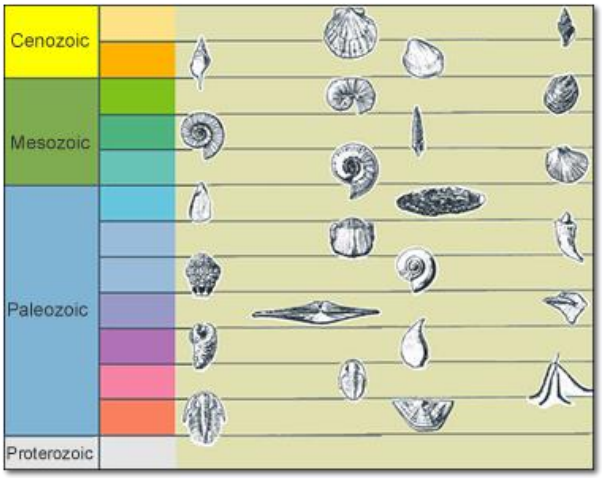
WEEK 4 Please read the following introduction to evolution before completing any assignments.

THE EVOLUTION OF LIFE ON EARTH

Paleontologists, or scientists who study fossils, use fossils to reconstruct and hypothesize about the history of life on Earth. They use fossils in the fossil record to help them determine when different groups of organisms lived and died. Paleontologists can estimate the age of fossils. Fossils closer to the Earth's crust are more recent, and fossils further down in the layers are older. The fossil record also shows the gradual order in which organisms changed, such as showing how limb structures in organisms have changed over time.

The horseshoe crab has changed very little and has been in existence for over 350 million years.

Scientists can also study fossil records to determine which groups of organisms have died out and no longer exist. Extinction occurs when every member of a specific species dies. Sometimes every member of a species dies in a relatively short amount of time, and this is referred to as a mass extinction. Gradual environmental changes and catastrophic events, such as an asteroid impact, can cause mass extinctions. The fossil record documents extinctions and mass extinctions in the way that fossils are present or disappear. For example, certain fossils may be present in the beginning of the fossil record but then decrease and disappear completely. This shows that the organisms from those fossils all died out. Scientists use this to hypothesize when and how different organisms may have gone extinct.



The fossils at the bottom represent fossils that are present in the beginning of the fossil record.

EVIDENCE OF EVOLUTION

There are four main areas of evidence that support Darwin's theory of evolution: the fossil record, structural similarities, developmental similarities, and DNA similarities. **Fossils** are the remains of traces of an organism found in earth or rock. Most fossils form when a dead organism is covered in a layer of sediment or mud, and more sediment eventually settles on top and hardens.

This fossil contains the remains of a prehistoric fish.

Many of the types of organisms found in fossils are not alive today, a clue that life changes over time. Fossils that are found in newer layers are usually more closely related to modern-day organisms than the fossils found in older layers, which are more likely related to organisms that no longer exist.

Fossils sometimes show the sequences of changes that have led to today's life forms. This can be seen in the fossil record. The **fossil record** is the total number of fossils that have been discovered and the information gathered from them. There are many organisms that lived in the past that are not alive today. Therefore the fossil record shows change over time.

There is also other evidence to support evolution and the idea that modern and ancient groups of similar organisms share an ancestor. In addition to fossils, scientists also study structural data, DNA, and developmental patterns as evidence to support the theory of evolution. By studying this evidence, scientists have found that sometimes populations become new groups of similar organisms.

This Congo Eel may show how snakes looked long ago if they had legs.

One source of evidence to support the theory of evolution is structural data of organisms. Structural traits are the physical features of an organism, such as legs on a frog. Scientists have observed that more closely related organisms share more similar structural traits and physical features. For example, a four-legged lizard, like an iguana, has a closer common ancestor to a dog than an organism without any limbs, like an eel. This suggests that animals with limbs developed from animals without limbs.

