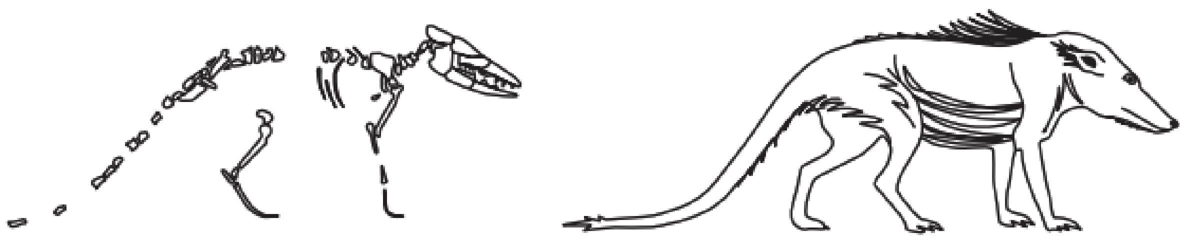
Student Worksheet

This task is about the fossil record.

Task

In the 1980s, a fossil was discovered in a mountainous, semi-arid region of Pakistan. Scientists determined it was a terrestrial, wolf-like animal that lived along the margins of a large shallow ocean where it ate fish and small animals. The extinct animal's fossils and images are shown in Picture 1.

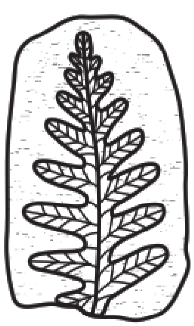
Picture 1. Extinct Fossil and Image



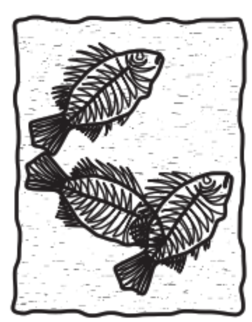
By studying fossils, scientists can piece together what happened in Earth's past and the evolutionary history between organisms living today!

Prompt 1

Fossils can be used to reconstruct the environment in the location at the time an organism was living.



Fossil A



Fossil B

Part A.

Describe the type of ecosystem in which each fossil, **Fossil A** and **Fossil B**, was formed. Explain your answer for each fossil.

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Part B.

Geologists use geologic columns to describe and explain the rock strata and fossils found in a given location. For example, a dotted pattern may represent sandstone, and a block pattern may represent limestone. That way, geologists know what types of rocks are in the sequence at that location. Then they can compare the rocks of the same relative age across various locations to develop a composited column.

Figure 1. Geologic Columns from Three Locations

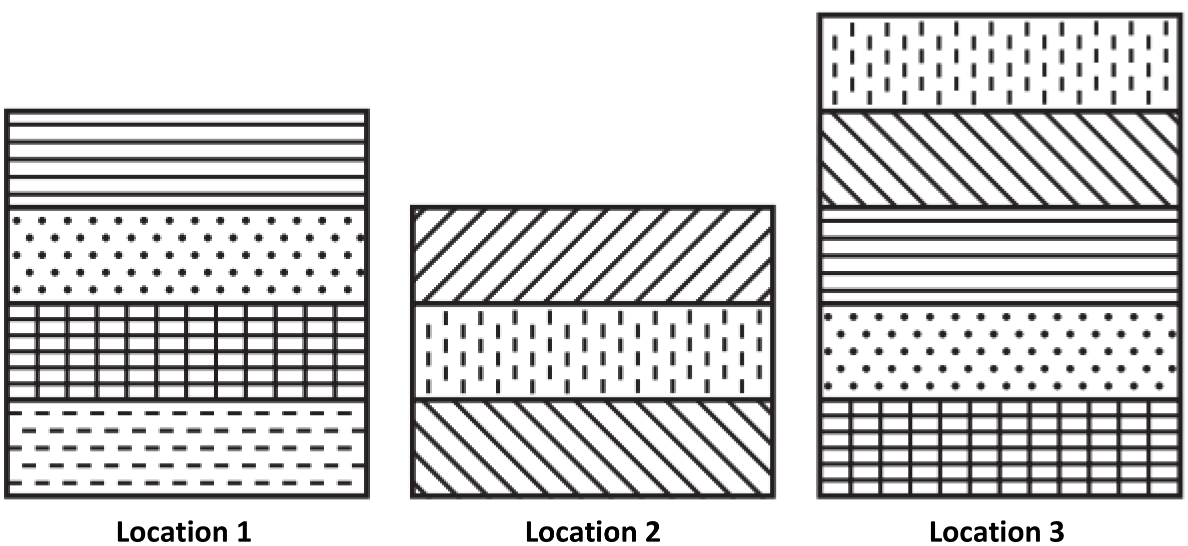
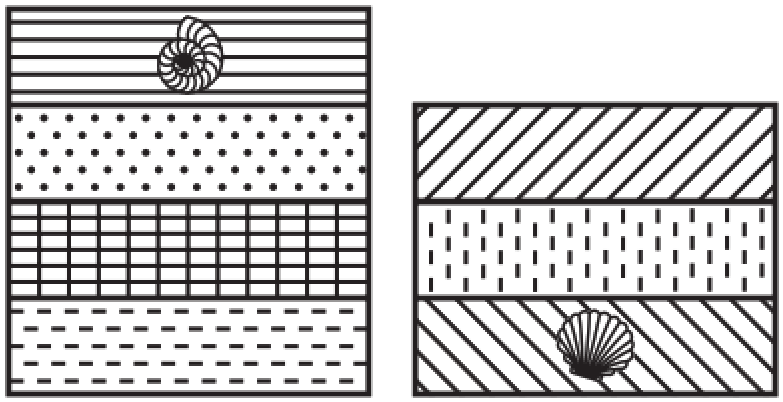


