms.

Fossils can be found in a variety of sizes and range in age from a few thousand of years to hundreds of millions of years.



## Where are fossils found?

Most fossils form in sediment (dirt/mud that hardens into rock). It takes many years for an organism to turn into a fossil. Fossils are typically best preserved in sediments beneath water. Fossils on land are less common due to the number of predators and an increased rate of decay.



Critical thinking: Why would increased predators and rate of decay affect fossil formation?

## Where are fossils found?

Most fossils form in sedimentary rocks. It takes many years for fossils to form. Fossils are typically best preserved in sedimentary rocks. Land fossils are less common than marine fossils. Increased rate of decay

rock). It  
s are  
on



It takes many years for an organism to turn into a fossil. Increased predators means that most organisms will be eaten before they can turn into a fossil. Increased rate of decay means that the organism is more likely to decay before it can turn into a fossil.

Critical thinking: Why would increased predators and rate of decay affect fossil formation?



## Where are fossils found?

Fossils can be found in any rock surface, from mountains to sea beds.

Critical thinking: How is it possible for this marine fossil to be found at the top of a mountain?





## Where are fossils found?

Fossils can be found in a variety of locations, from soil to sea beds.

Critical thinking: How is it possible for this marine fossil to be found at the top of a mountain?

Answer

At some point, this area was covered by an ocean. The movement of tectonic plates caused the formation of mountains. Weathering and erosion helped the fossil to be uncovered.



# Excavating Fossils

Fossils must be carefully freed from the encasing rocks without damaging it. Hand tools are used to free the surrounding rock.

Practice excavating fossils by clicking on the image below.

The screenshot shows the interface for the "Department of Paleobiology's Virtual Dinosaur Dig" interactive. The top left features the title "DEPARTMENT OF PALEOBIOLOGY'S VIRTUAL DINOSAUR DIG" in white text on a dark purple background. Below this is a stylized illustration of a desert landscape at sunset, with silhouettes of three people in hats and a shovel, and a large rock formation in the background. The top right corner displays the Smithsonian logo and the text "Smithsonian National Museum of Natural History". A central text box contains the following information:

**Welcome to the Department of Paleobiology's Virtual Dinosaur Dig Interactive.**

*In this interactive, you will be able to:*

1. find a virtual fossil;
2. learn how vertebrate paleontologists excavate the specimen and "excavate" your very own specimen;
3. learn about the anatomy of your specimen and some general information about where it lived, what it ate and how large it was; and
4. view a short slide showing illustrations of how this specimen may have looked with skin and

The bottom right corner of the interface shows a page number "1/13" and navigation arrows.

## 4 What are fossils?

- Remains of recently deceased organisms
- Preserved remains of organisms
- Sediment that has been compressed over time to form rock
- The skin and fur of deceased prehistoric animals

## 4 What are fossils?

- A Remains of recent animals
- B Preserved remains of ancient animals
- C Sediment that has become form rock
- D The skin and fur of dead animals

Answer

B

**5 All prehistoric bones turned into fossils, we just haven't found them all yet.**

True

False

5 All prehistoric bones that have been discovered have been found in the same places. **st**  
haven't found them in other places.

True

False

Answer

B

Fossils only form under certain conditions.

**6 Most fossils are formed when deceased remains are buried in \_\_\_\_.**

water

sediments

mold

carbon film

**6 Most fossils are formed \_\_\_\_\_ and are buried in \_\_\_\_.**

- water
- sediments
- mold
- carbon film

**Answer**

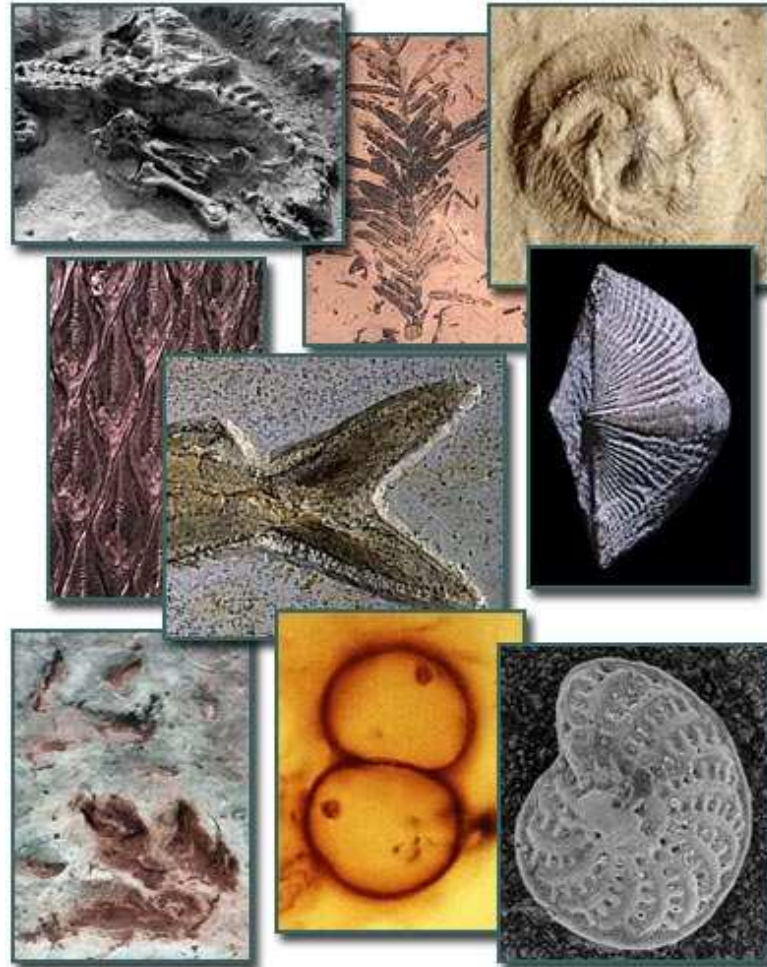
**B**



# Types of Fossils

Fossils are created in several different ways and classified into the following categories:

- mold & cast fossils
- true form fossils
- trace fossils
- carbon film fossils



## Mold Fossils

Mold fossils form when the hard parts of organic material are buried in sediment.

Over time the hard parts dissolve and disappear completely leaving a negative image of the fossil.



# Cast Fossils

Cast fossils form as the result of a mold. After an organism has created a mold, minerals enter the cavity and fill in the impression.

Sorry, this element requires Flash, which is not currently supported in PDFs.

Please refer to the original Notebook file.

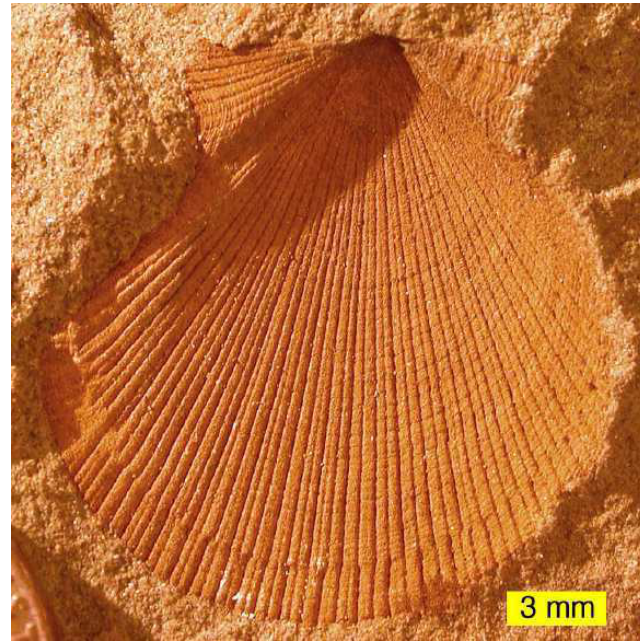


*Animation: Jennifer Loomis, TERC*



## Cast vs Mold

Look at the two fossils below. Which is a cast and which is a mold? Click in the boxes to check your answers.



## True Form Fossils

True form fossils are the actual remains, including the soft tissue of an organism.

Organisms are preserved in their original state when they are trapped in amber or tar. True form fossils also form when organisms are frozen in ice.



# Trace Fossils

Trace fossils provide clues to the activities of ancient organisms. They include footprints, teeth marks on bones, fossilized feces, nests or burrows.

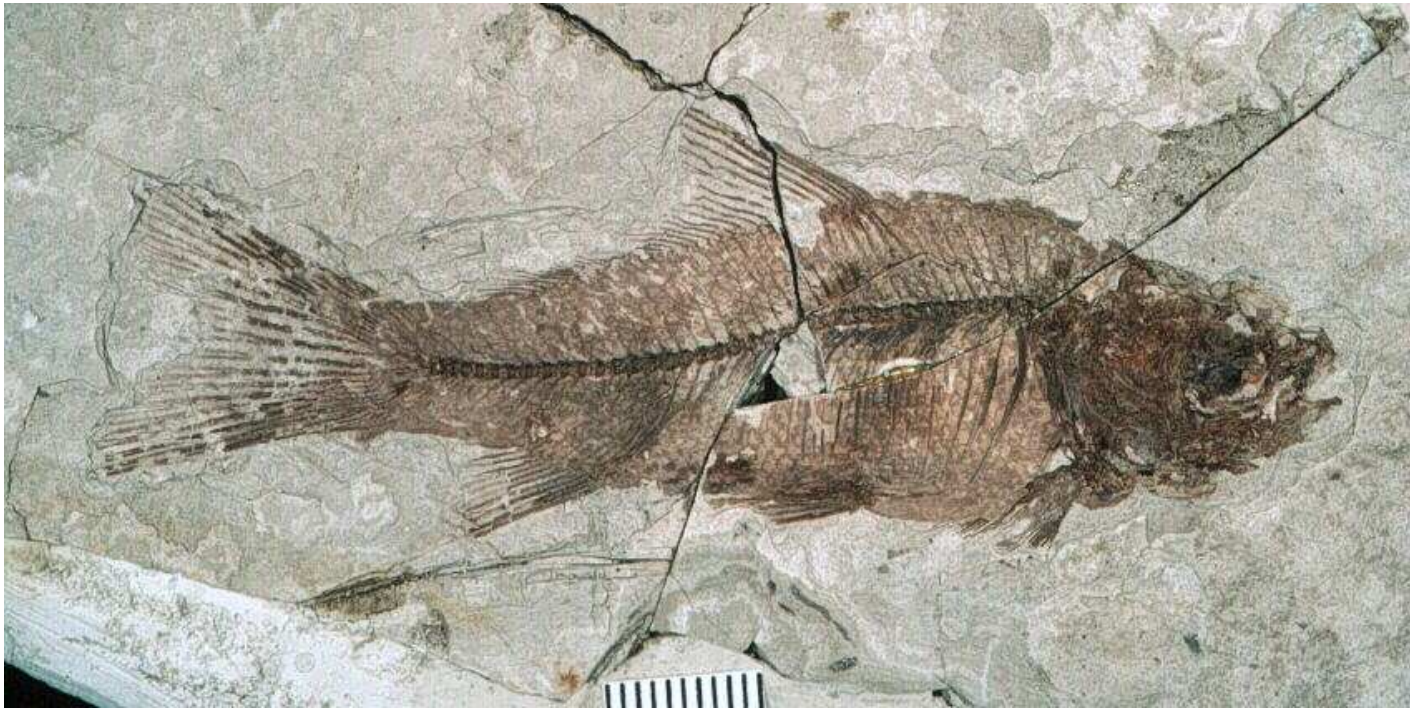


Impressions left by an animal or plant are buried under layers of sediment and become solid rock over time.



## Carbon Film Fossils

As organisms decompose, sometimes thin layers of carbon are left on the rock, creating a silhouette with fine details. This process is enhanced by pressure and heat.



# Fossil Classification

Fossils are often preserved by more than one form and can be classified as such.



This trilobite fossil has created a cast and a mold.



Carbon film fossils created by plants can also leave a cast and mold.



**7 A footprint is an example of this type of fossil.**

- A petrified fossil
- B fossil fuel
- C true form fossil
- D trace fossil

**7 A footprint is an example of this type of fossil.**

- A petrified fossil
- B fossil fuel
- C true form fossil
- D trace fossil

**Answer**

**D**

## 8 Which of the following is an example of a true form fossil?

A



C



B



D



8 Which of the following is an example of a true form fossil?

A



Answer

B



C



D

**9 Which of the following statements is true about cast fossils?**

- A Cast fossils are the actual remains of animals.
- B Cast fossils are created when mineralization fills a mold.
- C Cast fossils are formed when an impression is made.
- D Cast fossils are formed when carbon creates an impression in rock.

## 9 Which of the following statements is true about cast fossils?

- A Cast fossils are the
- B Cast fossils are a mold.
- C Cast fossils are formed
- D Cast fossils are formed when carbon creates an impression in rock.

Answer

B

**10 Fossils can be identified as more than one of the types?**

True

False

**10 Fossils can be identified in two types?**

True

False

**Answer**

A



# Fossilization

[Return to Table of Contents](#)

## How are Fossils Formed?

As ancient organisms died, their bones were quickly covered with sediment. Over time more sediment piled up on top of the bones.



After millions of years, the sediment hardened into rock, creating a fossil out of the remains. Fossilization is the complex process of converting a plant or animal remains into a fossil.

# Creation of Fossils

In order for fossils to form, the following must happen:

- The remains become buried quickly after death occurs.
- The remains are covered with layers of sediment.
- Dissolved minerals in water fill in tiny spaces in the bones.
- Pressure, chemical reactions and time transforms the bones into a fossil.



Critical thinking: Why would organisms need to be buried quickly after dying in order for a fossil to form?

# Creation of Fossils

In order for fossils to form, the following must happen:

- The remains become buried.
- The remains are protected from scavengers.
- Dissolved minerals fill the spaces.
- Pressure, heat, and time turn the remains into a fossil.