Sometimes scientists find organisms that appear to have similar structural traits, but the structures are not used for the same functions. For example, the arm of a human being and the front leg of a cat have a similar structure even though they do not look alike. The bone structures are similar, though these bones perform different functions in a human and a cat. However, these similarities suggest that humans and cats had a common ancestor hundreds of millions of years ago, during which many changes occurred in the common ancestor.

Scientists can also study organisms' DNA to determine their closest common ancestors. DNA contains stored genetic information and molecules that scientists can compare among different organisms. Two groups of organisms that have a greater number of DNA similarities are more likely to have recently shared a common ancestor, which means they are more closely related.

Notice some of the similarities between the structures of the front limb of a cat and the human arm. A cat's forelimbs support its body weight whereas a human's are used to interact with its surroundings more generally.

These questions are NOT required, however, they will help you check your own understanding.

1. What is a fossil?
    a. The remains or traces of an organism found in clouds
    b. The remains or traces of an organism found in trees
    c. The remains or traces of an organism found in earth or rock
    d. The remains or traces of an organism found in the Sun
2. The fossil record is _____.
    a. The total number of fossils that are used to create new fossils
    b. The total number of fossils that are missing and have yet to be found on Earth
    c. The total number of fossils that have been misplaced by paleontologists
    d. The total number of fossils that have been discovered and the information gathered from them.
3. Which of these is a reason a species may become extinct?
    a. Lack of food and water
    b. Asteroid impact
    c. Disease
    d. Environmental destruction
    e. All of the above

4. Look at the fossil below. What type of environment might this organism have lived in? Why do you say that?

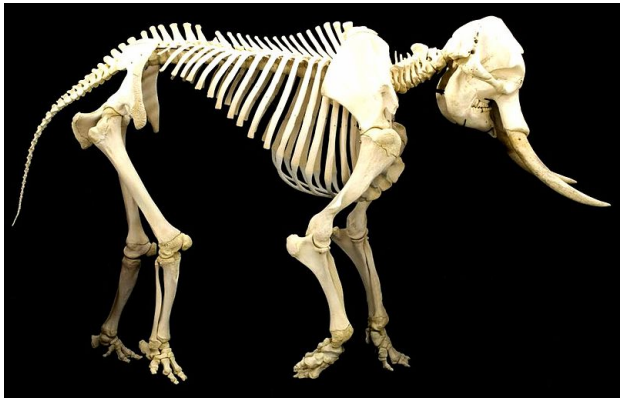
_____
_____
_____

5.

Choose the skeleton of the organism that has a more recent common ancestor to modern-day elephants.

6. Erica is examining a series of related fossils. She notices the limb structure gets longer over time. Based on these fossils, what might Erica conclude about how a species changed?
    a. It no longer needed limbs, so the limbs started to grow longer.
    b. It may have begun walking on land and needed longer limbs
    c. Erica cannot conclude anything from these fossils.

OPTION 1



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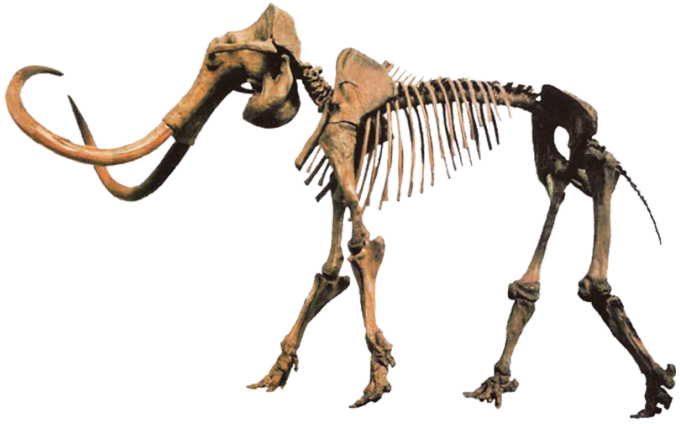