Figure 2 shows two different fossils found in rock strata in Location 1 and Location 2 from Figure 1.

Figure 2. Geologic Columns Containing Found Fossils



Location 1 **Location 2**

Identify the location in which the oldest fossil was found. Explain how you used the geologic columns in **Figure 1** and **Figure 2** to identify the relative ages of the two fossils.

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Prompt 2

Part A.

To learn about Earth's history, scientists also look at the shape of the fossils they find and compare them to the bones of living creatures today.

The images in Table 1 are fossils of organisms that lived long ago. Each fossil is an ancestor of modern dolphins and whales.

Table 1. Fossils of Extinct Organisms

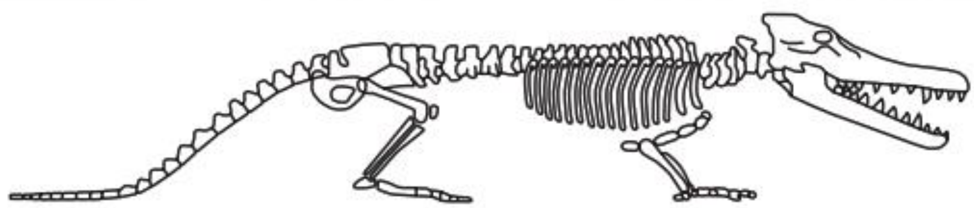
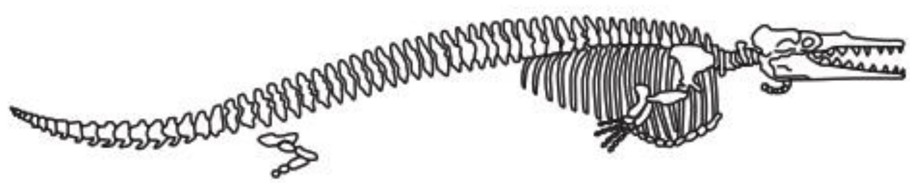
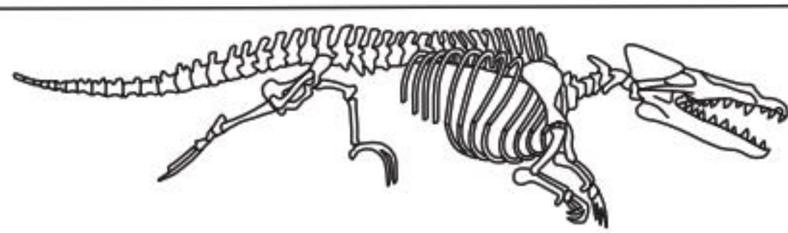
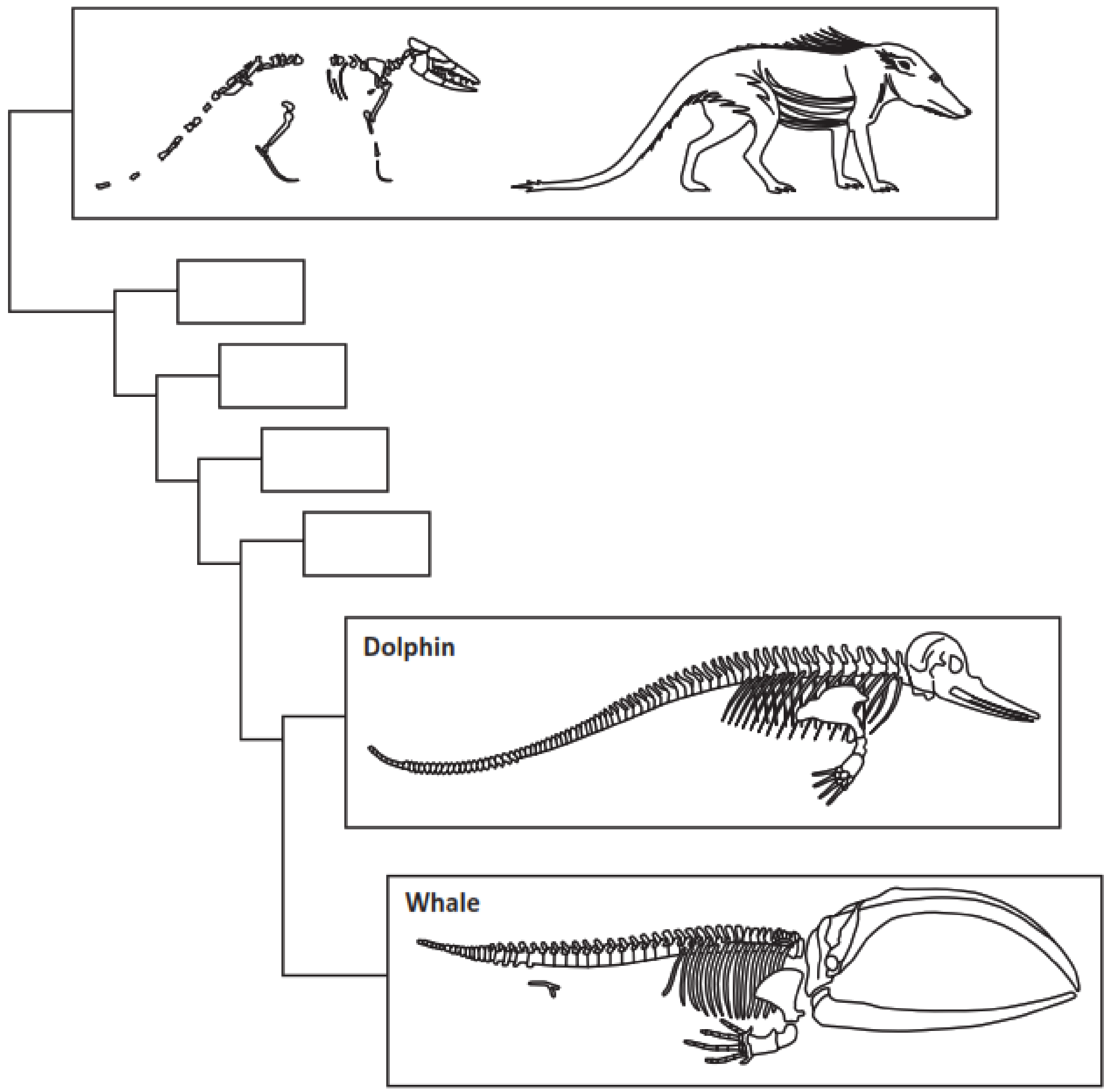
A	
B	
C	
D	

Figure 3 shows the relationship of extinct organisms from a wolf-like terrestrial mammal shown at the top of the figure that led to today's dolphins and whales at the bottom of the figure.

Use the letters in **Table 1** (**A, B, C, D**) to sequence the organisms and their changes over time in the boxes in **Figure 3**. Use one letter in each box.

Figure 3. Changes in Organisms Over Time



Part B.

Identify **at least two patterns** in the fossil record shown in your completed **Figure 3** and the fossils shown in **Table 1** that can be used to determine the sequence of changes over time that led to today's whales.

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Part C.

Use your completed **Figure 3** to support the following claim:

Prehistoric creatures with whale-like features once lived on land. The fossil record shows a gradual change in physical features which corresponds to adaptation to living in aquatic environments. These adaptations led to modern-day whales.

