Darwin

Synthetic Interview

Web quest

grades 3-6

Darwin 2009: A Pittsburgh Partnership

Produced by Regenerative Medicine Partnership for Education
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Principle funding from
Science Education Partnership Award
National Center for Research Resources
National Institutes of Health
Overview:
There are two 40 minute activities in this lesson plan that can be used independently or together. For both activities, students can work at their own pace as they explore the synthetic interview.

Activity A: Darwin’s Life
This activity is a crossword puzzle that gives students a chance to explore the life of Darwin and the basics of evolution. This activity is an excellent general introduction to Charles Darwin. Students will explore the life and work of Charles Darwin on the computer in a relaxed classroom setting with a fun crossword format.

Learning Objectives
Students will be able to:
1. Define evolution, adaptation, natural selection, inheritance, traits
2. Describe basic facts about Charles Darwin and his work

Activity B: A Revolutionary Idea
This more advanced activity delves into the details of the science behind Darwin’s theory of evolution by natural selection. Students will learn about how Darwin collected and combined evidence to develop his theory of evolution, and will see how the evidence reveals the link between environment and adaptation.

Learning Objectives
Students will be able to:
1. Define evolution, adaptation, natural selection, inheritance, favorable traits, and vestigial structures
2. Discuss the controversy around the publication of *Origin of Species*
3. Describe the types of data Charles Darwin collected and explain why the data provide evidence for evolution by natural selection
4. Predict the favorability of traits in changing environments

A few things your students should already know:
1. Charles Darwin is a famous naturalist who published his theory of evolution by natural selection in the book *Origin of Species*.
2. Scientists come up with theories to explain observations about the world around us and then collect data to try to prove those theories are correct.
3. What organisms and species are.
Vocabulary

1. Trait: A characteristic of an organism or species (ex: eye color, hair color, hair texture, etc.). A trait that helps an organism survive or thrive in its environment is called a **favorable trait**. This trait gives an organism an advantage over organisms without that trait.

2. Natural Selection: The process by which environmental conditions determine what characteristics of a species are favorable traits for its environment. Individuals with favorable traits produce more offspring.

3. Evolution: The accumulation of changes through natural selection within a population that occurs over a series of generations.

4. Adaptation (v): The process of an organism becoming better suited to its habitat over time.

5. Adaptation (n): A favorable trait that is important for a species survival.

6. Inheritance: The passing of traits from parent to offspring.

Overview

Charles Robert Darwin was born in Shrewsbury, England on February 12, 1809 to Robert Waring Darwin, a doctor, and Susannah Wedgwood, the daughter of a famous potter. Even as a young child, his interest in nature (and lack of interest in learning Greek, Latin and History) was plainly obvious. At sixteen, his father sent him to medical school, but he was unhappy and left to attend Cambridge University with the intent of becoming an Anglican minister. Again, Darwin showed little interest in his studies. During his free time he loved to collect beetles and to attend the botany lectures and excursions of Professor Henslow. The professor and Charles developed a friendship rooted in their mutual interest in the natural world. He graduated in 1831 at age 22.

The Voyage of the HMS Beagle

After graduation, Professor Henslow found Charles a position on the ship HMS Beagle as a volunteer naturalist. The voyage’s mission was to chart the South American coastline to help make maps. As a naturalist, Charles spent much of his time on land collecting specimens of animals, insects, and plants, and taking descriptive notes in his journal. He sent many of his notes and specimens to Professor Henslow.

During his journey, Charles was particularly intrigued by the Galapagos Islands. Formed by volcanoes more recently than the continents, these islands gave Charles the opportunity to observe a relatively “new” and recently populated land. The plants and animals here were like none that he has ever seen. There were beautiful birds with blue feet, tortoises unafraid of man, ugly iguanas, and bright red crabs. Charles realized that his passion for science was stronger than for subjects and happily started collecting lots of specimens - many of which he sent back to England.
Darwin’s Principle of Evolution

In January of 1837 - after he returned to England - the scientist that Darwin gave his Galapagos bird specimens to, John Gould, gave an interesting report: the birds that Darwin had assumed to be different species were actually twelve different species of finches! How could one there be so many closely related finches? This question haunted Darwin because at its heart it was in conflict with the widely accepted idea that all species were created at once.

