

Lesson 8.2: Theory of Natural Selection

Extension 8.2, Exploration 1: Darwin's Voyage on the HMS Beagle

Read the following passage and answer the questions that follow.

Charles Darwin was one of the most famous people to consider the question of how living things evolve; however, the concept of evolution had been discussed for more than 100 years when Darwin proposed his theory of evolution.

Darwin's Theory at a Glance --- Darwin's theory of evolution contains two major ideas:

1. One idea is that evolution occurs. In other words, organisms change over time. Life on Earth has changed as descendants diverged from common ancestors in the past.
2. The other idea is that evolution occurs by natural selection. Natural selection is the process in which living things with beneficial traits produce more offspring than others do. This results in changes in the traits of living things over time.

In Darwin's day, most people believed that all species were created at the same time and remained unchanged thereafter. They also believed that Earth was only 6,000 years old. Therefore, Darwin's ideas revolutionized biology. How did Darwin come up with these important ideas? It all started when he went on a voyage.

The Voyage of the Beagle

In 1831, when Darwin was 22 years old, he set sail on a scientific expedition on a ship called the HMS Beagle. He was the naturalist on the voyage. As a naturalist, it was his job to observe and collect specimens of plants, animals, rocks, and fossils wherever the expedition went ashore. The route the ship took and the stops they made are shown in Figure 1.

Figure 1. The Voyage of the Beagle - This map shows the route of Darwin's 5-year voyage on the HMS Beagle. Each stop along the way is labeled. Darwin and the others on board eventually circled the globe.

Darwin was fascinated by nature, so he loved his job on the Beagle. He spent more than 3 years of the 5-year trip exploring nature on distant continents and islands. While he was away, a former teacher published Darwin's accounts of his observations. By the time Darwin finally returned to England, he had become famous as a naturalist.

Darwin's Observations

During the voyage, Darwin made many observations that helped him develop his theory of evolution. For example:

- He visited tropical rainforests and other new habitats where he saw many plants and animals he had never seen before. This impressed him with the great diversity of life.
- He experienced an earthquake that lifted the ocean floor 2.7 meters (9 feet) above sea level. He also found rocks containing fossil sea shells in mountains high above sea level. These observations suggested that continents and oceans had changed dramatically over time and continue to change in dramatic ways.
- He visited rock ledges that had clearly once been beaches that had gradually built up over time. This suggested that slow, steady processes also change Earth's surface.
- He dug up fossils of gigantic extinct mammals, such as the ground sloth. This was hard evidence that organisms looked very different in the past. It suggested that living things—like Earth's surface—change over time.



The Galápagos Islands

Darwin's most important observations were made on the Galápagos Islands. This is a group of 16 small volcanic islands 966 kilometers (600 miles) off the west coast of South America. Individual Galápagos islands differ from one another in important ways. Some are rocky and dry. Others have better soil and more rainfall. Darwin noticed that the plants and animals on the different islands also differed. For example, the giant tortoises on one island had saddle-shaped shells, while those on another island had dome-shaped shells. People who lived on the islands could even tell the island a turtle came from by its shell. This started Darwin thinking about the origin of species. He wondered how each island came to have its own type of tortoise.



Saddle-Backed Tortoise – The high shell edge of saddle-backed tortoises allows them to stretch their long necks.



Domed Tortoise – Domed tortoises have a short neck and short legs.

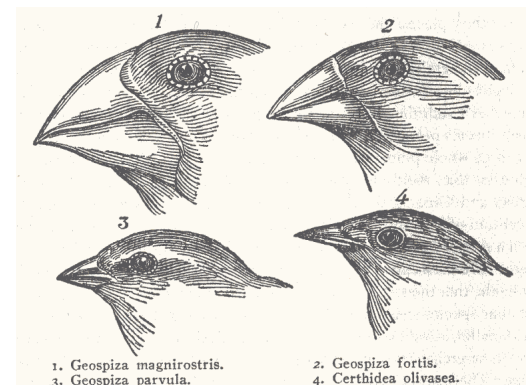
Influences on Darwin

Science, like evolution, always builds on the past. Darwin didn't develop his theory completely on his own. He was influenced by the ideas of earlier thinkers:

- **Jean Baptiste Lamarck** (1744–1829) was an important French naturalist. He was one of the first scientists to propose that species change over time. However, Lamarck was wrong about how species change. Lamarck developed a theory based on the *inheritance of acquired characteristics*, which states if an organism changes during life in order to adapt to its environment, those changes are passed on to its offspring. His idea of the inheritance of acquired characteristics is incorrect. Traits an organism develops during its own lifetime cannot be passed on to offspring, as Lamarck believed.
- **Charles Lyell** (1797–1875) was a well-known English geologist. Darwin took his book, *Principles of Geology*, with him on the Beagle. In the book, Lyell argued that gradual geological processes have gradually shaped Earth's surface. From this, Lyell inferred that Earth must be far older than most people believed.
- **Thomas Malthus** (1766–1834) was an English economist. He wrote an essay titled *On Population*. In the essay, Malthus argued that human populations grow faster than the resources they depend on. When populations become too large, famine and disease break out. In the end, this keeps populations in check by killing off the weakest members.