Include information about:

- Features for living on land versus living in water
- Structures of the fossils which resemble modern whales
- Transitional forms of prehistoric creatures to more well-known species of groups of organisms

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Student Worksheet

This task is about the evolution of horses.

Task

Horses can weigh well over a thousand pounds and still outrun most other animals. One of the fastest horses is Winning Brew. She has been recorded running nearly 44 miles per hour! Winning Brew is a Thoroughbred. Thoroughbreds have long legs with lean muscular bodies. They have been bred for racing. Modern horses are often bred for selected traits such as speed or strength.

Modern horses can be 6 feet tall and weigh 2,000 pounds. Compared to modern horses, one of their ancestors was only 2.5 feet tall and weighed about 20 pounds. By studying fossils, scientists can piece together the evolutionary history of horses.

Prompt 1

Part A.

Table 1 shows the change in height of horses and their ancestors over the last 50 million years.

Table 1. Height of Horses Over Time

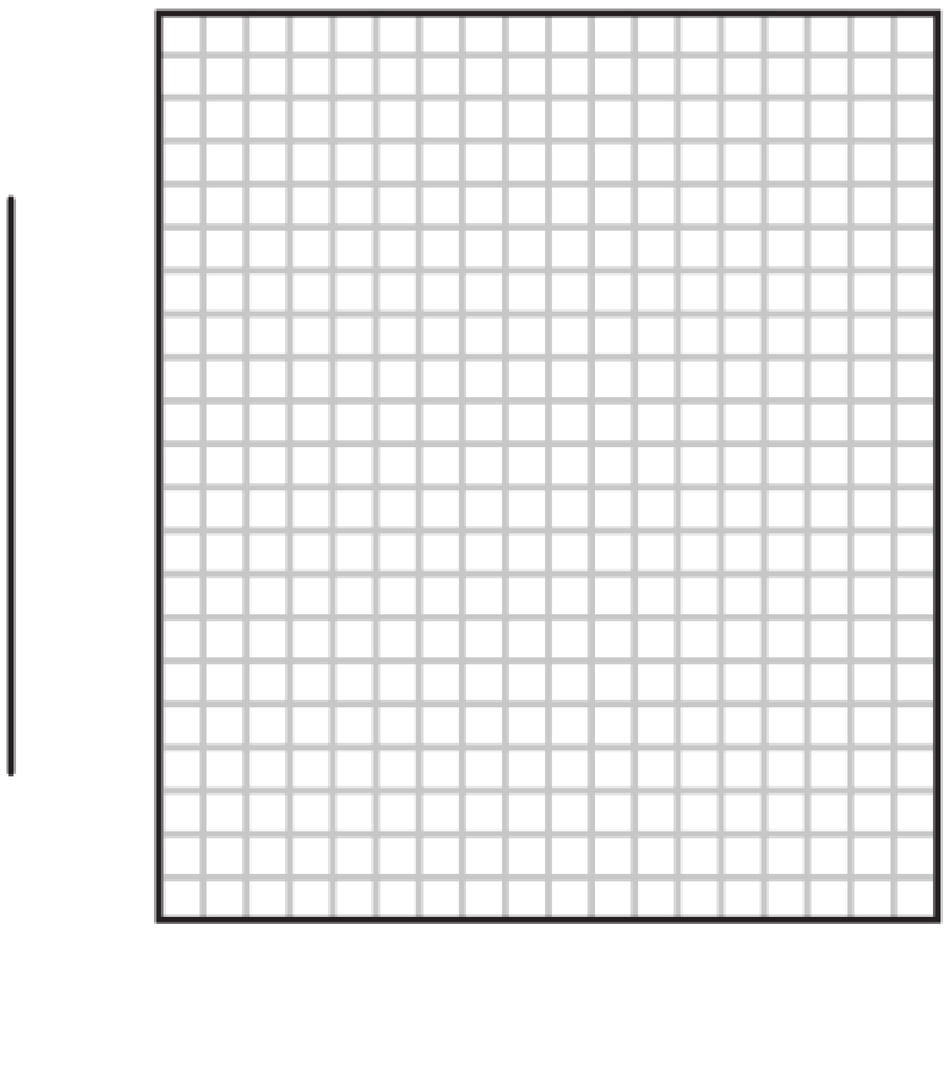
Animal	Time (in millions of years)	Height (in centimeters)
Eohippus	50	40
Mesohippus	35	60
Merychippus	15	100
Pliohippus	8	125
Modern Horse (Equus)	0	160

Source: (https://www.ck12.org/book/ck-12-life-science-for-middle-school/r13/section/7.2/)

Graph the change in the height of horses over time using the data in **Table 1.** The x-axis represents time, and the y-axis represents height. Your graph must include:

- a label for the x-axis and a label for the y-axis
- units
- data points connected with a line

Graph 1. Height of Horses Over Time



Part B.