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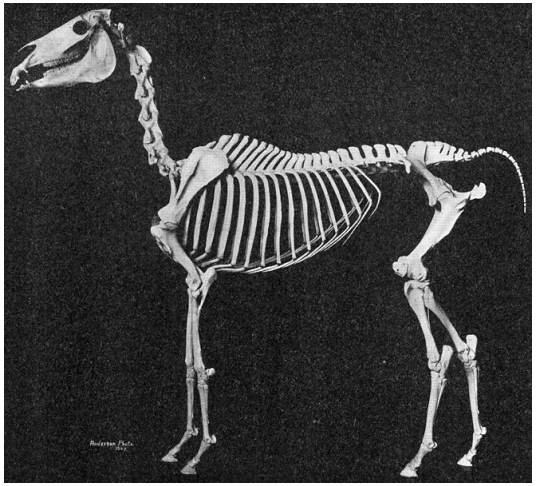

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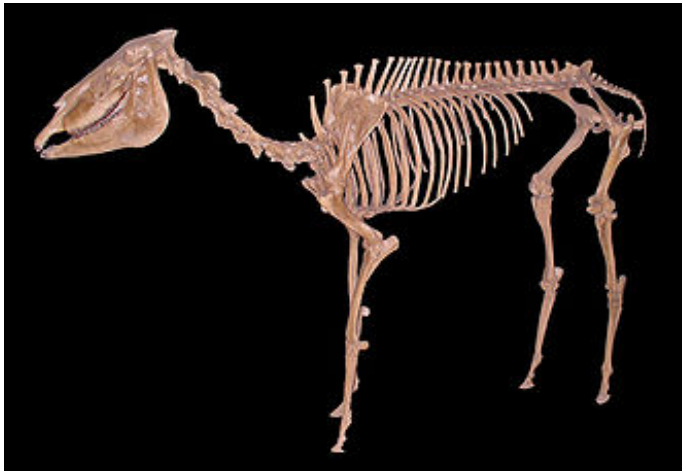

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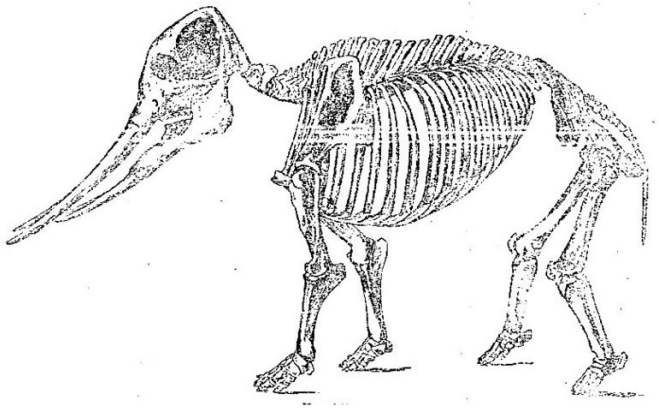

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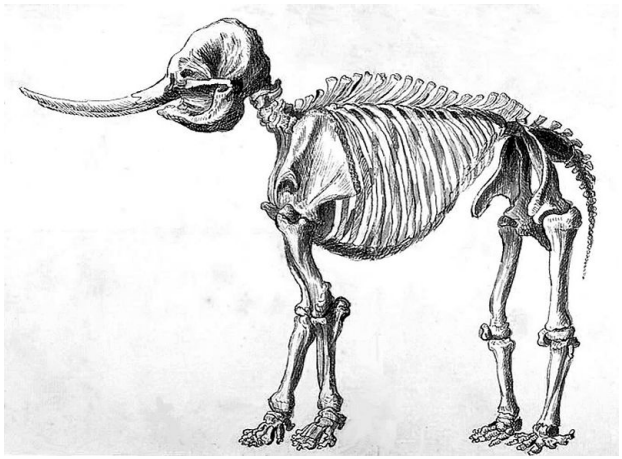