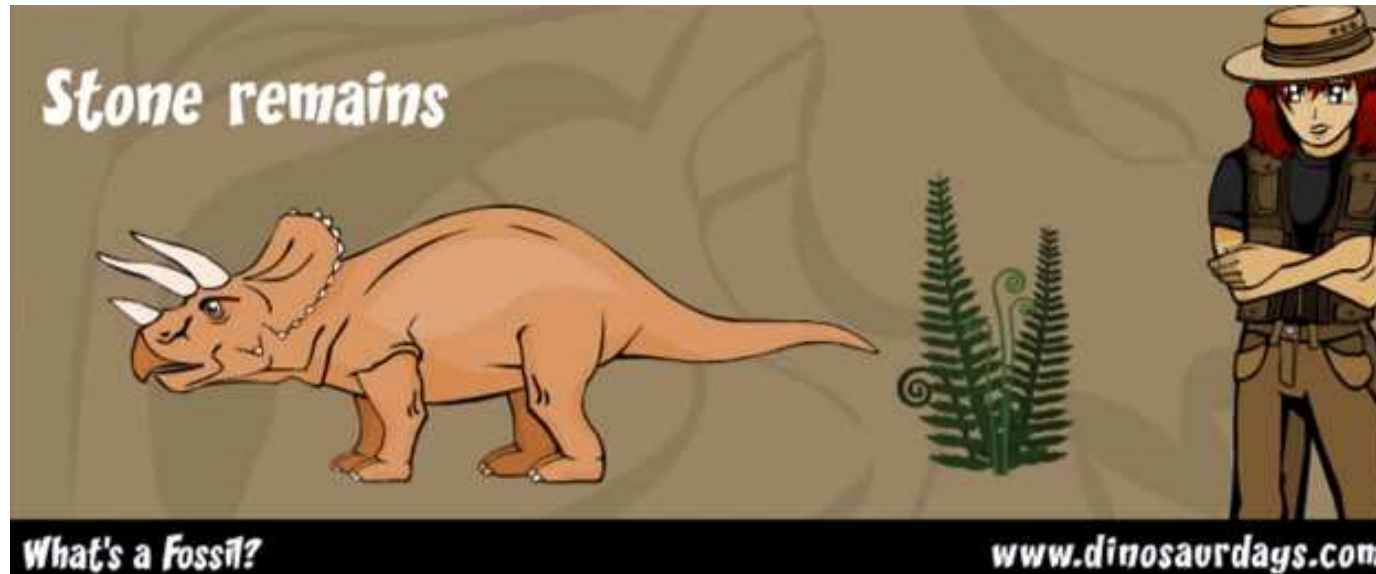
Answer

If organisms did not become buried quickly, then predators might eat the remains or they may decay before fossilization could occur.

s.  
nes

Critical thinking: Why would organisms need to be buried quickly after dying in order for a fossil to form?

# Creation of Fossils



Click above to watch a video about fossils.



# Permineralization

As plant and animal remains are buried under sediment, ground water slowly penetrates the little holes in the remains. Over time, minerals in the water can fill these spaces and then harden, creating fossils.



Most dinosaur fossils are created by permineralization.



# Replacement

Replacement is similar to permineralization. It occurs when minerals in the water replace all structures of an organism. It is a gradual process that preserves fine details of an organism.





## Permineralization vs Replacement

Permineralization and replacement are very similar to each other. They both occur as a result of minerals in water turning into rock.

However, in permineralization, the minerals only fill empty spaces in the organism's remains. Much of the organism's original organic matter remain in place.

In replacement, the minerals in the water replace ALL structures of the organism's remains. No original organic matter remains.



This petrified wood contains no original material from the tree. What type of fossilization is this?

## Unaltered Preservation

Unaltered preservation occurs when organisms are preserved in a substance, such as amber, ice or tar. The entire organism is preserved because the substance prevents the decay of tissue.



A baby mammoth trapped in ice for thousands of years is preserved in an unaltered form.

# Carbonization

Carbonization occurs when all the minerals in a organism, except for carbon, decays. The carbon that is left behind leaves a thin film that looks like an outline of the organism.

Carbonization is very similar to the transformation organic materials undergo during the creation of coal.



# Recrystallization

Recrystallization occurs when the original compounds in an organism reform as larger crystals.



The original compounds remain the same. The compounds, however, change into a different form.



**11 This fossil is an example of \_\_\_\_\_.**  
**Select all that may apply.**

unaltered Preservation

carbonization

cast

petrification



**11 This fossil is an example of \_\_\_\_\_  
Select all that may apply.**

- unaltered Preservation
- carbonization
- cast
- petrification

**Answer**

**B**



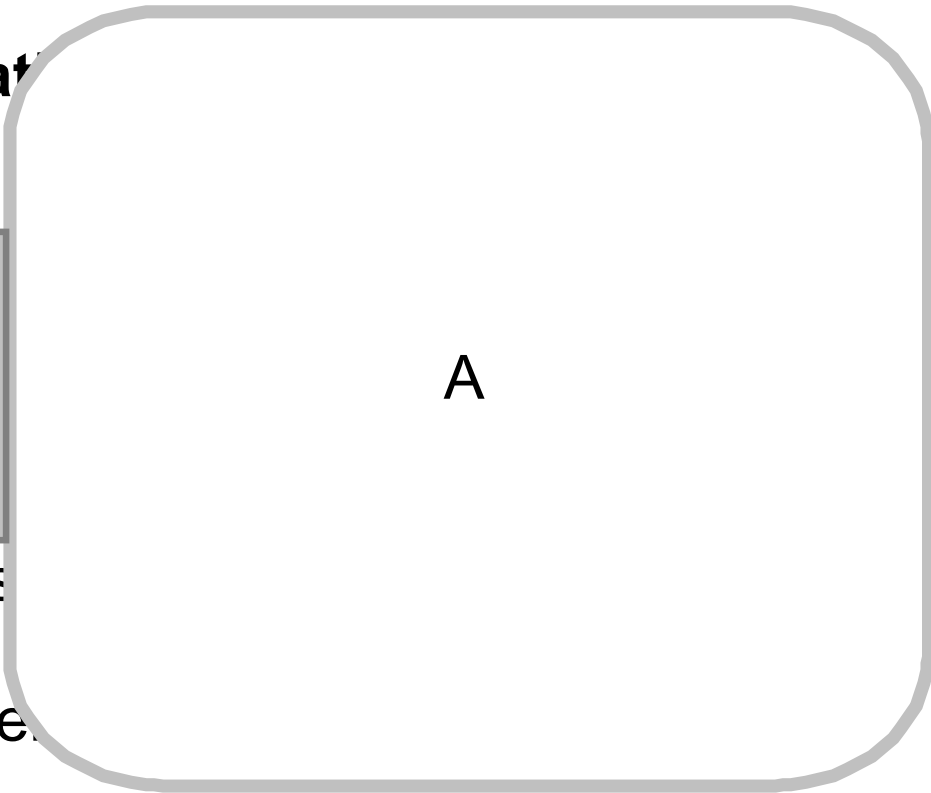
## 12 Unaltered preservation occurs when

- a fossil is preserved in amber, ice or tar.
- hard parts are replaced by silica, calcite or iron.
- a thin carbon film is left behind on the stone.
- all the organic material is replaced with minerals.

## 12 Unaltered preservation

- a fossil is preserved
- hard parts are replaced
- a thin carbon film is formed
- all the organic material is replaced by minerals.

Answer





**13 These fossils were created when minerals in water filled the tiny spaces in the organism's remains. This is an example of \_\_\_\_\_. (Choose all that apply.)**

mold

permineralization

cast

replacement



**13 These fossils were created when minerals in water filled the tiny spaces in the organism's remains. This is an example of \_\_\_\_\_**

- mold
- permineralization
- cast
- replacement

**Answer**

B, C

**14 The transformational process fossils undergo depends upon the material they are exposed to and the conditions present.**

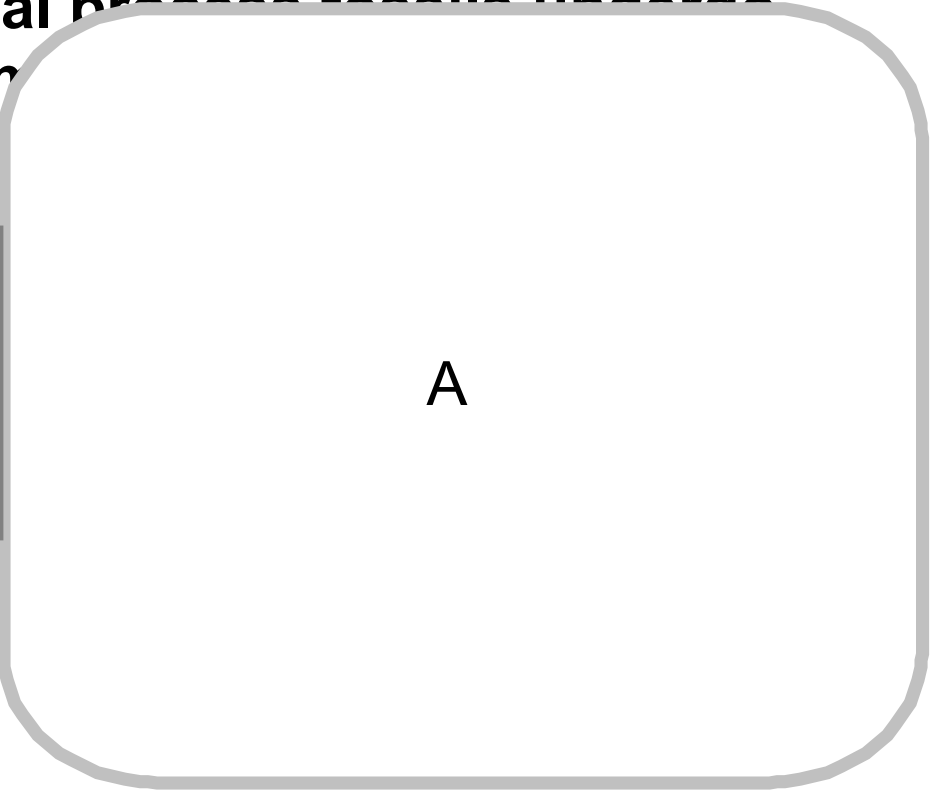
True

False

**14 The transformational process fossils undergo depends upon the rate of burial and the conditions**

- True
- False

**Answer**



# Dating Fossils

[Return to Table of Contents](#)

# Sedimentary Rock

Before we can understand how fossils are dated, we must first understand sedimentary rock.

Based on your knowledge about fossilization, how do you think sedimentary rock forms? Write your ideas below.

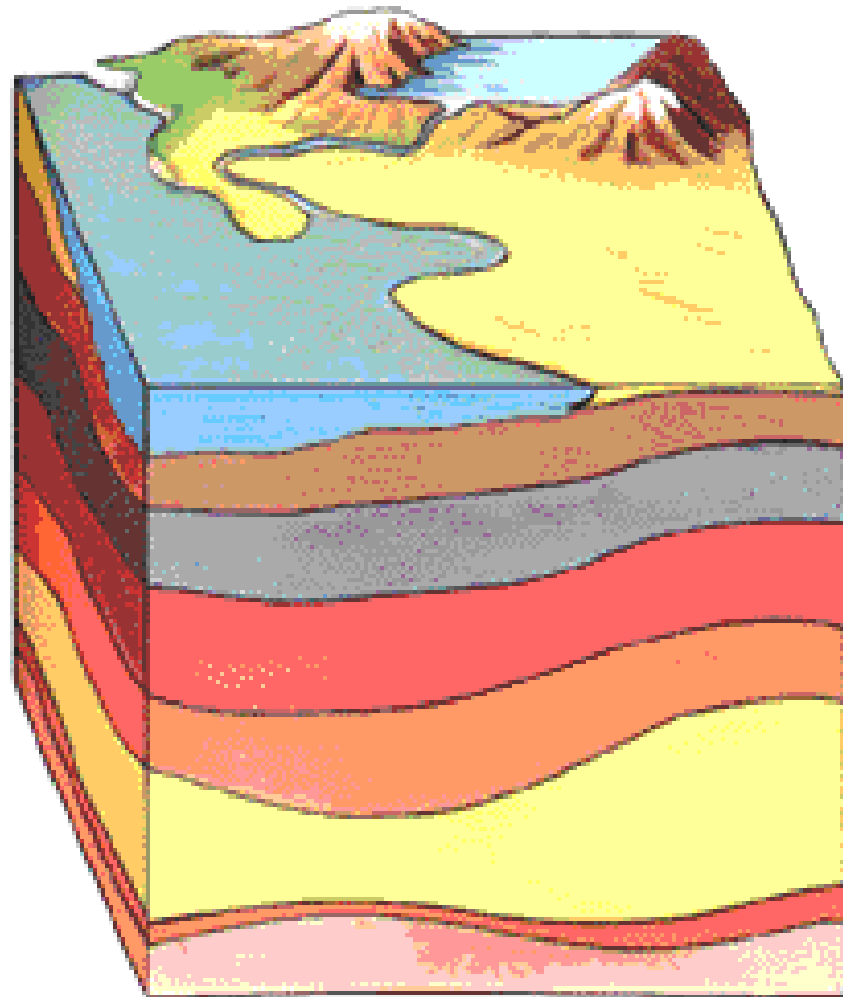
A large, empty, rounded rectangular box with a green border, intended for writing answers.

# Sedimentary Rock

Sedimentary rock is formed by the deposition of sediment over time, usually at the bottom of lakes or oceans.

Over time the sediment layers are compressed forming solid rock.

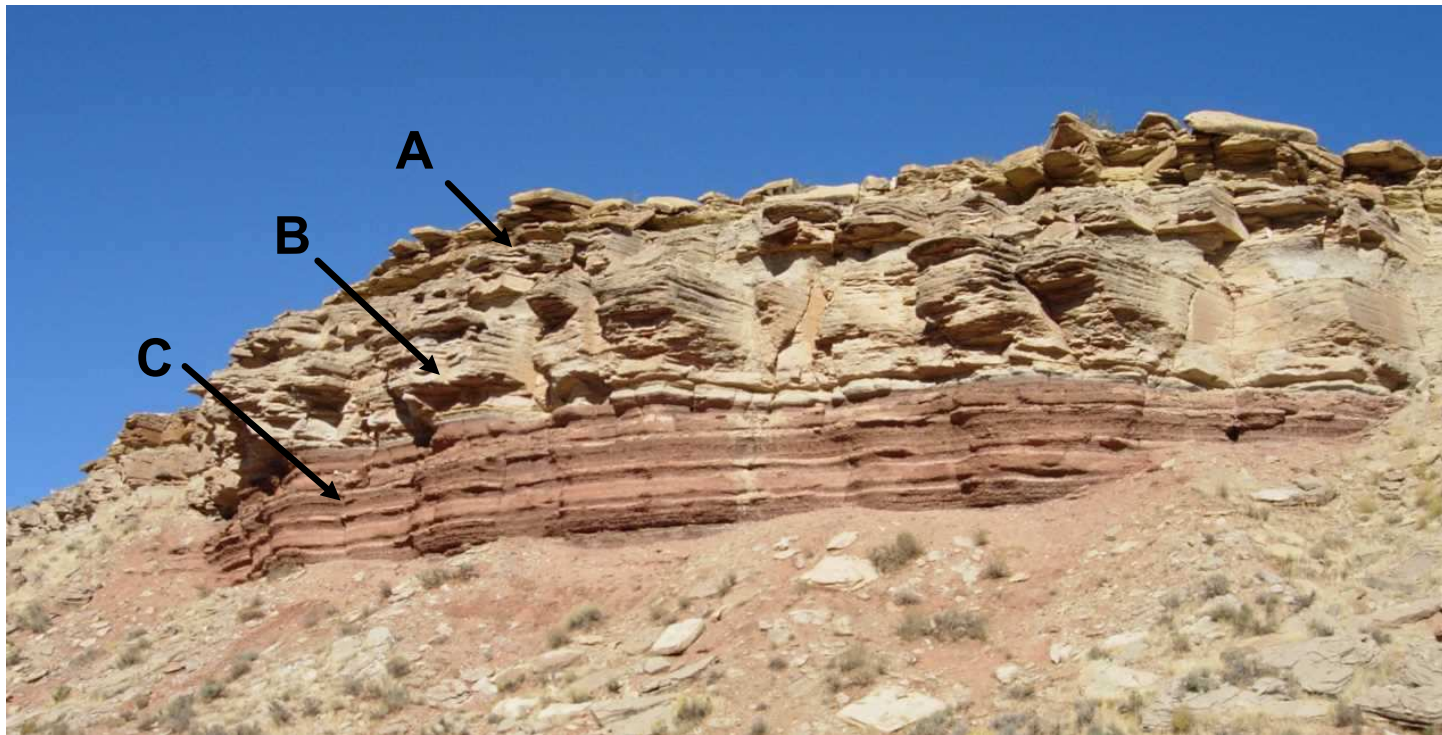
Each layer, or strata, forms on top of the previous layer and represents different time periods.