Table 2 shows the change in the crown length of molar teeth in horses and their ancestors over the last 50 million years. The crown is the area of the tooth visible above the gum.

Table 2. Crown Length of Molar Teeth in Horses Over Time

Animal	Crown Length of Molar Teeth (in millimeters)
Eohippus	4
Mesohippus	9
Merychippus	45
Pliohippus	60
Modern Horse (Equus)	85

Explain the patterns of anatomical changes in horses over the last 50 million years as shown in your completed **Graph 1** and **Table 2**.

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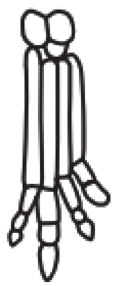
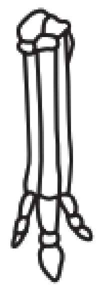
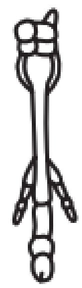
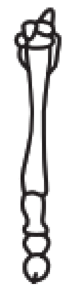
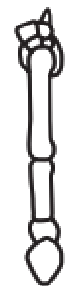
Prompt 2

Table 3 shows the change in the forefoot structure of horses and their ancestors over the last 50 million years.

Table 3. Forefoot Structure in Horses Over Time

Animal	Eohippus	Mesohippus	Merychippus	Pliohippus	Modern Horse (Equus)
Forefoot Structure					

The earliest animal, the Eohippus, had four toes on its forefoot and appears to have placed most of its weight on the middle toe.

Describe the observable **similarities** and **differences** among the fossil features of the animals over millions of years within **Table 3**. Consider the number of toes, bone size, and where the weight might be concentrated.

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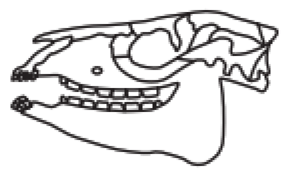
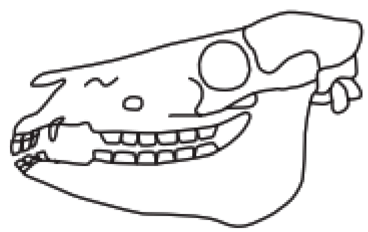
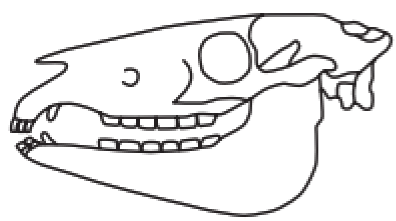
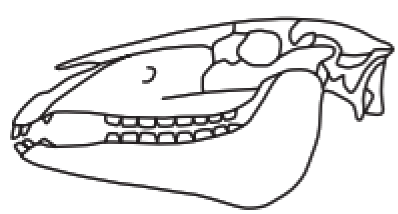
Table 4 shows the size and features of the skull of horses over 50 million years.

Table 4. Skull Size and Features of Horses Over Time

Animal	Skull
Eohippus	
Mesohippus	
Merychippus	
Pliohippus	
Modern Horse (Equus)	

Describe the observable **similarities** and **differences** among the fossil features of the animals over millions of years within **Table 4**. Consider the overall shape, size, and features of the skulls.

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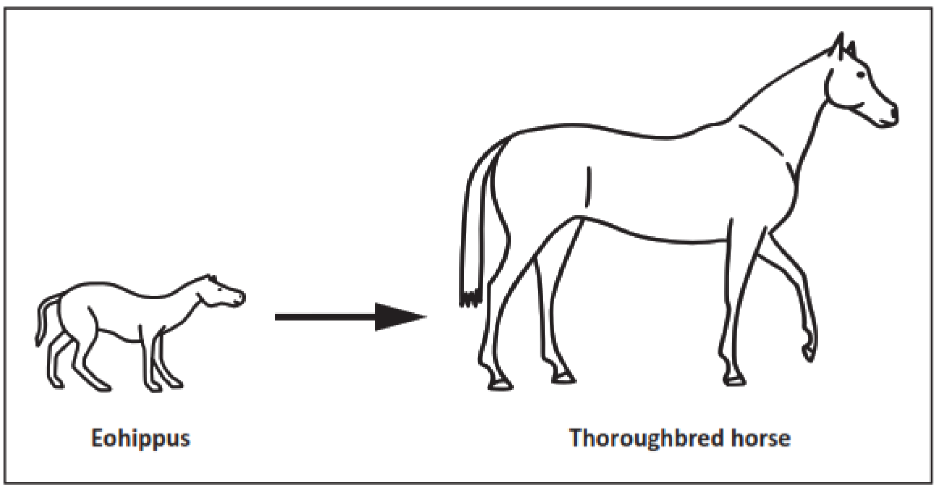
Prompt 3