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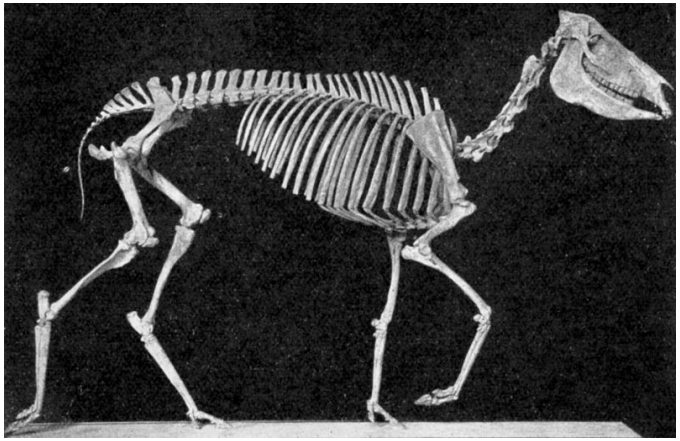

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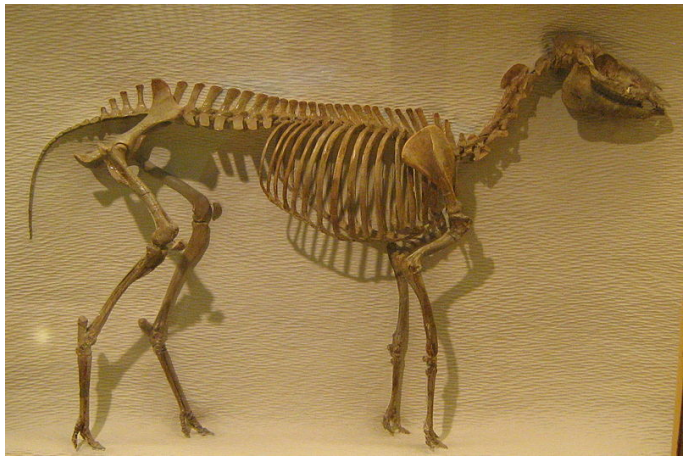

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K

Fossil Sort Questions:

1. Complete the **Fossil Card Sort** activity.
2. Organize the images into the two different animals they are
3. Answer the following questions:
    a. Choose one of your animals. Then sequence the cards for the animal chronologically based on time period they would have been alive (oldest to youngest). List the letters of the cards in the order you chose. Example: A, B, C, D, E
    b. How has you animal changed or evolved over time?
    c. What specific characteristic has changed the most?
    d. How do you imagine this adaptation has helped your animal survive?
    e. Then do a-d again for your second animal.

OPTION 3

NAME: _____ PERIOD: _____

WEIRD UTENSILS

Directions: Animals have very specific mouths to eat specific types of foods. Hummingbirds have long beaks to reach into flowers while some finches have really hard beaks to break into shells. What would happen if that was different?

Your goal is to eat four different foods with a utensil you normally wouldn't. Fill out data table with the different types of food, what you'd normally eat them with and what you tried eating them with. Then answer the questions

FOOD	NORMAL UTENSIL	NEW UTENSIL	WHAT HAPPENED?

Was there a food you COULD NOT eat with a new utensil?

_____

_____

Was there a food that was EASIER to eat with a new utensil?

_____

_____

How does this relate to animals and adaptations?