# Sedimentary Layers

As new layers form, the oldest sedimentary rocks are on the bottom with progressively newer layers on top.

The picture below shows sedimentary rock in southwestern Utah. Which layer of rock (A, B or C) is the oldest?

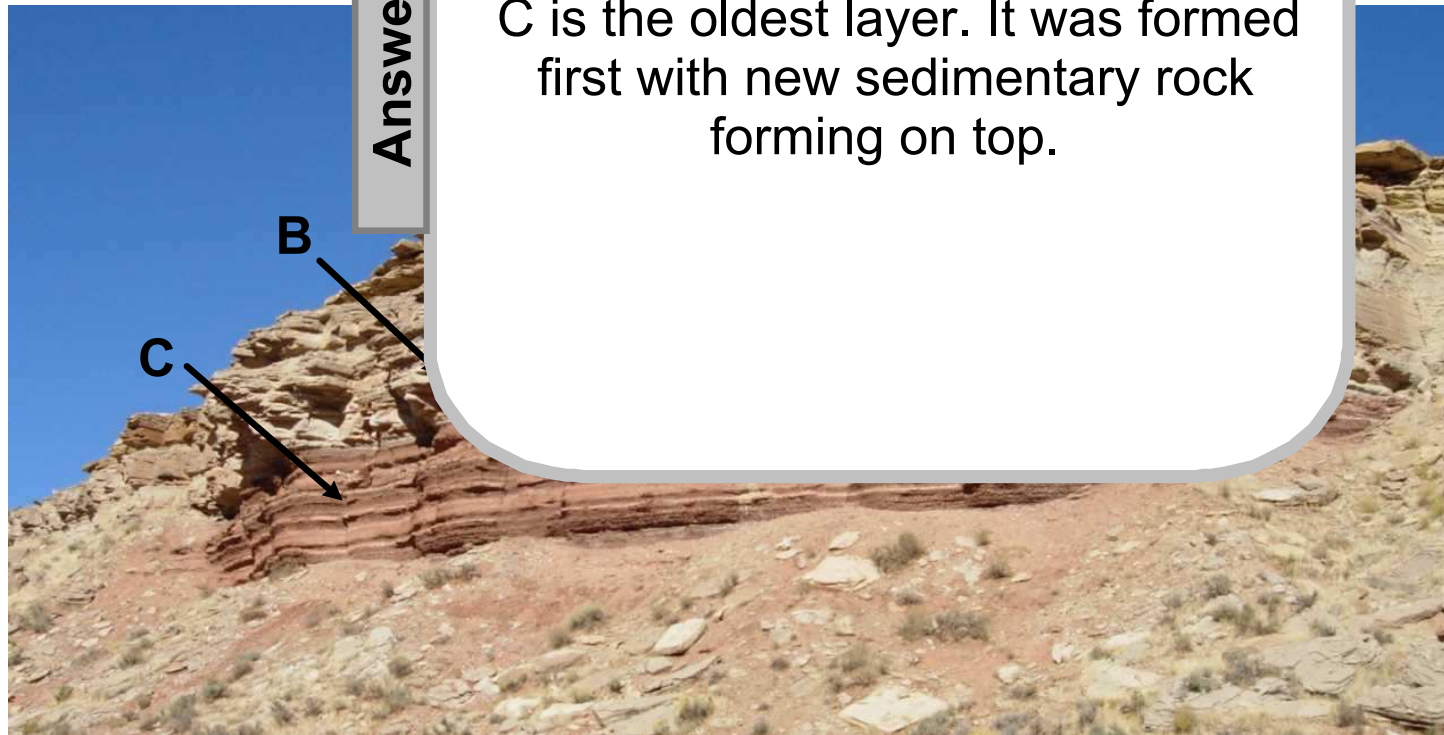




# Sedimentary Layers

As new layers form, the oldest sedimentary rocks are on the bottom with progressively newer layers on top.

The picture below shows a cliff face in southern Utah. Which layer of rock is the oldest?



Answer

C is the oldest layer. It was formed first with new sedimentary rock forming on top.

# Sedimentary Rock Principles

By understanding how sedimentary rock forms, scientists are able to determine the relative ages of fossils and rock layers. Four principles help them to do so:

- Principle of Original Horizontality
- Principle of Lateral Continuity
- Principle of Superposition
- Principle of Faunal Succession



These cliffs in Dorset, England, show how sedimentary rock forms in horizontal layers.

# Principle of Original Horizontality

Sedimentary rock forms in horizontal layers. Any changes to this indicate an event that happened after the rock was formed.



Michael Fogden/DRK Photo

Changes in the layers from geological events give clues to what has happened after deposition. Can you think of any events that may have led to the pattern of sedimentary layers shown above?

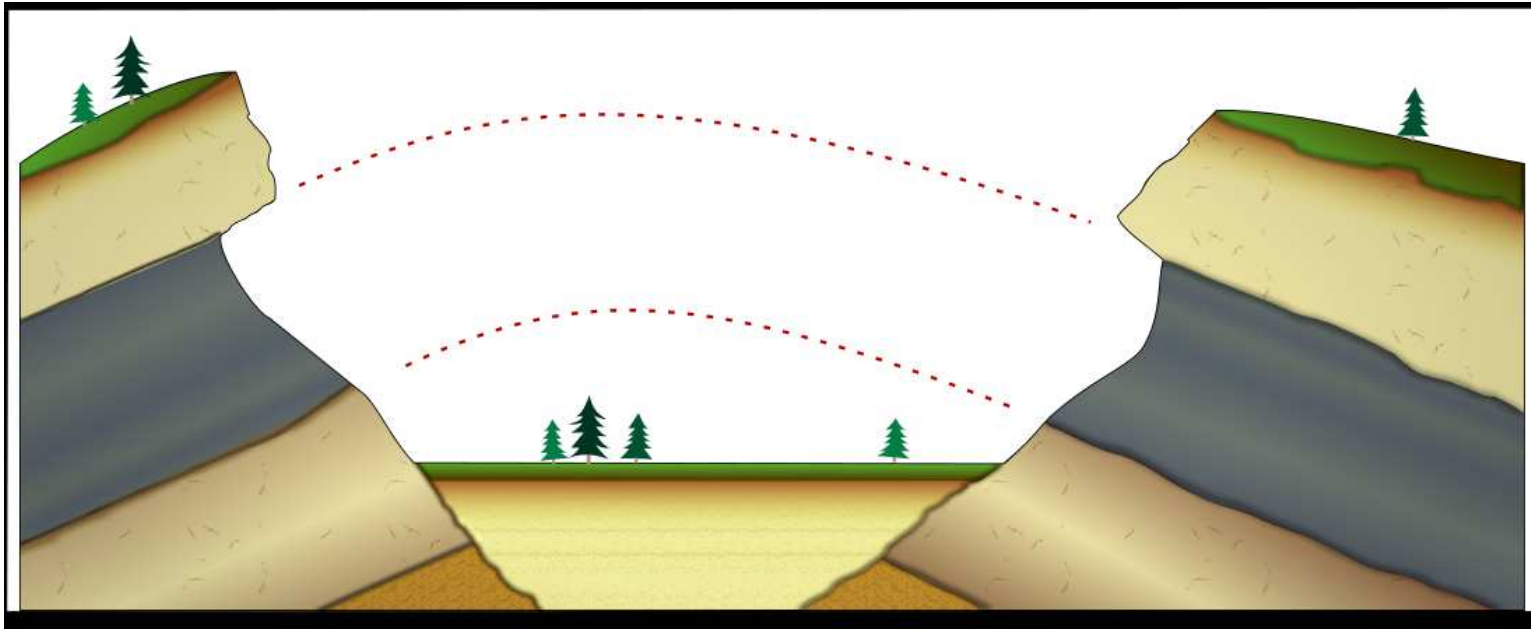
# Separated Rocks

Since sedimentary rocks form in horizontal layers, how can you account for the rock formation below?



# Principle of Lateral Continuity

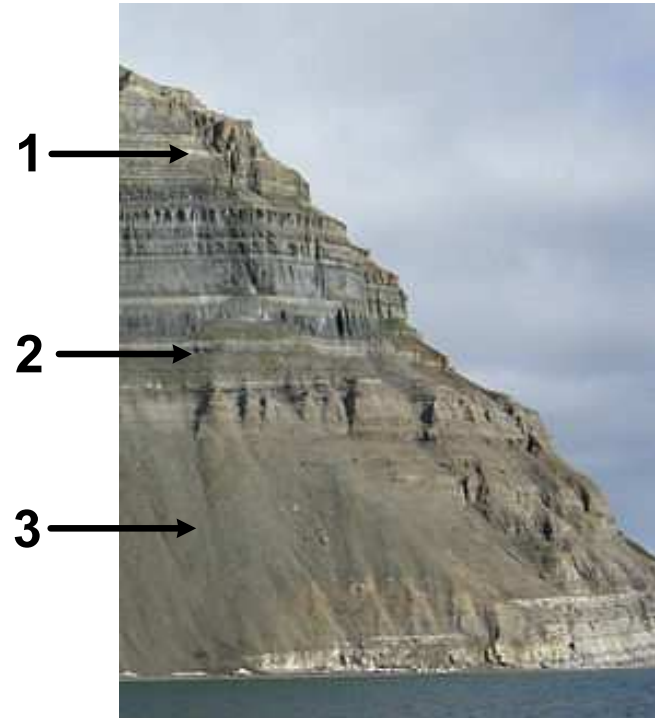
Sediments are deposited laterally (horizontally) in all directions until they reach a barrier. Rocks that are now separated are assumed to have been continuous (together) at one time.





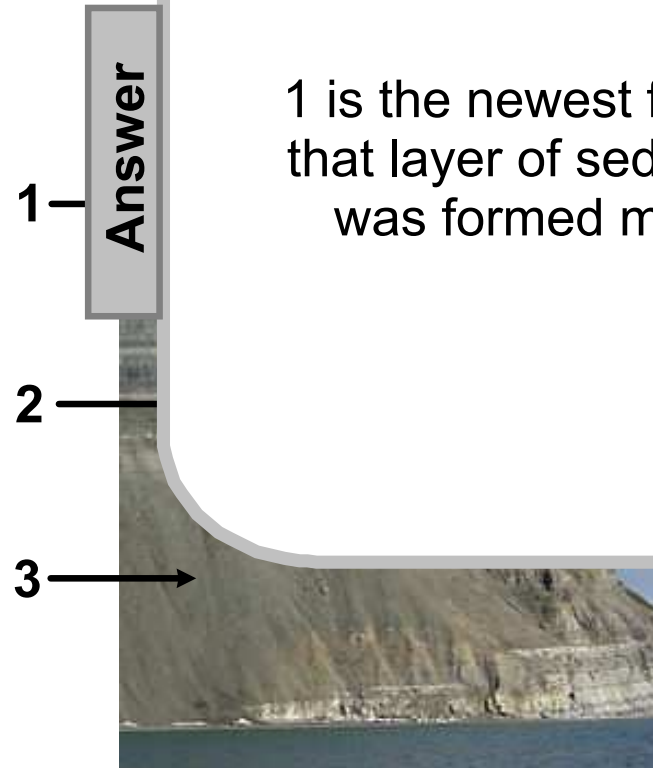
## Relative Age of Fossils

Look at the rock formation below. Suppose that fossils are discovered at locations 1, 2 and 3. Based on your knowledge, which fossil is the youngest?



## Relative Age of Fossils

Look at the rock formations  
discovered at locations  
which fossil is the young



**Answer**

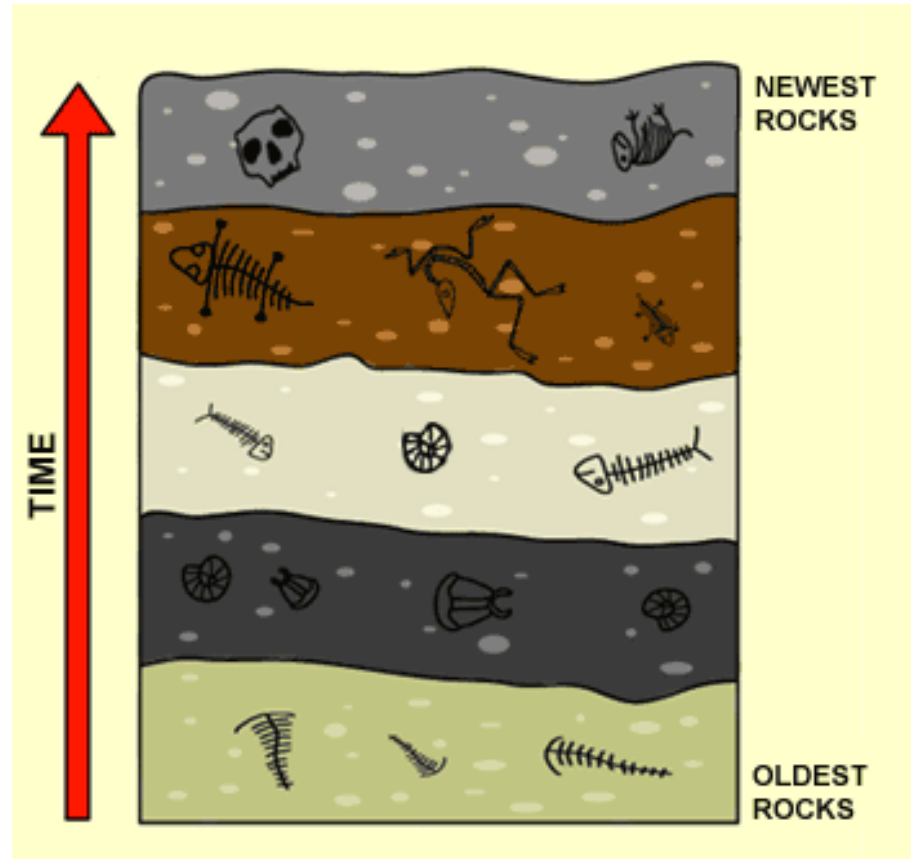
1  
2  
3

1 is the newest fossil because that layer of sedimentary rock was formed most recently.