Scientists have determined that the region in which horses evolved changed over time. Over the last 50 million years, the horse evolved from a small animal that lived in rainforests into an animal standing up to 6 feet tall that adapted to living on the plains.



The environment of the Eohippus was heavily wooded. This provided protection from predators, soft, moist grounds for walking, and plenty of food to eat. This environment was perfect for an animal with short legs with toes, small teeth, padded feet, and a dog-like body structure.

Over millions of years, the lush forests began to thin and disappear. Grassland eventually replaced the lush tropical forest. Hard, dry soil replaced the once soft, moist ground of the environment.

Scientists studying the evolutionary history of horses and evidence of changes in horses' environment over time have developed the following claim:

The change in the environment from forest to grassland caused changes in body structures in the population of horses over time.

Support the claim by explaining the cause-and-effect relationship between changes in the environment and the progression of changes that have led to modern-day horses. In your response:

- Use information from **Tables 1**, **2**, **and 3 AND Graph 1** to support your explanation
- Consider information about how a population may evolve in response to predators, survival, and food availability
- Use your scientific reasoning about how the process of natural selection results in the changes

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Student Worksheet

This task is about natural selection.

Task

Galapagos finches are a fascinating example of evolution by natural selection. There are 13 or 14 species, and each evolved from the same ancestor that arrived on the Galapagos Islands several million years ago from the South American mainland.

There are very few physical differences between the species of Galapagos finches. The birds generally have small, rounded wings with bodies covered in dull-colored feathers. However, the key to their differences lies in their beaks. Specifically, their size and shape, which vary according to the specific habitat in which the bird lives.

Prompt 1

Part A.

A pair of scientists working in the Galapagos Islands have studied several species of Galapagos finches for many years. In the early years of their research, they identified these types of beaks:

- very small beaks
- small beaks
- large beaks
- very large beaks

There were different types of shrubs, plants, and cacti on the islands. Some of the finches fed on the flowers of the cacti, some on very small seeds, and some on larger, hard seeds.

One year, there was a drought on the islands. Although the cactus plants survived, there were far fewer plants producing small seeds.

On one of the islands, the scientists recorded the number of birds and their beak size one day before the drought. They repeated these observations after the drought. Table 2 shows the data the scientists collected.