_____

_____

_____

OPTION 4

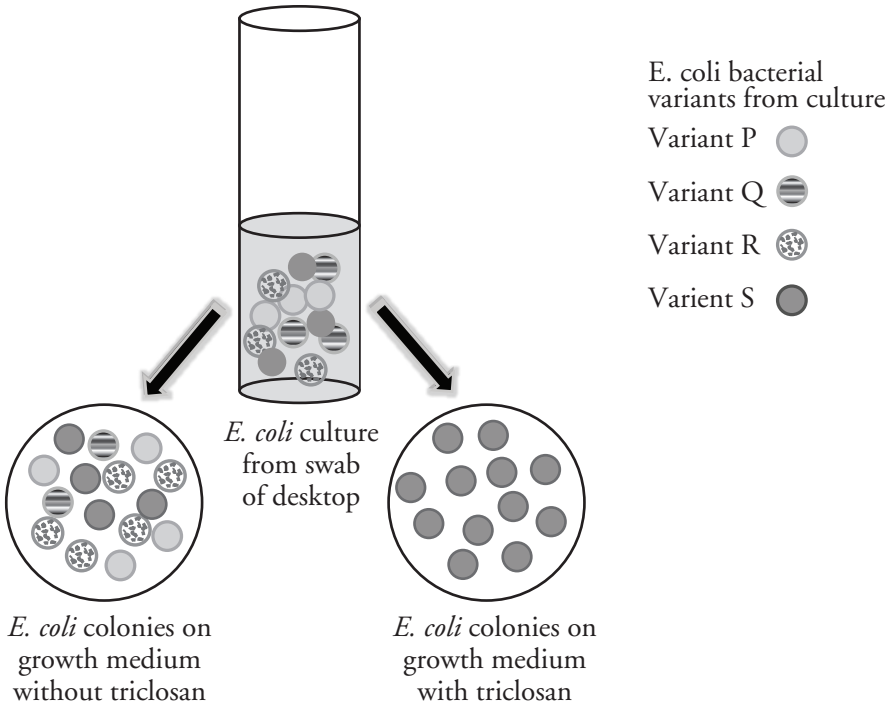
Evolution and Selection

What mechanisms lead to changes in the diversity of species on Earth?

Why?

People make choices by selecting options they like best. The natural world also "selects" (although not as a conscious decision) when environmental conditions allow organisms with a particular genetic trait to live healthier lives than other organisms. In this activity, we will explore how selection affects populations over time.

Model 1 – Desktop Swab Results



1. What is the source of the bacteria in the culture tube in Model 1?

2. How many genetic variants of *E.coli* were present in the culture from the initial swab?

3. What variants of *E.coli* are found on the dish grown without triclosan?

4. Refer to the dish in Model 1 with the medium that included triclosan.
   a. What variants of *E.coli* are found on the dish grown with triclosan?

   b. What likely happened to the other variants of *E.coli* on the dish with the medium containing triclosan?

5. Based on its effect on *E.coli,* why is triclosan used as a cleaning agent?

6. Suppose the desktop swabbed earlier was cleaned with a solution containing triclosan. Would living *E.coli* remain? Support your answer.

7. Suppose the desktop was swabbed again after cleaning it with triclosan over a 9-month school year. When the sample was cultured only variant S was seen.

   a. What characteristic does the variant S bacteria have that allows it to remain on the desktop even after several months of treatment with triclosan?

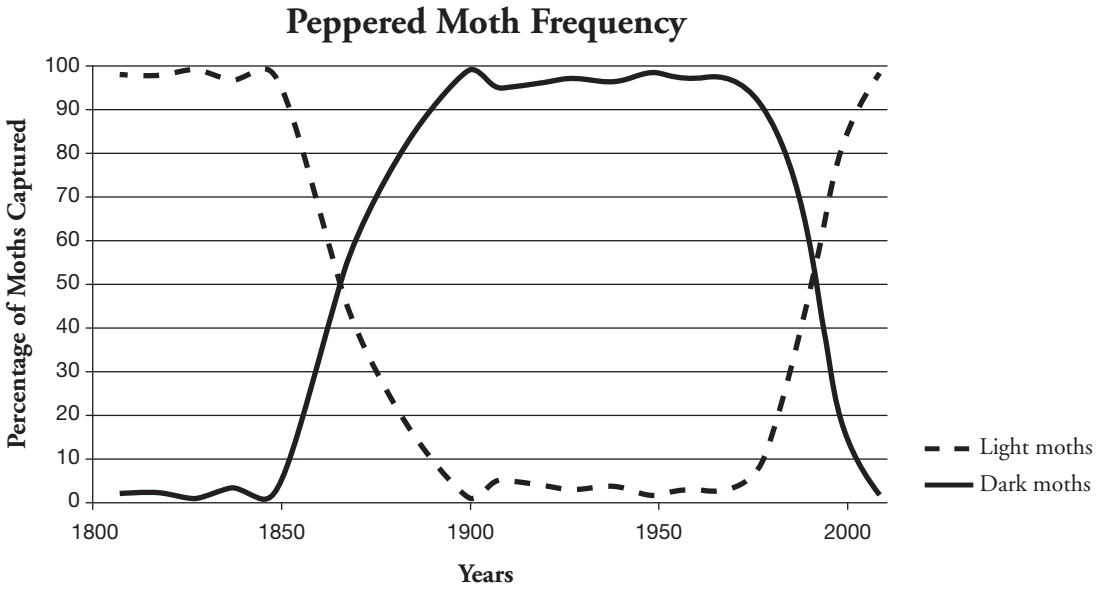
   b. Is it likely that the bacteria in the new swab were on the desk 9-months ago, or are they offspring of the original bacteria?