# Principle of Superposition

Sediment layers are deposited in a chronological order with the oldest rocks at the bottom and newest rocks on the top.

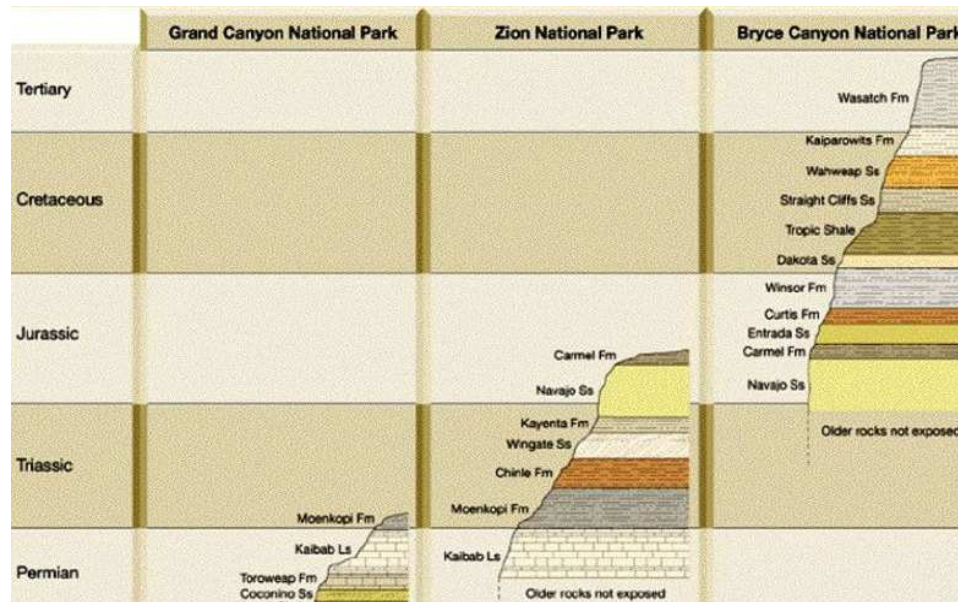
Application of this principle allows the relative dating of fossils based upon their position in the rock strata.





# Principle of Faunal Succession

Sedimentary rock containing flora and fauna fossils are layered in order that can be identified over great distances.



This means that specific rock layers (and their fossils) will be the same age no matter how far apart they are. This principle helps scientists to use information at one location to help provide answers to questions at a different location.

**15 Sedimentary rock is originally formed vertically.**

True

False

**15 Sedimentary rock is originally formed vertically.**

- True
- False

**Answer**

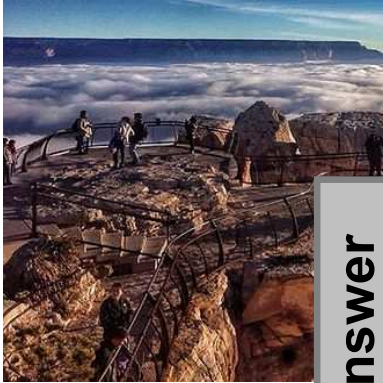
**False**

**16 This picture is taken at the Grand Canyon. What does the Principle of Lateral Continuity tell us about the two visible parts of the canyon?**



- A At one point, the two areas were connected as one area.
- B The rock layers on the top are younger than the rock layers on the bottom.
- C Sometimes rock layers can form vertically.
- D Since the rock layers are similar, they are probably the same age.

**16 This picture is taken at the Grand Canyon. What does the Principle of Lateral Continuity tell us about the two visible parts of the canyon?**



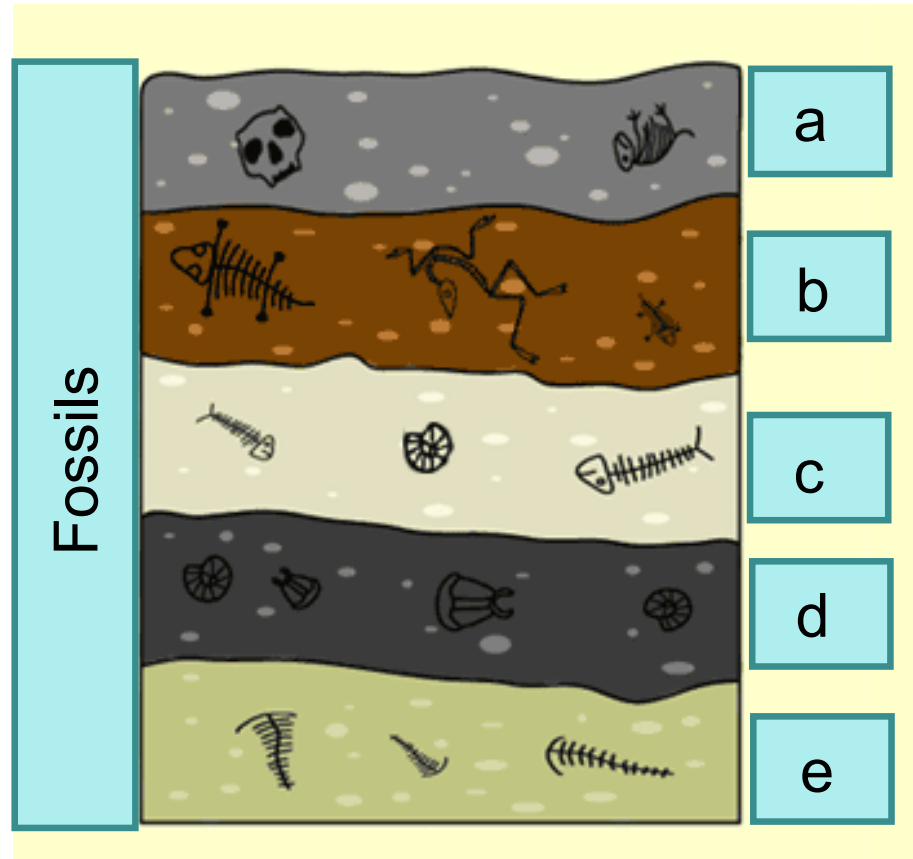
Answer

A

- A At one point, the top of the canyon was a continuous area.
- B The rock layers on the top of the canyon are the same as the rock layers on the bottom.
- C Sometimes rock layers can be deposited on top of older rock layers.
- D Since the rock layers are similar, they are probably the same age.

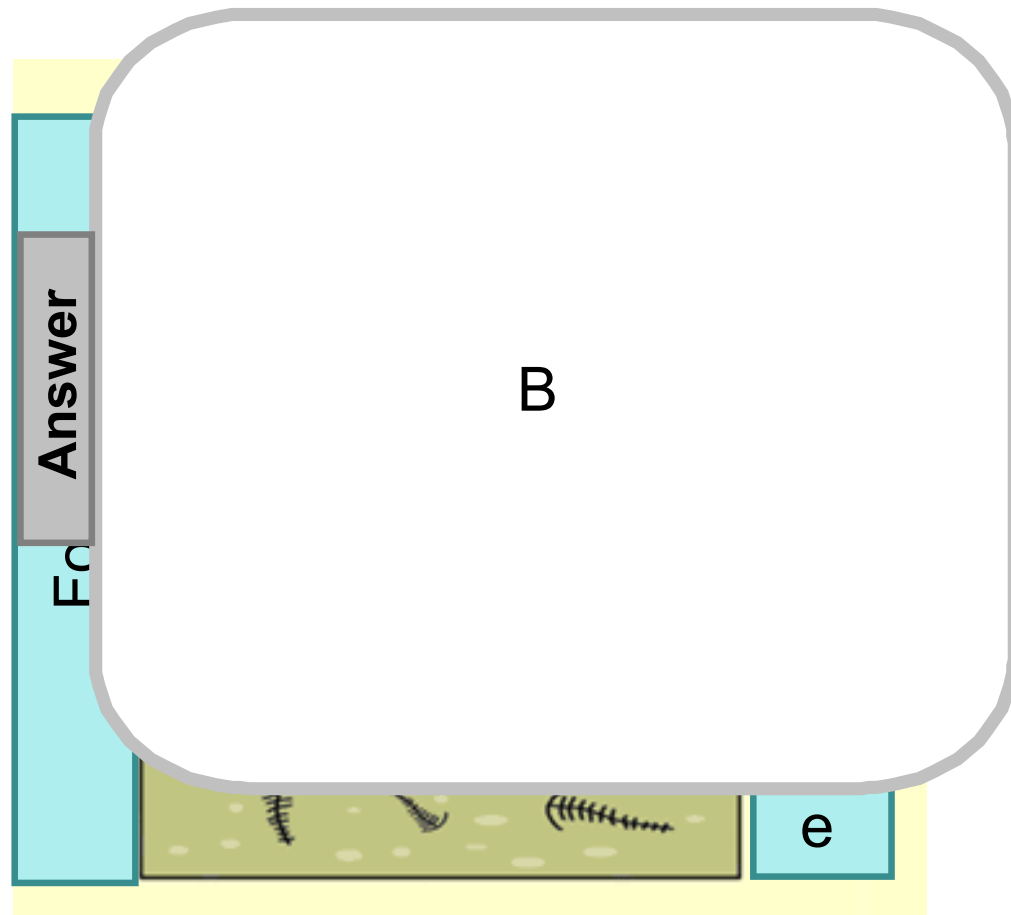
17 The Principle of Superposition tells us that fossils found at position \_\_\_ are older than fossils found at position \_\_\_.

- A b, e
- B c, a
- C a, e
- D b, d



17 The Principle of Superposition tells us that fossils found at position \_\_\_\_ are older than fossils found at position \_\_\_\_.

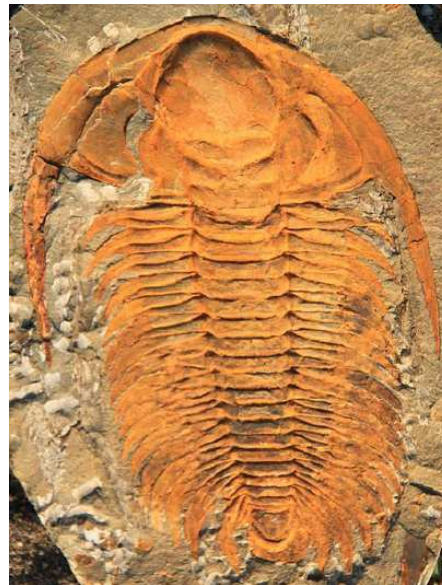
- A b, e
- B c, a
- C a, e
- D b, d





**18 This trilobite fossil was determined to be 251 million years old. The fossil was buried in layers of sedimentary rock. The same type of sedimentary rock was found across the country. Due to the Principle of \_\_\_\_, this sedimentary rock is determined to be approximately 251 million years old.**

- A Horizontality
- B Lateral Continuity
- C Superposition
- D Faunal Succession



**18 This trilobite fossil was determined to be 251 million years old. The fossil was buried in layers of sedimentary rock. The same type of sedimentary rock was found across the continent. Principle of \_\_\_\_, this fossil is determined to be approximately 251 million years old.**

- A Horizontality
- B Lateral Continuity
- C Superposition
- D Faunal Succession

Answer

D



# Ammonites

Ammonites are extinct marine animals that are related to current day octopus and squid.



Ammonites were only on Earth for a specific period of time before going extinct. How do you think scientists can use this information to help date other fossils?

# Ammonites

Suppose that this ammonite fossil from England is determined to be from the Jurassic period. In Australia, similar fossils are found along with other unknown fossils.



How old is the sedimentary rock layer in Australia?

How old are the unknown fossils?

Explain your answers.

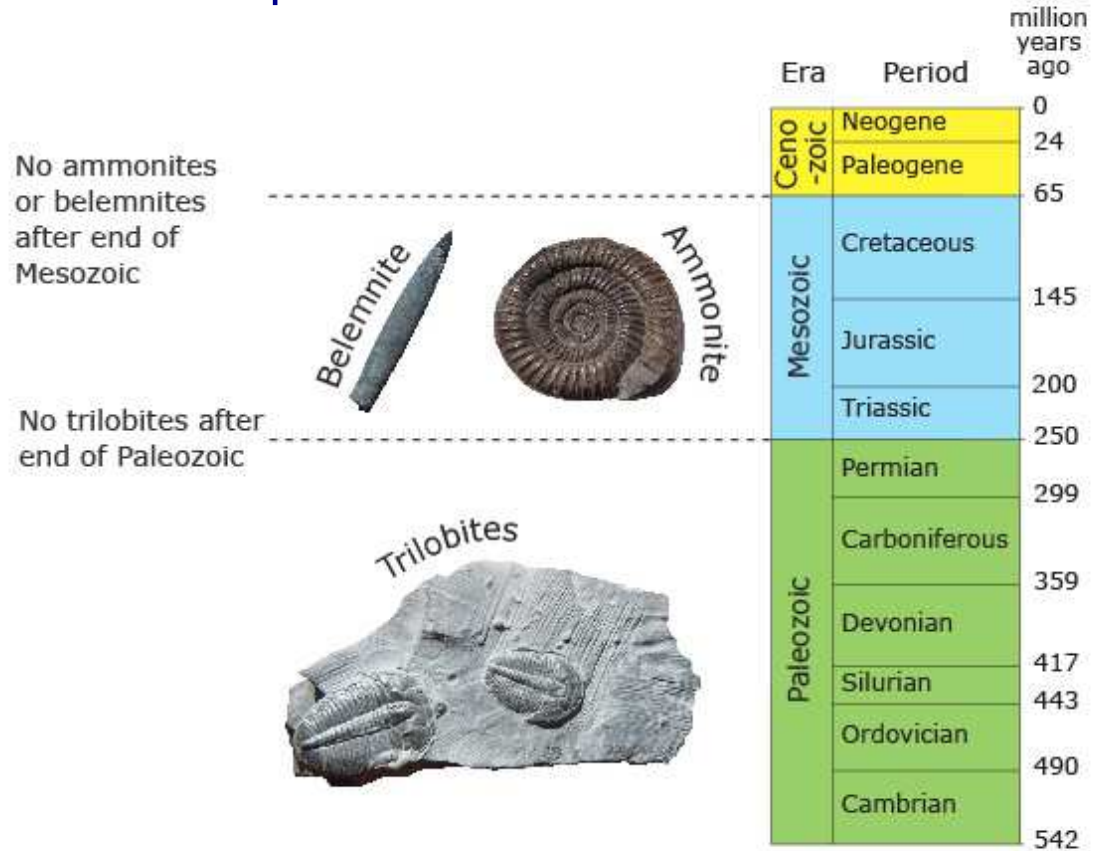
(Click below to see answer.)