Table 2. Beak Sizes Before and After the Drought

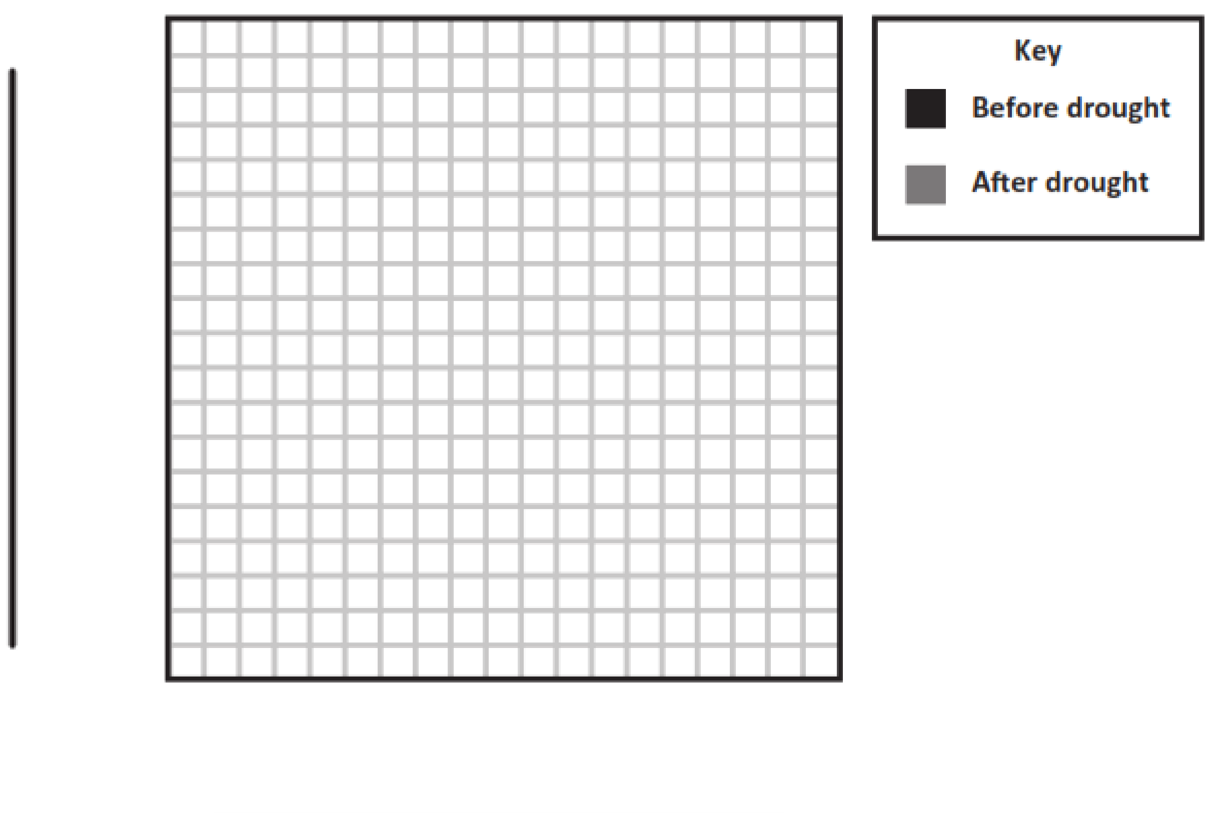
Beak Size	Number of Birds Before the Drought	Number of Birds After the Drought
Very Small	20	4
Small	24	12
Large	26	22
Very Large	24	20

Create a bar graph showing the number and type of each beak size (**Very Small, Small, Large, Very Large**) **before and after** the drought. Use the data from **Table 2 AND** the **provided key** to distinguish the bars.

Your graph must include:

- labels for the x- and y-axis
- units
- labels for the bar graphs showing the **before** and **after** beak size for each type of beak

Graph 1. Beak Sizes Before and After the Drought



Part B.

Use the information about the environment before and after the drought and **Graph 1** to answer the following questions:

1. The population of finches with very small beaks and small beaks decreased because

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2. Why was the population size of the birds with large and very large beaks less affected by the drought than the population of finches with small and very small beaks?

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Prompt 2

Part A.

Traits like differences in the beak shape of the finch populations can vary between and within species. Sometimes the instructions for traits can be altered. Suppose that a mistake occurs in one gene of a chromosome. This alteration in the genetic code is called a mutation.

DNA is a genetic code that is made of four different nucleotides that each include a different base molecule: adenine (A), thymine (T), guanine (G), and cytosine (C). In the genetic code, every nucleotide triplet, or codon, encodes for one amino acid. Some codons are "stop" codons, which signal the end of a protein.

Figure 1 shows the general codon table. The circle should be read starting from the center outwards. For example, the codon ACG encodes for threonine. Some codons code for the same amino acid. Some codons are "**STOP**" codons, which signal the end of a protein.