Darwin took many notes on what he called the “transmutation of species” - the idea that species changed over time. He recorded every detail of his correspondences and the specimens he found relating to the changes in species over time. He wrote questions in his notebooks like: “Each species changes. Does it progress?” He noticed that the finches had many similarities, which made Darwin think that maybe they came from a common ancestor. But something had caused these finches to change over time...what was it? And, how did it work?

Farmers of the time knew one simple and practical “rule” - traits are usually passed down from parent to offspring. This simple observation allowed farmers to artificially select favorable traits in species of plants and animals for many years. You may have heard of artificial selection by the name “domestication”. It refers to the way that farmers bred fast horses with fast horses, or hardy peas with hardy peas, in order to create offspring with desirable traits. Charles Darwin thought about artificial selection in relation to nature and formed his principle of natural selection.

What is Natural Selection?

Natural selection describes the way a species’ environment selects for favorable traits and against unfavorable traits. Just like the farmers would choose the fastest horse to mate, Darwin proposed that, for example, a dry environment would select animals that are able to survive with less water. But Darwin could not determine what force in nature actually “selected” which organisms reproduced.

The answer came to him while reading Thomas Malthus’ Essay on the Principle of Population. The book outlined the way that organisms can produce many offspring, but the number of offspring that survive is affected by the amount of available resources. In other words, the earth does not become overpopulated because limited food resources control the number of organisms that reach maturity and reproduce.

Suddenly Darwin saw the answer to his problem. Competition between individuals selected favorable traits.

All organisms must compete with each other for basic resources—food, water, and space. There is competition both between species and among species. Darwin noticed that competition forced species to change, or adapt, in order to survive. If too many birds eat insects, then one species of bird might evolve to have a beak adapted to cracking open nuts. The competition for food led the species of bird to a new food source.

The environment creates specific pressures, such as a lack of water. Some individuals that are better adapted, or more fit, for this particular environment (maybe they lose less water to perspiration). These more-fit organisms are able to out-compete the others and create more offspring. Over time, these favorable traits accumulate and the species changes so all organisms in the species share the ability to lose less water to perspiration.
This change over time is evolution. Though other scientists such as Jean-Baptiste de Lamarck were also developing theories of evolution, Darwin was the first to get it right. On November 1859, Darwin's book about evolution and natural selection, *The Origin of Species*, was published. All 1,250 copies sell on the first day.

**Evidence of Evolution**

**Fossils**

During his travels to South America, Darwin discovered fossils and observed that the bones of extinct mammals that he unearthed closely resembled some of the current mammals in those regions. For example, he noticed a relationship between the fossils of extinct large armadillos that he found and the armadillos he saw walking around on the continent.

Today, scientists have found even more exciting fossils that show direct relationships between animals. One of the most fascinating of these fossil links is the Archaeopteryx, which looks like a sort of cross between a dinosaur and a bird. If you look closely, you can see that it has the feathers and wings of a bird and the tail of a reptile. It shows how some dinosaurs evolved to become birds.

**Biogeography**

Biogeography is the scientific study of the way in which plants and animals are spread around the globe. Certain types of plants and animals can only be found in specific locations. Cacti are found in deserts; monkeys are found in tropical regions. It would be a surprise to see a polar bear in the desert. Why? Because those large, heavily insulated animals aren't properly equipped to live in dry, hot regions. The way that animals are well suited to fit into their specific environment serves as evidence for evolution.

**Vestigial Structures**

Plants and animals, including humans, have body parts that they don’t use, known as vestigial structures. The goosebumps you get when you’re scared are actually a vestigial structure. They serve no purpose. The only way to explain their existence is by looking at our ancestors. When other mammals get goosebumps, their long hair stands on end, making them look bigger. We can speculate that our goosebumps come from sharing a common ancestor with other mammals that had the same characteristic. Other human vestigial structures include the tailbone and the appendix. Vestigial structures show how animals are related to their common ancestor.

**Biochemical Evidence**

Today, scientists have proved that genetic material (DNA) - which contains the traits an organism has (genes) - gets passed down from parent to offspring. Now, scientists can look at the sequence of the DNA of different organisms and see how genes have changed as species evolved and diverged. Organisms with similar types of genes are likely to have a common ancestor. For example, humans and chimpanzees have many traits in common - for example, similar body structure, opposable thumbs, and the ability to walk upright - so it shouldn’t surprise you to learn that 95% of their DNA is the same! So, only 5% encodes for traits that make us uniquely human.
Pre-Activity

Darwin Synthetic Interview Webquests

Reflection
1. Who is Charles Darwin?