# Index Fossil

The ammonite is an example of an index fossil.

Index fossils are fossils that are commonly found during specific time frames of Earth's history. They help to identify the age of other fossils and rock layers.



# Index Fossil

Index fossils provide a *relative* timeframe but not a specific date.

For example, finding a *Paradoxides pinus* fossil (trilobite) tells us that all surrounding fossils are from the Cambrian period. This period began 543 million years ago and ended 490 million years ago. So any surrounding unknown fossils would have existed at any point during this 53 million year time span.

Quaternary Period	<i>Pecten gibbus</i>	<i>Neptunea tabulata</i>
Tertiary Period	<i>Calyptrophorus velatus</i>	<i>Venericardia planicosta</i>
Cretaceous Period	<i>Scaphites hippocrepis</i>	<i>Inoceramus labiatus</i>
Jurassic Period	<i>Perisphinctes tiziani</i>	<i>Nerinea trinodosa</i>
Triassic Period	<i>Trochites subbullatus</i>	<i>Monotis subcircularis</i>
Permian Period	<i>Leptodus americanus</i>	<i>Parafusulina bosei</i>
Pennsylvanian Period	<i>Dictyoclostus americanus</i>	<i>Lophophyllidium proliferum</i>
Mississippian Period	<i>Cactocrinus multibrachiatus</i>	<i>Prolecanites gurleyi</i>
Devonian Period	<i>Mucrospirifer mucronatus</i>	<i>Palmatolepus unicornis</i>
Silurian Period	<i>Cystiphyllum niagarense</i>	<i>Hexamoceras hertzeri</i>
Ordovician Period	<i>Bathyrurus extans</i>	<i>Tetraraptus fructicosus</i>
Cambrian Period	<i>Paradoxides pinus</i>	<i>Billingsella corrugata</i>

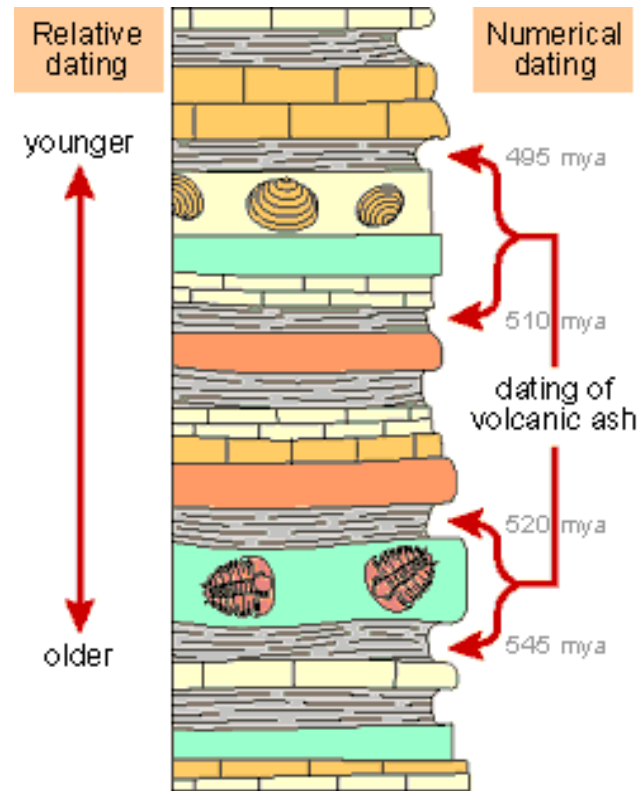


# Relative Dating

The use of index fossils is an example of relative dating.

Relative dating relies on determining the order of events in a sequential fashion.

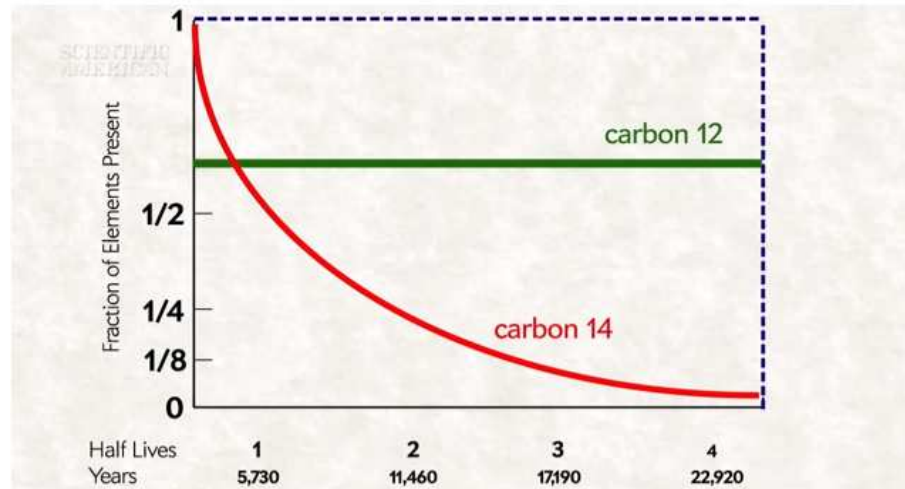
Relative dating gives information about sequence (what came first), but no actual dates.



# Carbon-14 Dating

Radiocarbon, specifically carbon-14, is a common isotope that is formed in the atmosphere.

All plants and animals take in carbon while they are alive and stop taking in carbon when they die.



Carbon-14 is very unstable and starts to break down once an organism dies. By measuring the amount of carbon-14 present, scientists can determine the age of a fossil.

Click on the image for more information.



## 19 When is an index fossil useful?

- A When it is found surrounded by other known fossils
- B When many index fossils are found together
- C When it is found surrounded by unknown fossils
- D When it is found in known rock layers

## 19 When is an index fossil useful?

- A When it is found with many other fossils
- B When many index fossils are found
- C When it is found in a wide geographic area
- D When it is found in a wide range of rock types

Answer

C

**20 Relative dating tells us the chronological order of events.**

- True
- False

**20 Relative dating tells us the chronological order of events.**

- True
- False

**Answer**

True

**21 The fossil record provides a chronological history of Earth based on the order of fossils deposited in sedimentary rock. The fossil record provides what type of a time scale?**

- A relative time scale
- B specific dates for occurrences

**21 The fossil record provides a chronological history of Earth based on the order of fossils deposited in sedimentary rock. The type of a time scale**

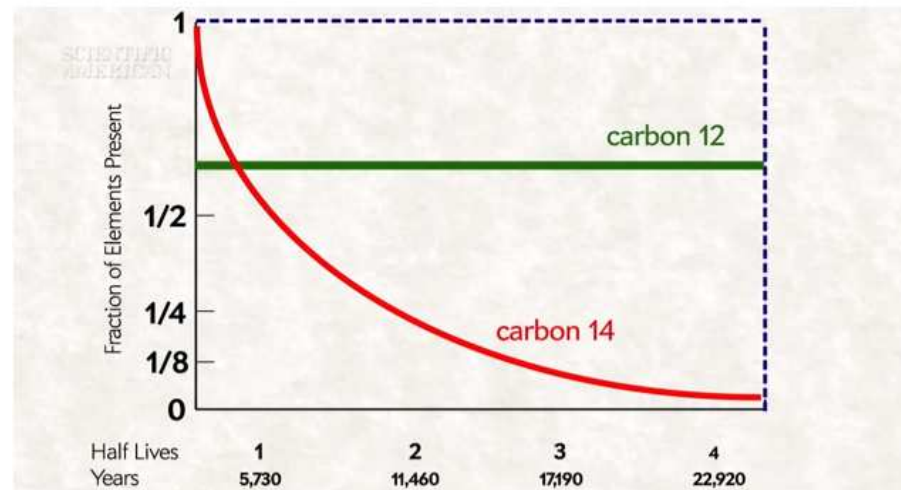
- A relative time scale
- B specific dates for

**Answer**

A

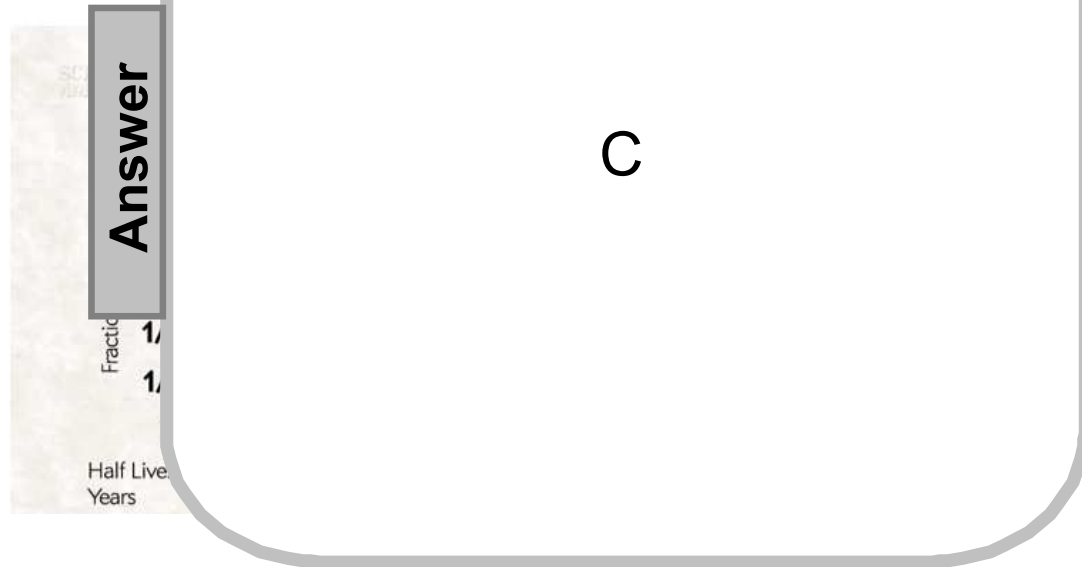
**22 Analyze the graph to answer this question. After 11,460 years, how much of the original amount of carbon-14 remains in an organism?**

- A 100%
- B 50%
- C 25%
- D 12.5%



**22 Analyze the graph to answer this question. After 11,460 years, how much of the original amount of carbon-14 remains in**

- A 100%
- B 50%
- C 25%
- D 12.5%





**23 Carbon-14 provides relative information about the age of a fossil.**

True

False

**23 Carbon-14 provides relative information about the age of a fossil.**

- True
- False

**Answer**

False

# Evidence of Evolution

[Return to Table of Contents](#)

# Galapagos Islands

The Galapagos Islands are a chain of islands to the west of Ecuador in South America.



At some point in the history of the Galapagos Islands, a group of finches arrived on the islands from the mainland of South America.

# Galapagos Finches

Initially, there was just one species of finch.

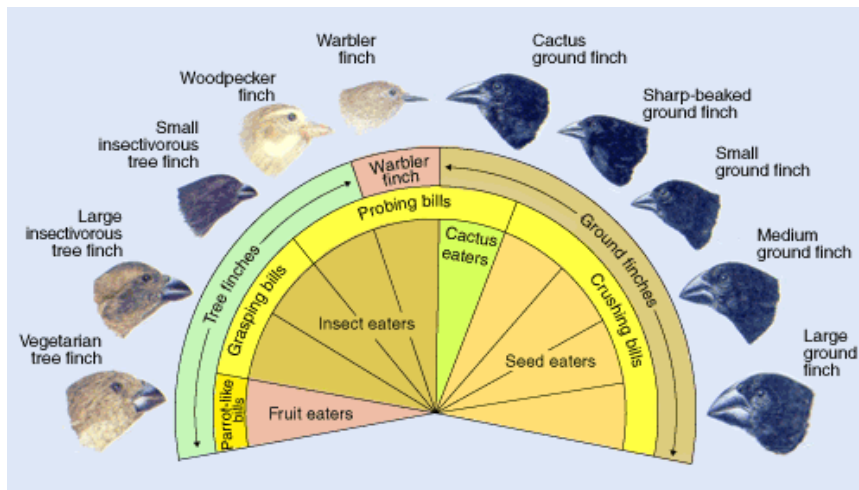
As the finches traveled from island to island, they discovered that there was a variety of food choices available: fruit, insects, cactus and seeds.

In small groups, discuss what may have happened to these finches over the years as they specialized their diet to a particular type of food.



# Galapagos Finches

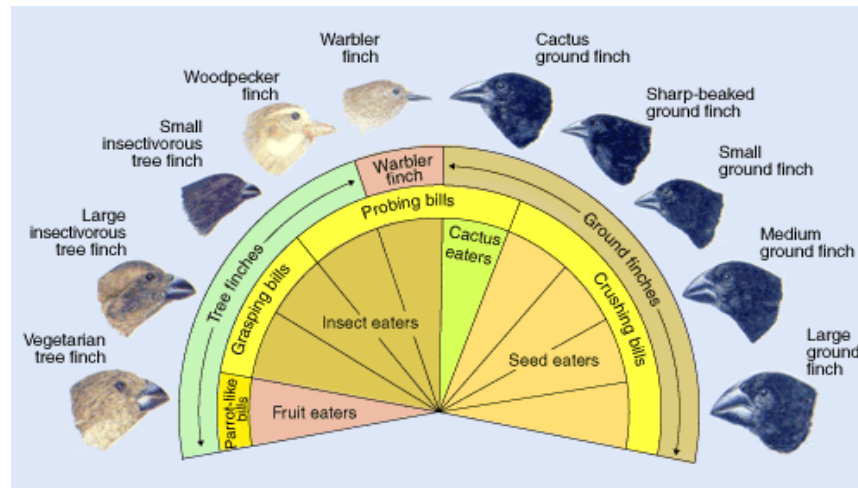
As groups of finches specialized their diet, different beak shapes became more or less prominent. For example, in groups that ate seeds, birds with small, skinny beaks could not break seeds open and did not survive. Birds with thick, strong beaks became prominent in those groups.