Figure 1. General Codon Table

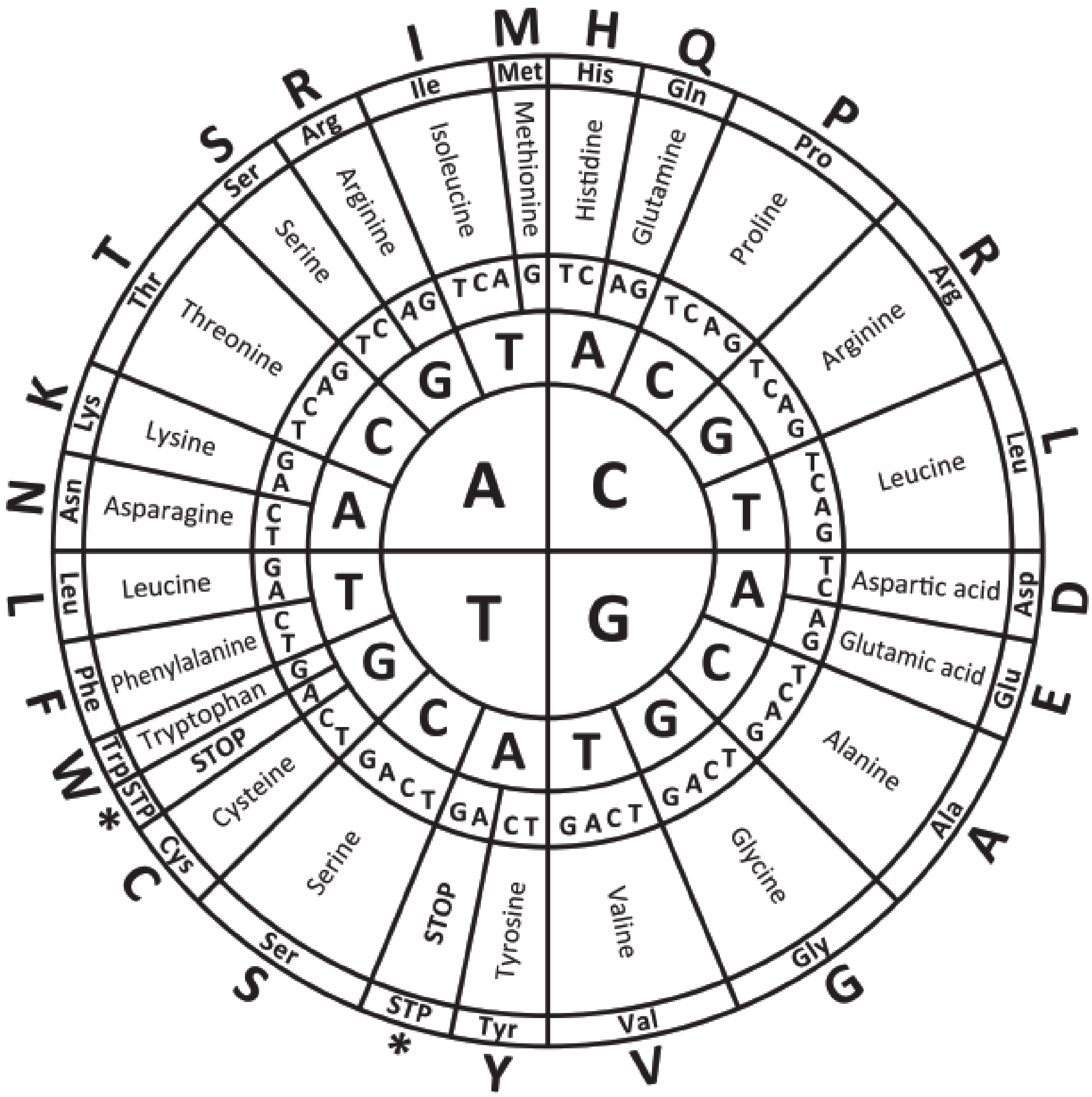

Table 3 is a random gene sequence showing the resulting protein sequence and a mutated DNA sequence.

Table 3. Random Gene Sequence

Codon	**1**	**2**	**3**	**4**	**5**	**6**	**7**
DNA	ACT	TGC	CCG	CAG	TCC	AGT	TAA
Protein	Thr	Cys	Pro	Gln	Ser	Ser	Stop
Mutated DNA	ACT	TAC	CCA	CAG	GCC	AGC	TAA

Using **Figure 1**, which mutations in **Table 3** cause a changed amino acid sequence in the resulting protein?

A. Codons 3 and 6

B. Codons 2 and 5

C. Codons 1 and 4

D. Codons 2, 3, and 6

Part B.

Explain how mutations contribute to genetic variation. In your response, include the five following terms:

DNA	**protein**	**gene**	**amino acid**	**mutation**

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Prompt 3

All of the different species of finches living on the Galapagos Islands can be traced back to the same ancestor. In humans, a similar phenomenon occurred to eye color, which resulted in people having different eye colors.

Originally, all humans had brown eyes. A genetic mutation that affects one gene in our chromosomes turned off between 6,000 to 10,000 years ago. This led to humans with blue eyes. Approximately 80% of the world's population has brown eyes. All other eye colors can be linked back to a single common ancestor.

Part A.

How is a genetic mutation, like eye color, **different** from the process of natural selection, like the development of different beak types of finches?

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Part B.

Why does natural selection explain what happened with the finches but not the eye color example?

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