2. What is evolution?

3. What kinds of things are affected by evolution?

Navigating the Synthetic Interview with Charles Darwin

The synthetic Interview has 5 main sections:
1. the categories you can choose from
2. the questions you can ask
3. the question Darwin is answering
4. the video screen
5. the Charles Darwin animation
6. the experts

1. Click here to choose a category.
2. Click here to choose a question.
3. The question shows up here.
4. Darwin will answer here.
5. Pictures show up here.
6. Darwin doesn’t always have the answers. For some questions, you can get information from modern scientists and theologians. Click the face of an expert for a modern perspective:

Your teacher will hand out Activity A or Activity B - follow the instructions and have fun!

www.sepa.duq.edu
Activity A: Darwin’s Life

ACROSS
1. When farmers purposely breed cows to create new breeds that produce more milk, this is an example of ________ selection.
5. The type of bird that Darwin studied the most
9. The fossil of Archeopterix is an example of a ________ form between reptiles and birds.
10. Evolution is descent with ________.
11. Darwin made some of his most important observations on the ________ islands.
13. The boat Darwin worked on
14. Humans and apes have a common ________.
16. Darwin’s middle name
17. ________ selection is a law of nature that leads to adaptation in all species.

DOWN
2. The Captain of the Beagle (two words)
3. Darwin’s father’s job
4. The earth is 4.5 ________ years old.
6. The ________ can influence adaptation.
7. The Galapagos islands were formed by ________.
8. In natural selection, ________ is the process of an organism becoming better suited to its environment.
12. One of Darwin’s favorite hobbies
15. The HMS Beagle was sent to map the coast of ________ America.
What You Will Do

Open the Sythetic Interview and explore it to learn about the life and work of Charles Darwin. Use the questions below to help you learn more about how Darwin lived and how he collected evidence in support of the Theory of Evolution.

Part 1 - Thinking about Evolution

For this section, explore the sections “The Origin of Species and Evolution” and “Evolution and the Skeptics”

1. What is a trait?
   A. a behavior that you learn from your parents
   B. a characteristic of an organism that changes as you get older
   C. a characteristic of an organism that can be passed to offspring
   D. all of the above

7. What is adaptation?

8. What is natural selection?

9. Name one person who thought about evolution before Darwin.

10. Darwin was inspired by the work done on evolution by other scientists. What did these scientists know about evolution?
11. What was different about what Darwin proposed about evolution?
A. that artificial selection was the mechanism of evolution
B. that natural selection was the mechanism of evolution
C. that evolution only happens for complex organisms
D. that evolution stopped in the 1700s

12. How did people and other scientists react to the publication of the *Origin of Species*?

13. Name one objection that people had to Darwin’s theory of evolution.

14. There are four main types of evidence of evolution. Name 3.

15. How do fossils provide evidence that evolution works through natural selection?

16. **Vestigial structures** are structures on organisms that seem to have lost all or most of their function. Which of these are examples of vestigial structures in humans?
Circle all of the correct answers.
A. beards   B. tailbones
C. eyelashes   D. wisdom teeth
E. goose bumps   F. toenails
17. Why are vestigial structures evidence of common descent of humans?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Part 3 - Re-thinking Evolution
18. Now that you’ve had a chance to explore, what is evolution?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

19. How is your answer above different than it was at the beginning of the Quest?

________________________________________________________________________

________________________________________________________________________

You’re done with the synthetic interview. Great job!
Additional Exercises - Can it adapt?  

1. The environment is constantly changing, and animals aren’t always able to survive the change. In the table below there is a list of animals with one example of a heritable trait for each animal and a type of environmental change. For each one, decide if the heritable trait would be favorable or unfavorable in that new environment.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Trait</th>
<th>Environmental Pressure</th>
<th>Favorable or Unfavorable?</th>
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<td>Polar Bear</td>
<td>Thick, fuzzy fur</td>
<td>Increase in temperature</td>
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</tr>
<tr>
<td>White Owl</td>
<td>White feathers</td>
<td>Increase in the amount of snow</td>
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<tr>
<td>Mallard Duck</td>
<td>Webbed feet</td>
<td>Decrease in the number of lakes</td>
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<tr>
<td>Jack Rabbit</td>
<td>Large ears</td>
<td>Faster predators</td>
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2. Think of your favorite animal and draw it.