From the initial species of finch that arrived on the Galapagos Islands, there are now several different species.

# Evolution

Organisms are constantly adapting to their environment. When organisms change over time in response to their environment, it is called evolution.



Despite the differences in the warbler finch and the large ground finch, they evolved from the same finch that first came over from South America.

# Evolution

Scientists use many different tools to determine the evolutionary relationship between different organisms.

Think about what you have learned in this unit so far. In what ways can scientists study how organisms have changed over time?

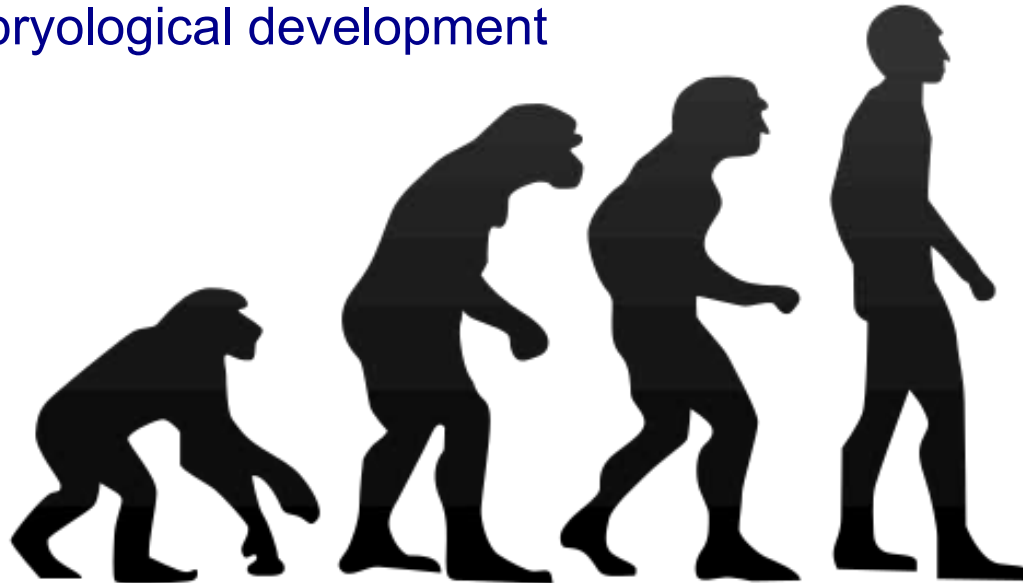




# Evidence of Evolution

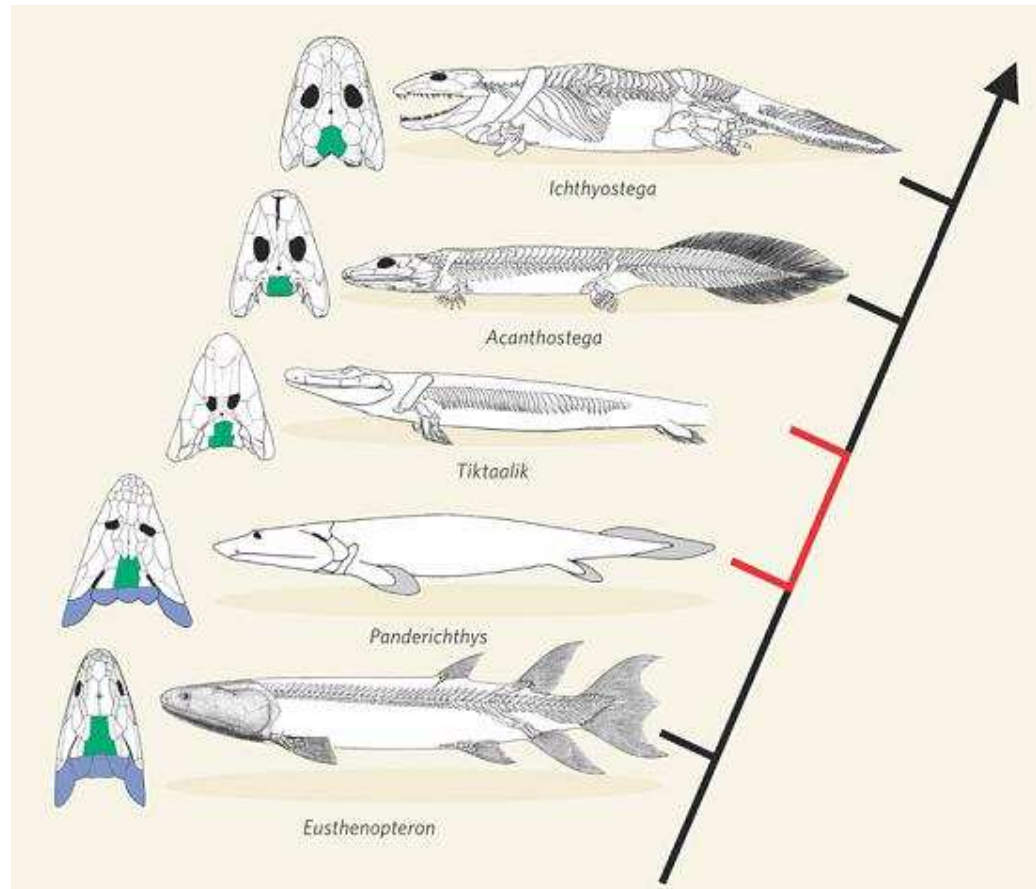
Scientists have gathered different types of information to support the theory of evolution:

- the fossil record
- homology
- embryological development



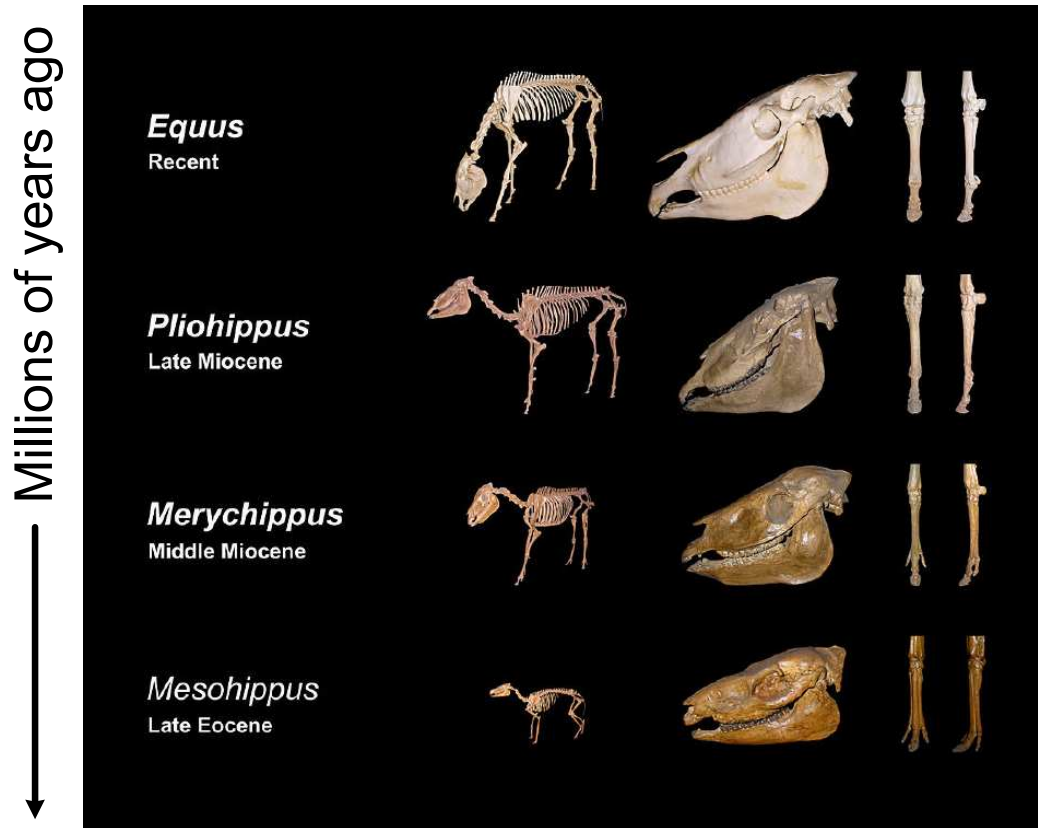
# The Fossil Record

Since fossils show organisms in a sequential order, they provide evidence of the evolutionary changes of specific organisms.



# The Fossil Record

These fossils show how the horse has evolved over several million years.



What changes has the horse undergone over millions of years of evolution?

In small groups, choose one change and determine a plausible explanation for why that change may have occurred.

**24 Evolution occurs as organisms change over time in response to their environments.**

True

False

**24 Evolution occurs as organisms change over time in response to their environments**

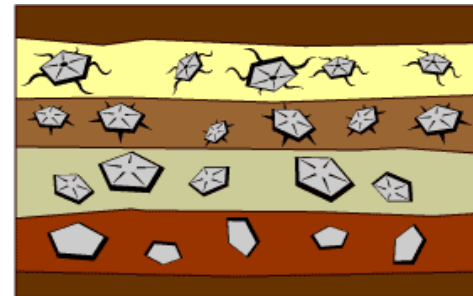
- True
- False

**Answer**

True

**25 The rock strata below documents changes in the organism over time. What can be inferred from this fossil record?**

- A The organism's limbs disappeared over time.
- B The organism lives in the ocean.
- C The organism grew limbs over time.
- D The organism went extinct and was replaced by a new organism.



Rock strata with fossils

Source: [www.evolution.berkeley.edu](http://www.evolution.berkeley.edu)

**25 The rock strata below documents changes in the organism over time. What can be inferred from this fossil record?**

- A The organism's limbs disappeared over time.
- B The organism lived in the ocean.
- C The organism grew larger limbs over time.
- D The organism went extinct and was replaced by a new organism.

Answer

C

## How are these animals similar?

The theory of evolution includes the idea that all organisms on Earth evolved from one common ancestor.

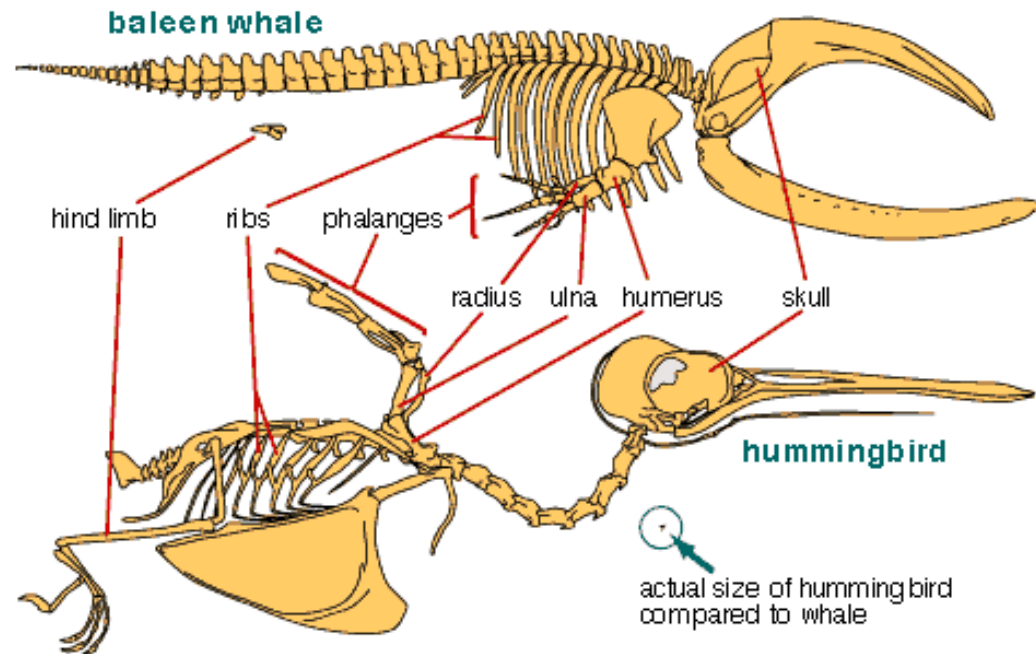
Look at the pictures below. What evidence can you see in all of the animals that would indicate they share a common ancestor?





# Anatomical Similarities

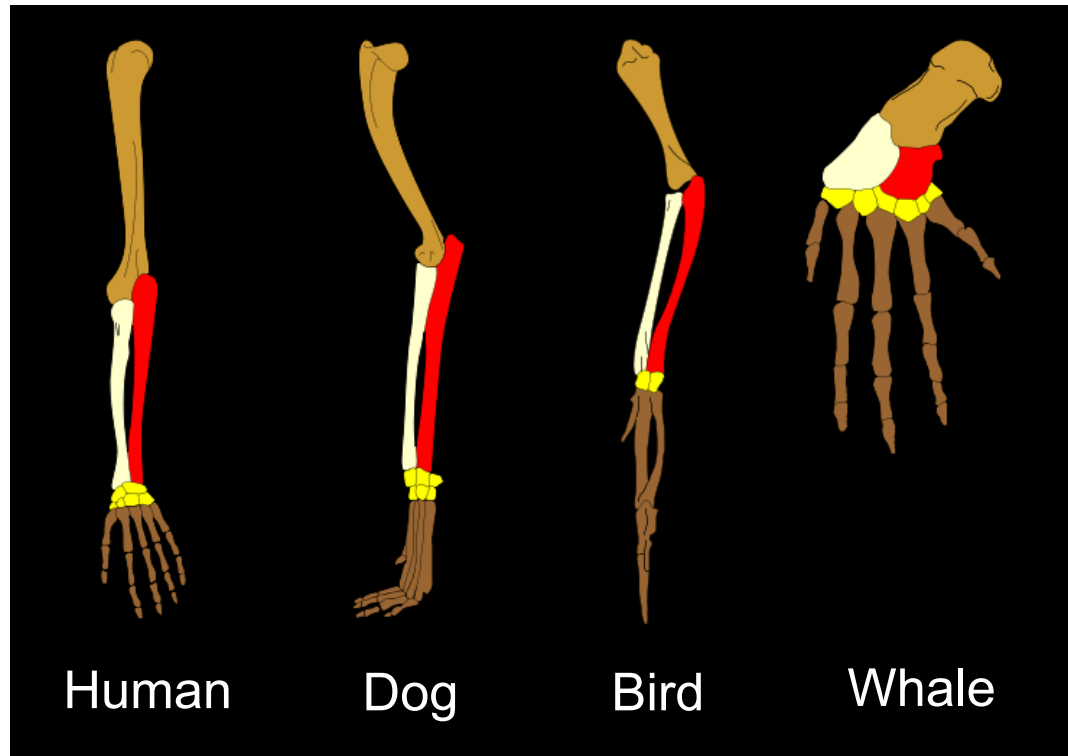
Studying the physiological similarities between different plants and animals reveal how one species' body parts resembles another species' body parts.