1. State Darwin's theory of evolution by natural selection.
2. Describe two observations Darwin made on his voyage on the *Beagle* that helped him develop his theory of evolution.
3. What is the *inheritance of acquired characteristics*? What scientist developed this mistaken idea?
4. Which of the two tortoises would have likely adapted to eating tall plants?
5. Which of the two tortoises would have likely adapted to eating short plants and mosses?

6. Darwin also observed various species of finches on the islands. . Using the figure to the right, what food sources might the finches have adapted to eat?



7. Apply Darwin's theory of evolution by natural selection to a specific case. For example, explain how Galápagos tortoises could have evolved saddle-shaped shells.
8. Why did Darwin's observations of Galápagos tortoises cause him to wonder how species originate?

Exploration 2: Developing the Theory of Natural Selection

Lamarck's Theory of Evolution:

example:

Darwin's Voyage:

Pattern of Biological Diversity	Description & Example
Species Vary Globally	
Species Vary Locally	
Species Vary Over Time	

Variations in Finches in the Galapagos:

Draw a bird with a beak adapted to eating...

Insects	Large Seeds	Worms
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adaptation -

artificial selection -

What is an example of *artificial selection*?

heritability -

8.2.2 Extension: Natural Selection and Adaptation - Complete using the Adaptations Sway on my website.

Arctic Fox vs Desert Fox

5 Structural Adaptations

1. .
2. .
3. .
4. .
5. .

Watch the video on The Life of Blister Beetles.

Why the beetle's habitat is extreme?

Why getting food is difficult?

How the larvae are adapted to find food?

Extremophiles (Choose One)

Describe the extreme environment (reference abiotic factors)

Three organisms that belong to this category:

Five adaptations that are typical of these organisms:

Explain how each adaptation helps the organism survive in its environment.

Exploration 3: Principles of Natural Selection

What did Darwin term his *method of evolution*?

Natural Selection:

Variation
Overproduction
Adaptation
Descent With Modification

How would natural selection be different if...

There were no existing variations?

All organisms had an equal chance of survival?

There were very few offspring?

What is **fitness**? Give an example:

What is the selecting agent in artificial selection?

In natural selection?

CRASH COURSE: HUMAN EVOLUTION

1. What happened 65-million years ago, that changed life on planet Earth?
2. What are New World Monkeys? What makes them different from their evolutionary cousins in Africa?
3. What event led to the creation of the Himalayas?
4. About how many years ago did Chimpanzees and Humans take different evolutionary paths?
5. Why do scientists believe pre-humans became bipedal?
6. About how tall were Australopithecines?
7. What did scientists point to as the first bit of evidence that Homo (Ergaster) Erectus showed technological improvement with their tools?
8. What is Collective Learning? Does it still exist today?
9. According to the presenters, who had an easier day, Foragers (Hunters & Gatherers) or Peasants? Why?
10. What do you think? Are humans born innocent and peaceful OR do we need rules and structures to keep us in order?
Explain by providing your opinion and at least 3 points to back up your view.

Extension 8.2, Exploration 3: Evolution by Natural Selection

Misconceptions about Natural Selection

It is tempting to assume that any feature on an organism must be the ideal trait for that organism's environment. However, not all traits are adaptations. For example, humans have a tailbone, but this anatomical feature is not the result of natural selection in humans. A feature such as this may have resulted from natural selection for a previous function, but it now serves no specific function. This trait is heritable, so it is passed down from person to person, but it no longer serves its original purpose.

It also is important to keep in mind that natural selection does not produce individuals who are perfectly suited to their environment. This is partly because organisms have combinations of traits that result from complex sets of tradeoffs. For example, having large horns may help an organism fight successfully for mates, but they may make it difficult for the animal to escape predators as effectively as it could with lighter horns. Therefore, it would be difficult for selective pressures to produce "ideal" traits, because a trait that is ideal for one purpose may be less than ideal in other contexts.

Another reason natural selection does not produce ideal traits is that it acts only on traits that already exist. Genetic variation within a population is what allows for the environment to "select" for certain traits. New alleles are not made by natural selection—they occur by genetic mutations.