   c. Propose an explanation for the presence of only variant S on the desktop after so much time.

Read This!

Populations of most living organisms exhibit genetic diversity among individuals. Certain traits in a population give some organisms a greater chance of survival than individuals that lack these traits. Because these traits tend to increase the chance of survival, these individuals may produce more offspring that will also have the trait that favors survival. Over time, the number of individuals within the population possessing the favorable trait increases while the number of offspring with the favorable trait decreases.

Model 2 – Color Variations in Moths in Great Britain



8. Refer to the graph of Peppered Moth Frequency in Model 2.

   a. Which moth color was more prevalent before 1850?

   b. Which color was more prevalent between 1900 and 1950?

9. Describe the change in the percentage of light-colored moths and dark-colored moths between 1850 and 1900.

10. Describe the change in the percentage of light-colored moths and dark-colored moths between 1950 and 2000.

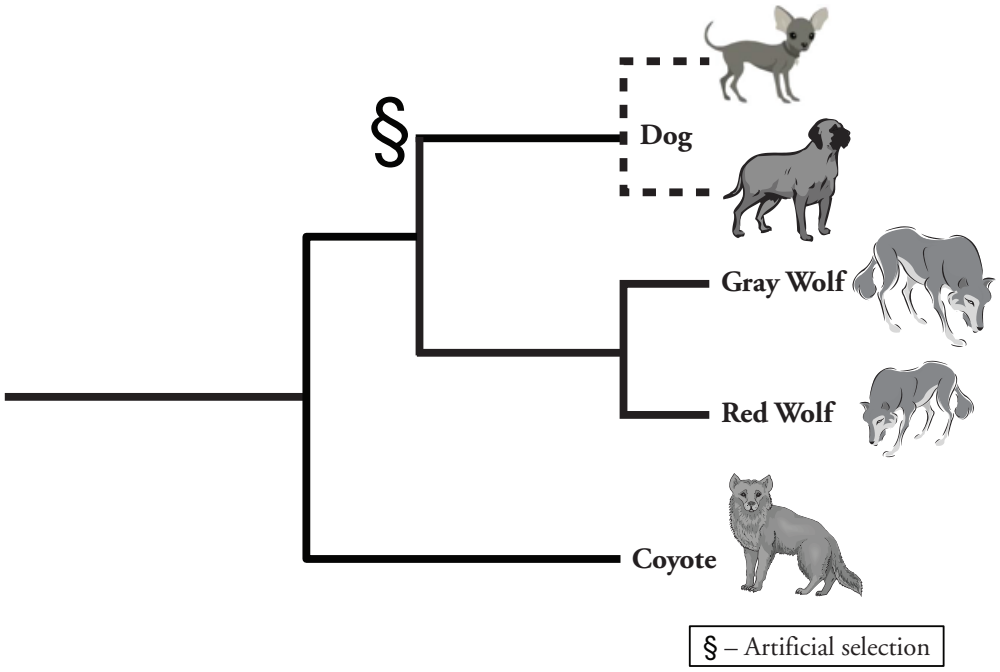
11. During the Industrial Revolution through the mid-20th century, factories and power plants, which burned coal, produced large quantities of soot and smog. Near industrialized areas, black powder covered surfaces, including the moth habitat.

    a. Which color moth would have a better chance of surviving predation (better camoflage to hide from predators) on this dark surface?

    b. How does this help explain the change in the colors of the moth population shown in Model 2?