Even though they live in vastly different environments, a whale and hummingbird share remarkably similar bone structures. These similarities provide evidence for evolution.

## Anatomical Similarities

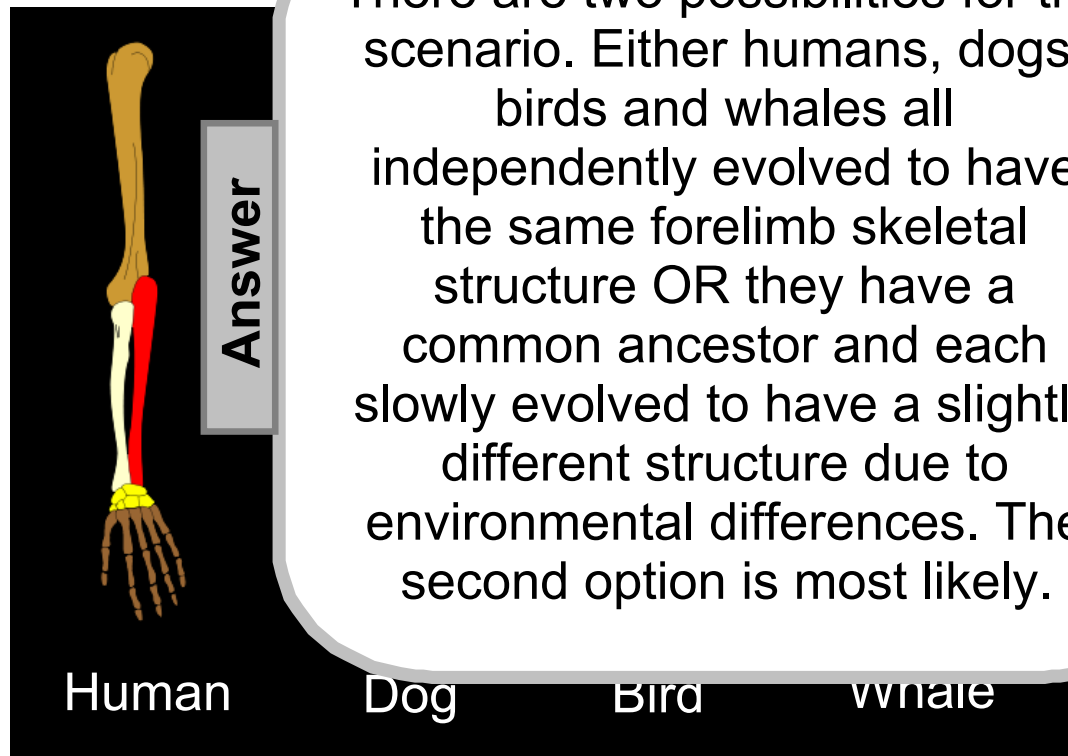
Humans, dogs, birds and whales all have the same skeletal structure in their forearms.



Critical thinking: How do these anatomical similarities provide proof that these animals evolved from a common ancestor?

## Anatomical Similarities

Humans, dogs, birds and whales all have the same skeletal structure in their forearms

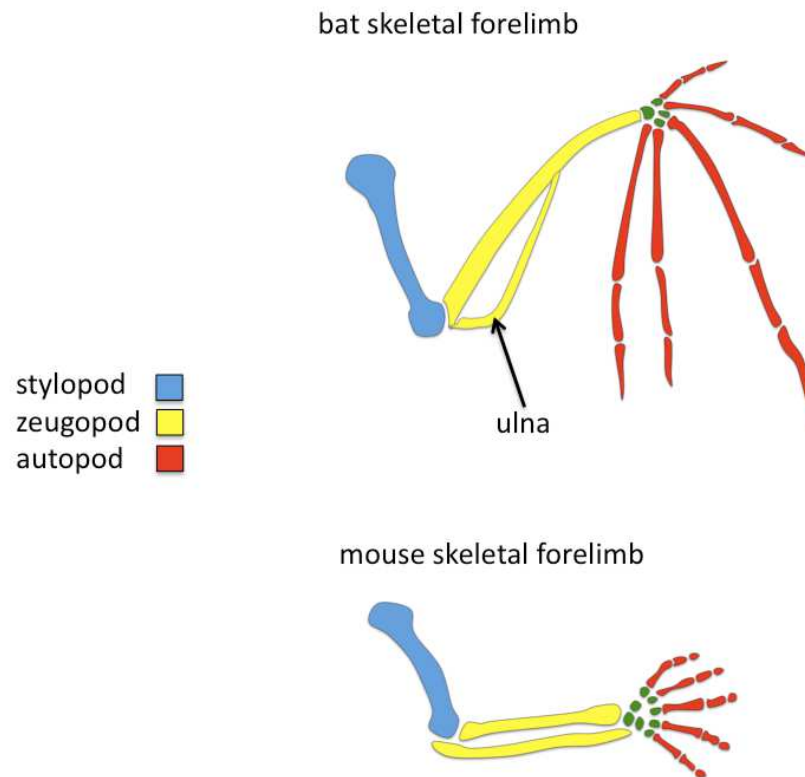


There are two possibilities for this scenario. Either humans, dogs, birds and whales all independently evolved to have the same forelimb skeletal structure OR they have a common ancestor and each slowly evolved to have a slightly different structure due to environmental differences. The second option is most likely.

Critical thinking: How do these anatomical similarities provide proof that these animals evolved from a common ancestor?

# Homologies

Similarities that result from sharing a common ancestor are called homologies.



## Case Study: Blind Cave Fish

The blind cave fish is a freshwater fish that lives in caves in Mexico.

Because the fish lives in complete darkness in caves, it has no need for vision. However, it has remnants of eyes that have been covered up by skin.

Think about what you have learned about homologies. What does the presence of nonfunctional eyes on the blind cave fish tell us about its evolution?



## Case Study: Blind Cave Fish

The blind cave fish is a freshwater fish that lives in caves in Mexico.

Because the fish lives in complete darkness in caves, it has no need for vision. However, it has no eyes. Its eyes are covered up by skin.

Think about what you have learned about the presence of nonfunctional structures in evolution?



**Answer**

The blind cave fish evolved from a fish that used eyes for vision. When the fish moved into caves, they no longer needed to use their vision. Over the years, evolution caused the eyes to become nonfunctional.

es the  
out its

**26 Despite its long neck, a giraffe has the same number of neck vertebrae (neck bones) as a whale and a human. What does this indicate?**

- A Giraffes, whales and humans evolved from a common ancestor.
- B Giraffes evolved separately from whales and humans.
- C The neck vertebrae are vestigial structures.
- D The giraffe is more highly evolved than whales or humans.

**26 Despite its long neck, a giraffe has the same number of neck vertebrae (neck bones) as a whale and a human. What does this indicate?**

- A Giraffes, whales and humans share a common ancestor.
- B Giraffes evolved from humans.
- C The neck vertebrae of giraffes are fused.
- D The giraffe is more highly evolved than whales or humans.

Answer

A



**27 A similarity resulting from common ancestry is called a homology.**

True

False

**27 A similarity resulting from common ancestry is called a homology.**

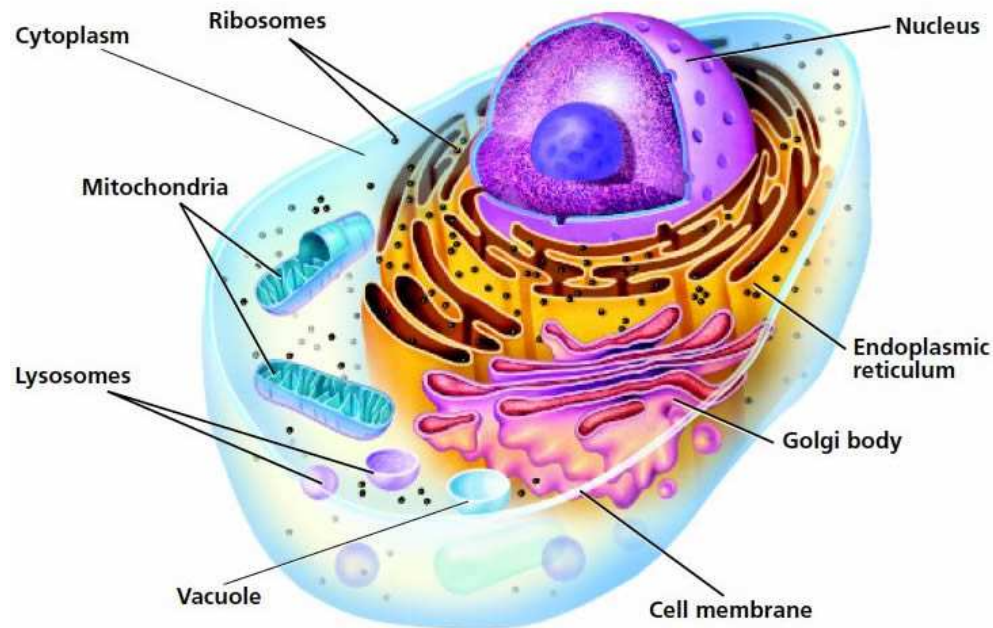
- True
- False

**Answer**

True

# Cellular Homologies

The cellular makeup in all living organisms is incredibly similar.



Which is more likely?

1. Organisms independently evolved the exact same organelles.
2. All organisms evolved from a common ancestor who had these organelles.

# Cellular Homologies

Cytoplasm      Ribosomes      Nucleus

The cellular makeup in all living organisms is incredibly similar.

**Answer**

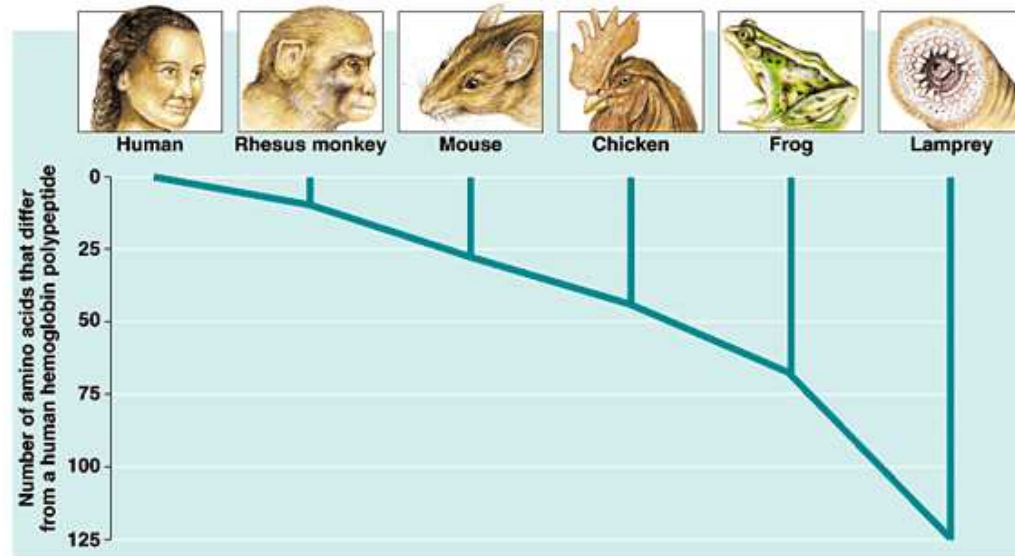
It is much more likely that organisms evolved from a common ancestor.

Which is more likely?

1. Organisms independently evolved these organelles.
2. All organisms evolved from a common ancestor who had these organelles.

# Molecular Homologies

Hemoglobin is a molecule that carries oxygen and carbon dioxide throughout the body. This chart shows how similar the hemoglobin molecule is in different organisms.

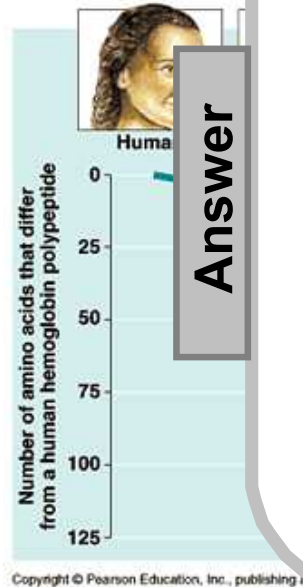


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- Which organism has hemoglobin that is most similar to humans?
- All of these organisms have hemoglobin. What does this indicate?

# Molecular Homologies

Hemoglobin is a molecule that carries oxygen and carbon dioxide throughout the body. This hemoglobin molecule is in different forms in different organisms.

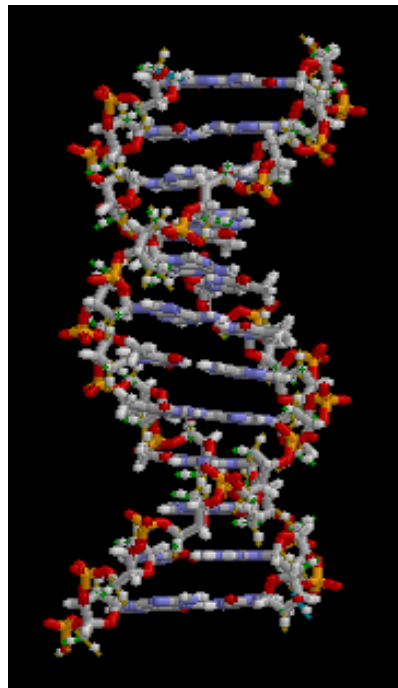


The monkey hemoglobin is most similar to human hemoglobin. Since all of the organisms have hemoglobin, it indicates that we all evolved from a common ancestor.

- Which organism has hemoglobin that is most similar to humans?
- All of these organisms have hemoglobin. What does this indicate?