Many mutations have harmful results and therefore are not likely to produce a trait that is beneficial in a given environment. However, some mutations lead to traits that might be advantageous to certain individuals. A mutation could change an organism's DNA in a way that leads to the production of a new type of protein. If this results in a trait that increases an organism's fitness, this trait would be selected for. Therefore, new traits can occur, but they are not created through natural selection.

Another common misconception about natural selection is that individuals can adapt to their environment. Natural selection leads to changes in populations, not in individual organisms. Evolution is a change in the proportion of alleles in a population over many generations. Therefore, individuals do not adapt to their environment over the course of one lifetime. Adaptations occur in populations, and those adaptations evolve over time through the process of natural selection. This process may take millions of years, or it may occur very quickly, as it does in single-celled organisms, such as bacteria.



1. What does natural selection lead to?
2. Why does natural selection not produce *ideal* traits?
3. How does the cartoon of the cats demonstrate a misunderstanding of the theory of natural selection?

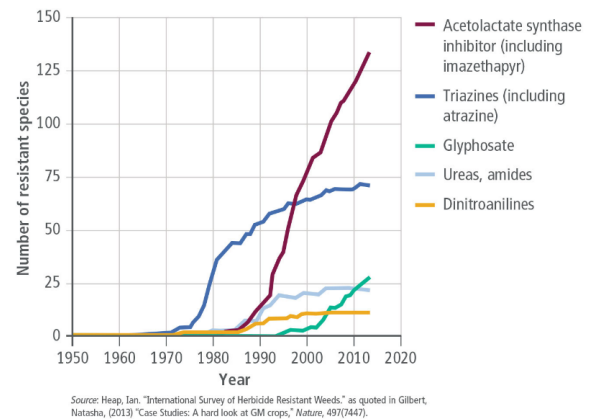
Unit Practice and Review

- DNA nucleotides are said to be universal because they are the same for all known organisms. What is this evidence of? Select all correct answers.
 - Common Ancestry
 - Fossil Record
 - Evolution
 - Natural Selection
- Which lines of evidence did Darwin use to explain the variety of finches on the Galapagos Islands? Select all the correct answers.
 - DNA evidence
 - Fossil evidence
 - Geological evidence
 - Anatomical evidence
- How did fossils contribute to Darwin's ideas?
 - Fossils supported Darwin's ideas about common ancestry and the relationship of living species to fossil species.
 - Fossils showed that all species are the result of gradual changes over time.
 - Fossils explained how species develop different traits.
 - Fossils showed how humans had been affecting the traits of organisms for thousands of years.
- Which statement best describes the relationship between natural selection and variation?
 - All variations are acted upon by natural selection.
 - Variations evolve during natural selection to make a species better adapted to its environment.
 - Natural selection acts on variations that are selected for or against based on the environment.
 - Natural selection creates variations that are selected for or against based on the environment.
- Which is not required for natural selection to take place?
 - Adaptation
 - Competition
 - Heritability
 - Sexual Reproduction
 - Variation

Use the following information and graph to answer the next three questions.

Chemical herbicides are used in agricultural and landscape maintenance to kill unwanted vegetation, such as weeds. As the use of an herbicide becomes more common and widespread, weeds can evolve resistance to particular types of herbicide.

- Weeds first evolved resistance to which herbicide class?
 - Acetolactate Synthase Inhibitor
 - Dinitroanilines
 - Glyphosate
 - Triazines
 - Ureas, amides
- What is most likely indicated by the fact that the number of species resistant to an herbicide class never decreases?
 - Individual weeds evolve herbicide resistance and pass the trait to their offspring.
 - The herbicide resistance trait is maintained in resistant populations.
 - The weed populations frequently lose, then re-evolve with a resistance to herbicides.
 - Whenever one weed species loses herbicide resistance, one or more species gains resistance, leading to a net increase in resistant species.



Extension 8.2, Exploration 2: Cause and Effect – Selection of Exercise Ability

Cause & Effect: Selection of Exercise Ability

In artificial selection, humans can make use of genetic variation by acting as the selective agent. Scientists used mice to study whether exercise ability can improve in animals over several generations. In this experiment, mice were artificially selected for increased wheel-running behavior. The mice that were able to do the most wheel running were selected to breed the next generation. The control group represents generations of mice that were allowed to breed randomly.

Answer these questions about the data presented in the graph:

1. What is the difference in results between the mice in the control group and the mice in the experimental group?
2. Use the trend in the data to make a prediction about the number of revolutions on the wheel per day for mice in Generation 10 of the experimental group.