3. Now imagine that the planet gets much hotter and draw what your animal might look like after it adapted to the new temperature.
Activity A: Darwin CrossWord Key

**ACROSS**

1. When farmers purposely breed cows to create new breeds that produce more milk, this is an example of ________ selection.
2. The type of bird that Darwin studied the most
3. Darwin's father's job
4. The earth is 4.5 _______ years old.
5. Evolution is descent with ________ .
6. Darwin made some of his most important observations on the ________ islands.
7. The boat Darwin worked on
8. Humans and apes have a common ________ .
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10. ________ selection is a law of nature that leads to adaptation in all species.

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2. The Captain of the Beagle (two words)
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4. The earth is 4.5 _______ years old.
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6. The Galapagos islands were formed by ________ .
7. In natural selection, ________ is the process of an organism becoming better suited to its environment.
8. One of Darwin's favorite hobbies
9. The HMS Beagle was sent to map the coast of ________ America.
Activity B: The Revolutionary Idea Key

Part 1 - Thinking about Evolution

1. What is a trait?
   A. a behavior that you learn from your parents
   B. a characteristic of an organism that changes as you get older
   C. a characteristic of an organism that can be passed to offspring
   D. all of the above

2. What is an adaptation?
   The process of an organism becoming better suited to its habitat over time.

3. What is natural selection?
   Natural selection is the process that causes favorable heritable traits become more common in successive generations, and unfavorable heritable traits become less common.

4. Name one person who thought about evolution before Darwin.
   Jean-Baptist Lemark, Darwin’s grandfather, Charles Lyell or the Unknown author 1844 Vestiges of the Natural History of Creation.

5. Darwin was inspired by the work done on evolution by other scientists. What did these scientists know about evolution?
   Scientists already thought that species were changed by the environment, but they didn’t know how.

6. What was different about what Darwin proposed about evolution?
   A. that artificial selection was the mechanism of evolution
   B. that natural selection was the mechanism of evolution
   C. that evolution only happens for complex organisms
   D. that evolution stopped in the 1700s

7. How did people and other scientists react to the publication of the Origin of Species?
   Many scientists thought it was brilliant, but others thought it was completely wrong. Some people thought Darwin didn’t have enough evidence. Others didn’t think that he explained all of the theory well enough (for example, the cause of variation)

8. Name one objection that people had to Darwin’s theory of evolution.
   Many people believed (and some still do) that Darwin’s theory went against their religious beliefs, some didn’t want to believe humans descended from apes.
Part 2 - Evidence of Evolution

9. There are four main pieces of evidence of evolution. Name 3.
   1. Similarities in body structure of similar animals
   2. Fossil records of animals changing over time
   3. Geographical distribution of animals
   4. The fact that all living things have DNA as their genetic material

10. How do fossils provide evidence that evolution works through natural selection?
    If evolution of species via natural selection is a true scientific phenomenon, then we should see changes in fossils over time. If we look at the skeletal imprints of fossils in the older, deeper layers and compare them to the skeletons of the newer, shallower layers, we see that they change slowly over time. Also, fossils provide evidence of “transitional” and extinct species.

11. Vestigial structures are structures on organisms that seem to have lost all or most of their function. Which of these are examples of vestigial structures in humans? Circle all of the correct answers.
    A. beards  B. tailbones  C. eyelashes  D. wisdom teeth  E. goose bumps  F. toenails

12. Why are vestigial structures evidence of common descent of humans?
    It doesn’t make sense for an species to spontaneously develop a useless part of the body. Instead, these structures stop being used by newer generations, but don’t get eliminated. If a more modern species has a vestigial structure, you can look for the ancestor that had it.

Additional Exercises: Can it adapt?

The environment is constantly changing, and animals aren’t always able to survive the change. In the table below there is a list of animals with one example of a heritable trait for each animal and a type of environmental change that might make that heritable trait more favorable or unfavorable. For each one, decide if the heritable trait would be favorable or unfavorable in that particular environment.

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