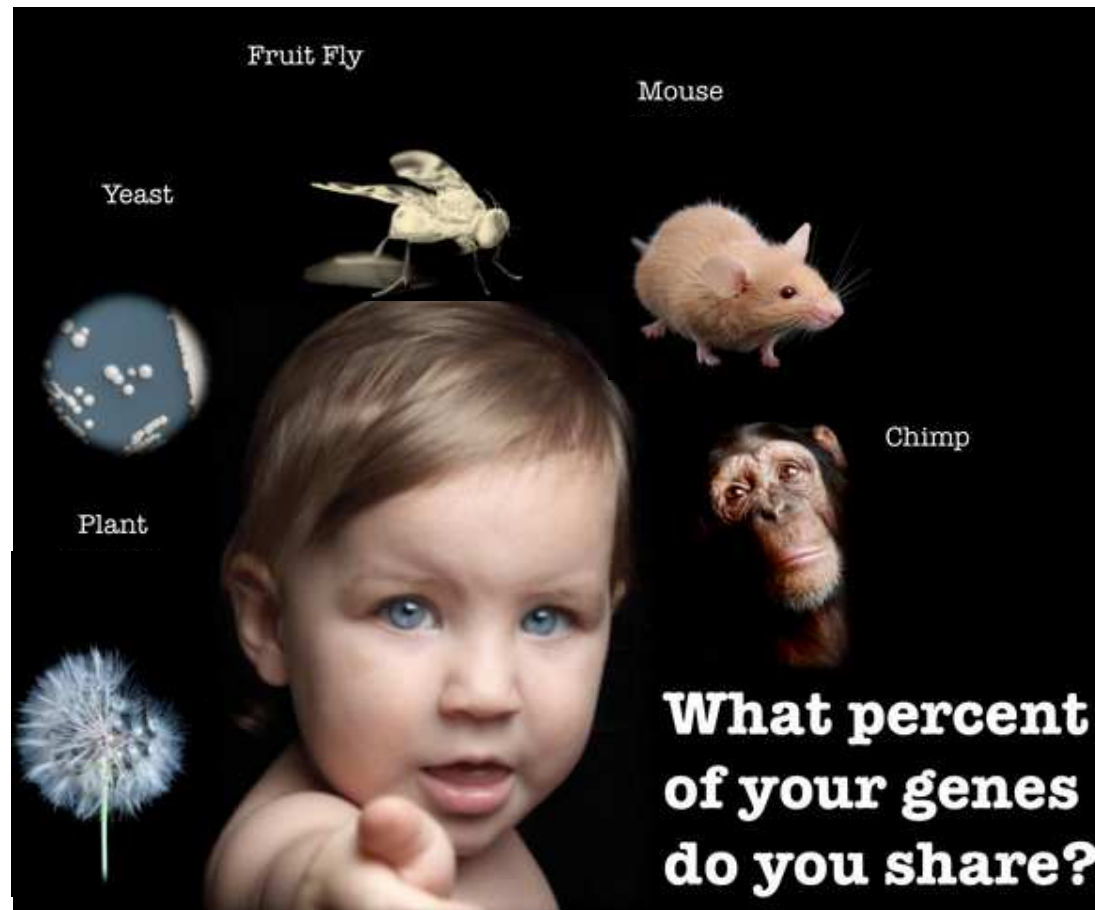
# Molecular Homologies

All living things use the same four bases in their DNA and RNA. This universal code provides evidence of the theory of a common ancestor.



# Similarities of DNA

How similar DNA sequences are between organisms indicates how closely related they are. Click below to see how similar we are to the following organisms.





**28 Homologies can be seen in the following ways.  
(Select all that apply.)**

- anatomical similarities
- genetic code
- anatomical differences
- cellular make-up

**28 Homologies can be seen in the following ways.  
(Select all that apply.)**

- anatomical similarities
- genetic code
- anatomical differences
- cellular make-up

**Answer**

A, B, D

**29 Humans, chimpanzees and plants have genetic codes composed of the same molecules. The genetic code of humans is 98% similar to chimpanzees and 18% similar to plants. What does this information tell us? (Select all that apply.)**

- Humans are more related to chimpanzees than to plants.
- Chimpanzees are more related to plants than to humans.
- Humans and chimpanzees evolved from a common ancestor and plants evolved separately.
- Since all three have genetic codes made from the same materials, they all evolved from a common ancestor.

**29 Humans, chimpanzees and plants have genetic codes composed of the same molecules. The genetic code of humans is 98% similar to chimpanzees and 18% similar to plants. Which of the following is/are true? (Select all that apply)**

- Humans are more closely related to plants.
- Chimpanzees are more closely related to humans.
- Humans and chimpanzees share a common ancestor and plants do not.
- Since all three have genetic codes made from the same materials, they all evolved from a common ancestor.

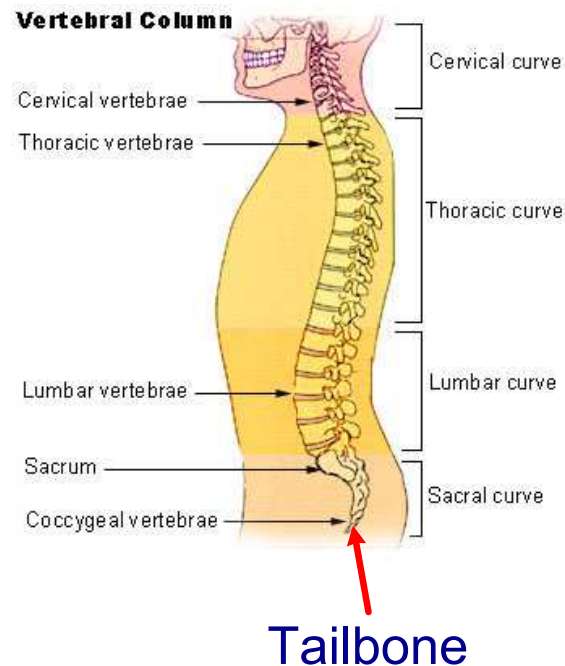
Answer

A, D

# Vestigial Structures

Parts of an organism that have no apparent use are called vestigial structures. They are homologies that provide clues about the evolution of the organism.

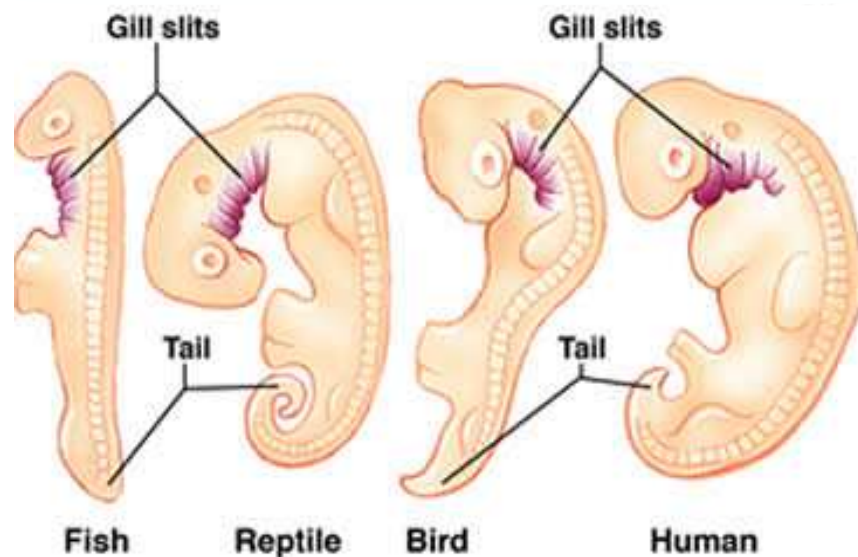
Humans have several vestigial structures.



- We have a tailbone but do not have a tail connected to it.
- We have specific ear muscles that no longer function as a means for survival. (Think about other mammals that are able to move their ears in all directions to hear approaching predators.)

# Embryological Development

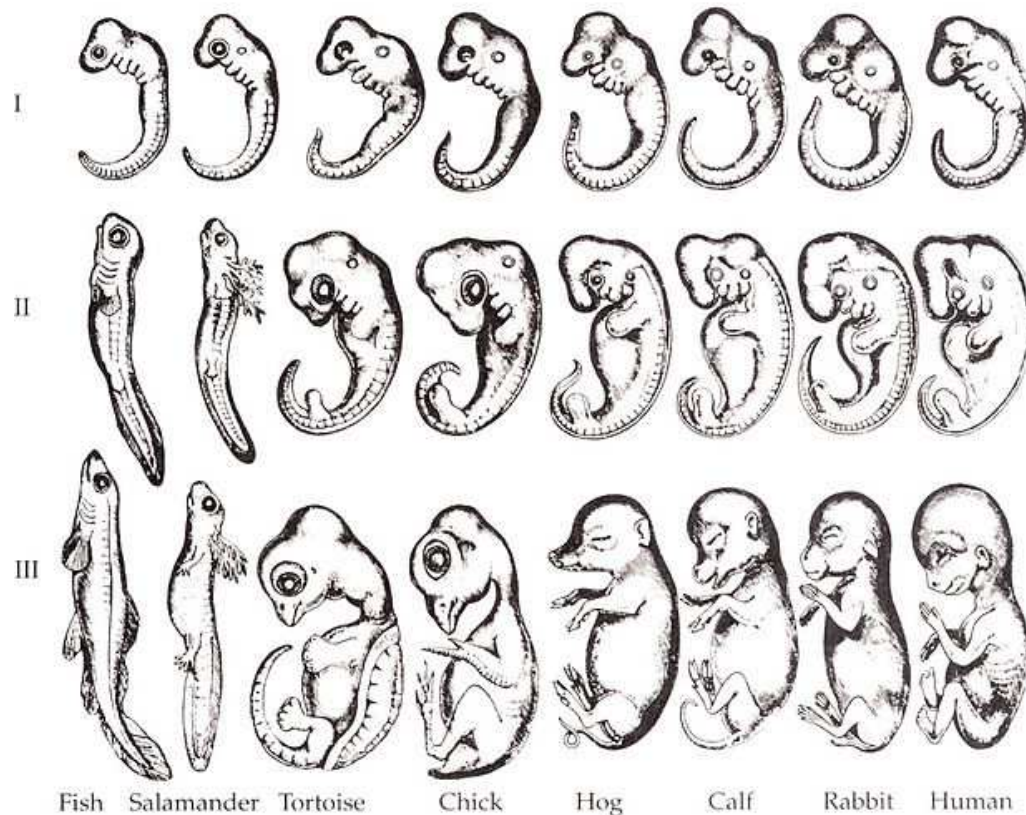
Studying the development of organisms from the time they are fertilized eggs to the time they are born provides evidence for evolution.



Human embryos form gill slits similar to fish although they never fully develop gills. Also, four week old human embryos develop a tail, similar to other mammals! These traits indicate that all of these animals evolved from a common ancestor.

# Comparative Analysis of Vertebrate

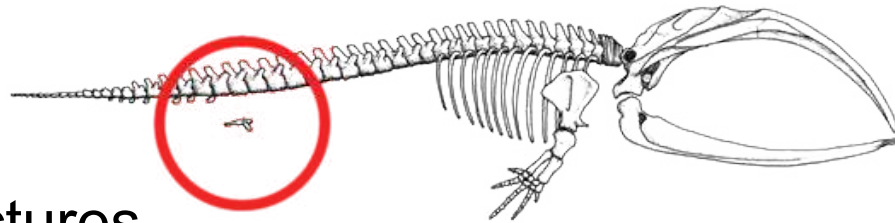
Ernst Haeckle studied the structure and range of variation in structure among vertebrates.



He compared various embryos at different stages to document their similarities.

During the embryological development, species shared similar features despite being vastly different once fully grown!

**30 Whales evolved from an organism that had four limbs and walked on land. Over the years, the front limbs evolved into flippers. The hind limbs serve no purpose and are only present as small outcroppings of the skeleton. What would these small hind limbs be called now?**



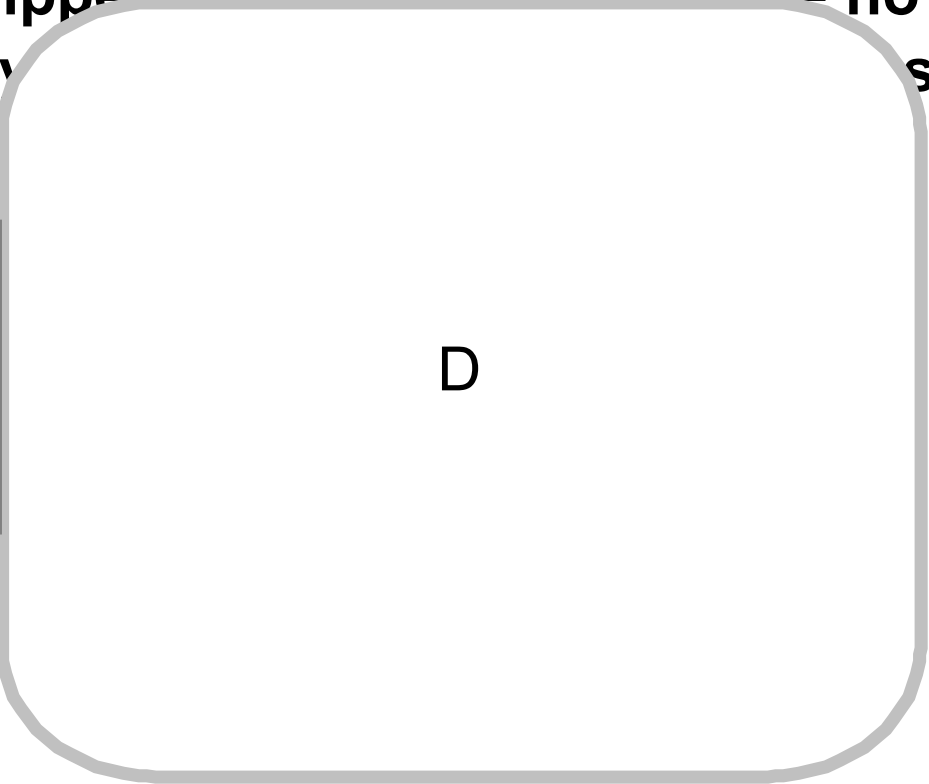
- A analogous structures
- B former structures
- C extinct structures
- D vestigial structures



**30 Whales evolved from an organism that had four limbs and walked on land. Over the years, the front limbs evolved into flippers. The hind limbs serve no purpose and are only bones of the skeleton. What are they now called?**

- A analogous structures
- B former structures
- C extinct structures
- D vestigial structures

Answer



**31 Fish embryos and rabbit embryos both have gills at some point during their embryological development. What does this indicate?**

- A Fish and rabbits are more closely related than humans.
- B Fish and rabbits evolved from a common ancestor.
- C Fish and rabbits both evolved gills separately from each other.
- D Fish and rabbits are both able to breathe underwater.

**31 Fish embryos and rabbit embryos both have gills at some point during their embryological development. What does this indicate?**

- A Fish and rabbits share a common ancestor with humans.
- B Fish and rabbits share a common ancestor with humans.
- C Fish and rabbits both have gills at some point during their embryological development.
- D Fish and rabbits are both able to breathe underwater.

Answer

B