12. Clean Air Acts were passed by governments of industrialized nations beginning in the mid-1950s. Use this information to explain why the color of the moth population shifted again.

Model 3 – Natural vs. Artificial Selection



13. Model 3 traces the lineage of what organisms?

14. How does Model 3 indicate that all three types of organisms came from a common ancestor?

15. According to Model 3, wolves (gray and red) are more closely related to what other group—dogs or coyotes? Explain your answer.

16. Think about the characteristics of the organisms above.
    a. What are some differences that you note between wolves and dogs?

    b. What similarities can you identify?

17. Modern domesticated dogs arose from wolves through selective breeding by humans.

    a. What traits might humans have selected in the common ancestor of dogs and wolves that would account for the differences between dogs and wolves?

    b. According to Model 3, what is the name of this type of selection?

Read This!

The events that lead to changes in groups of organisms are called **selection** by evolutionary biologists. Charles Darwin (1809–1882) is the person credited with carefully outlining how various changes in populations of organisms might occur through time. He called this process **natural selection**. Humans participate in selection through selective breeding of plants and animals. This is referred to as **artificial selection**.

18. Is the selection that led to the development of wolves and coyotes an example of natural selection or artificial selection? Explain your choice.

19. Refer to Model 1. Is the selection leading to changes in the *E. coli* variants natural or artificial selection? Explain your choice.

20. Two differences between red and gray wolves is their color and size. What environmental conditions might have resulted in selection for red wolves and gray wolves?

21. Refer to Model 2. Is the selection of moths that blend in to their environment an example of natural or artificial selection? Explain your choice.

Extension Questions

22. For the past 10 to 25 years, farmers have planted crop seeds that have been genetically modified to withstand treatment with a common weed killer called Roundup®. This allows the farmers to spray their fields to get rid of weeds without harming their crops. Recently, more and more farmers have discovered that their fields have Roundup-resistant pigweed growing along with their crop. Use what you've learned in this activity to explain how this came about.

23. Many popular products from hand soap to clothing advertise that they have antibacterial qualities. Most microbiologists recommend against their routine use in our daily lives. How can you explain this using your knowledge from this activity?

OPTION 5

Darwin fascinated by finding fossils in his early career

By The Guardian, adapted by Newsela staff on 05.30.18
Word Count **655**
Level **850L**

A visitor to the traveling Darwin exhibit passes a display of animal skeletons at the American Museum of Natural History in New York City. Photo by: Mary Altaffer/ AP Photo

On September 23, 1832, a young naturalist named Charles Darwin found an enormous skull in Argentina. The skull was so old that it had petrified and become a fossil. It was embedded in the rock of a cliff.

It took Darwin three hours to chip the skull out of the cliff face. Then, it took hours more to lug it back to his ship, the Beagle.

Darwin was only 24 at the time. He was wild with excitement about the chase for fossils. In a letter to a friend, he wrote: "I have just got scent of some fossil bones of a Mammoth. What they may be I do not know, but if gold or galloping will get them, they shall be mine."

Journal Records Of Fossil Finds

Darwin's treasures were brought on board after every shore trip. Then, they were sent back to England whenever he came upon a ship making the return journey. Darwin's finds were all

carefully recorded in his journals. They were labeled according to a four-color system.

Darwin later went on to develop the groundbreaking theory of evolution. The theory explains how living things develop and change over millions of years. It made Darwin one of the most famous scientists who ever lived.

Today, many of the fossils Darwin collected are stored at the Natural History Museum in London. They are still of great interest to scientists all over the world. Unfortunately, many are almost too delicate to handle. They crumble or break apart very easily.

Perfect Digital Copies

The bones may soon be much easier to study, however. In April, the Natural History Museum launched a bold new project. It is making perfect digital copies of the fossils. These copies are 3-D and can be studied online by anyone. The copies are so precise that they will be very useful to scientists.

The first digital copy to go online is the skull of a Toxodon platensis. Darwin found the original propped up against a fence in a Uruguayan farmer's yard. Children had been throwing stones at it and had knocked out its teeth. Darwin bought the skull for a small sum of money. Its curved teeth made Darwin and fellow scientists wonder if it was a gigantic rat. They later realized it was in fact a distant relative of the rhinoceros.

The fossils Darwin sent back to England quickly made him famous. One set contained a missing section of a skeleton that had already been sent back by another collector. That earlier set of bones was the body of the creature whose skull Darwin had chipped out of the cliff face.

Huge Sloth Fossil Found In South America

The bones Darwin and the other collector found were the remains of a Megatherium, a ground-dwelling relative of modern sloths. Today's sloths are the size of a small dog. Megatherium was as big as a car. It was the largest and heaviest land animal ever to live in South America.

Back at the Natural History Museum, Pip Brewer and Adrian Lister have been doing their own hunting for bones. As part of the museum's digitization project, they have been trying to locate several of the fossils Darwin collected.

The two men are very excited, because they have just tracked down a missing chunk of one of Darwin's fossils. The piece disappeared more than 100 years ago.

The missing piece was a slice of the skull that Darwin chipped out of the Argentinian cliff in 1832. It turned up in his own home, Down House, which is now a museum.

"They told us they had a bit of tooth in the stores but they had no idea what it was," Lister said. "When we got there, they had had it laid out on a table and we recognized it as the missing piece of Megatherium in seconds."

The discovery of the missing piece was "such a thrill," Brewer said.

Quiz

1 Which detail from the article MOST CLEARLY shows that Darwin was willing to work hard to collect fossils?

(A) On September 23, 1832, a young naturalist named Charles Darwin found an enormous skull in Argentina.

(B) It took Darwin three hours to chip the skull out of the cliff face. Then, it took hours more to lug it back to his ship, the Beagle.

(C) Darwin's finds were all carefully recorded in his journals. They were labeled according to a four-color system.

(D) One set contained a missing section of a skeleton that had already been sent back by another collector.

2 Read the following paragraph from the section "Perfect Digital Copies."

The first digital copy to go online is the skull of a Toxodon platensis. Darwin found the original propped up against a fence in a Uruguayan farmer's yard. Children had been throwing stones at it and had knocked out its teeth. Darwin bought the skull for a small sum of money. Its curved teeth made Darwin and fellow scientists wonder if it was a gigantic rat. They later realized it was in fact a distant relative of the rhinoceros.

Which detail from the paragraph BEST supports the conclusion that it can be hard to tell what animal a fossil came from?

(A) The first digital copy to go online is the skull of a Toxodon platensis.

(B) Darwin found the original propped up against a fence in a Uruguayan farmer's yard.

(C) Children had been throwing stones at it and had knocked out its teeth. Darwin bought the skull for a small sum of money.

(D) Its curved teeth made Darwin and fellow scientists wonder if it was a gigantic rat. They later realized it was in fact a distant relative of the rhinoceros.

3 What effect did Darwin's theory of evolution have?

(A) It made him one of the most famous scientists in the world.

(B) It made him realize that there were more fossils to search for.

(C) It made him decide to make digital copies of every fossil he found.

(D) It made him open the Natural History Museum to share his discoveries.

4 Why did Brewer and Lister feel thrilled after finding the Megatherium tooth?

(A) because Darwin had never been able to find it

(B) because it had been missing for 100 years

(C) because it was lost during the digitization project

(D) because Megatherium was a large animal

Short Answer:

1. What was Megatherium?

_____

_____

_____

2. What was the most interesting part of this article?

_____

_____

_____