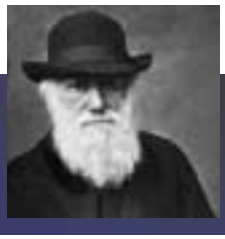

Unit 2 Who Was Charles Darwin?

***Evolution* TV Show**
"Darwin's Dangerous Idea"

At a Glance

Learning Goals

Understand how Darwin used the processes of science to support his theory

Distinguish between artificial and natural selection

Recognize Darwin's contribution to science

Quick Clicks

Teacher's Guide Web Resources

Access the Web resources referenced in this guide—from handouts to video segments to Web features—by going to **pbs.org/evolution** and clicking on Teachers and Students, and then going to the *Evolution Teacher's Guide,* where the material is presented by unit.

"From my early youth I have had the strongest desire to understand or explain whatever I observed—that is, to group all facts under some general laws. These causes combined have given me the patience to reflect or ponder for any number of years over any unexplained problem....I have steadily endeavoured to keep my mind free, so as to give up any hypothesis, however much beloved (and I cannot resist forming one on every subject), as soon as facts are shown to be opposed to it. Indeed I have had no choice but to act in this manner, for with the exception of the Coral Reefs, I cannot remember a single first-formed hypothesis which had not after a time to be given up or greatly modified."

"I...followed a golden rule that whenever a published fact, a new observation or thought came across me, which was opposed to my general results, to make a memorandum of it without fail and at once; for I had found by experience that such facts and thoughts were far more apt to escape from memory than favorable ones."

"During some part of the day I wrote my Journal, and took much pains in describing carefully and vividly all that I had seen; and this was good practice....Everything about which I thought or read was made to bear directly on what I had seen and was likely to see; and this habit of mind was continued during the five years of the voyage. I feel sure that it was this training which has enabled me to do whatever I have done in science."

– Charles Darwin,
The Autobiography of Charles Darwin
(Nora Barlow, ed., pp. 141, 123, 78)

Background

Charles Darwin's life represented the essence of science. He was naturally curious and reflective and a keen observer who was always gathering evidence to explain the world around him. Even before Darwin stepped onto the *Beagle,* he was an experienced naturalist. He spent much of his early life outdoors observing nature and during college had many scientists as mentors who engaged in long conversations with him about science.

But the voyage of the *Beagle* was the turning point in Charles Darwin's life. It gave a breadth and depth to his experience that was invaluable to his later thinking. During the five-year journey of the *Beagle* (1831–1836), Darwin spent only 18 months at sea. His curiosity, coupled with his frequent bouts of seasickness, inspired him to take long expeditions exploring the natural history and geology of South America, the Galapagos Islands, Tahiti, and Australia. Darwin made careful observations and looked for patterns wherever he went. His key observations about the diversity and distribution of **species** spurred his thinking for *On the Origin of Species by Means of Natural Selection*.

Darwin wrote letters to his mentors and sent his collections home throughout his journey. By the time Darwin stepped off the *Beagle,* he was already recognized by the scientific community for his expertise.

Upon Darwin's return, he spent eight years studying barnacles and believed that his in-depth knowledge in this one area sparked his thinking in others. In the years following his *Beagle* voyage, Darwin began to develop his revolutionary theory of **natural selection** that explained a mechanism for **evolution.** He carefully explored different lines of evidence, experimenting and gathering information to support his case for evolution.

One of Darwin's interests, pigeon breeding, played a significant role in the development of his theory of natural selection and in the way he presented his argument in *On the Origin of Species.* Darwin wanted to understand how new species could be created from a common ancestor by the accumulation of small changes over generations and believed that studying breeding by **artificial selection** of animals like pigeons would offer clues.

Darwin spent 20 years gathering evidence and writing about his theory before he published it. He anguished over the controversy it would create in Victorian England. And, if the naturalist Alfred Wallace hadn't come to similar conclusions and written to Darwin for help in presenting them, it might have been even longer before the world heard about *On the Origin of Species*.

"Even without evolution, Darwin would have been one of the great nineteenth-century biologists; even without biology, he would have gone down in history as a great geologist. It is a measure of the importance of the theory of evolution that those other achievements seem modest in comparison to it."

(From Michael White and John Gribbin, *Darwin: A Life in Science,* p. 173.)

Know More

Web Sites

www.literature.org/authors/darwin-charles/ (Online versions of Darwin's books *The Voyage of the Beagle, The Origin of Species,* and *The Descent of Man)*

www.biology.com/visitors/ae/voyage/introduction.html (A virtual voyage of the *Beagle* activity)

http://www.inform.umd.edu/EdRes/Colleges/LFSC/life_sciences/.plant_biology/darwin/darwindex.html (The Darwin-Wallace paper of 1858)

www.galapagos-ecological.com/charles-darwin-research-station.html (Charles Darwin Research Station–Galapagos Islands)

Books

Barrett, Paul, ed. *The Collected Papers of Charles Darwin.* Chicago: University of Chicago Press, 1977.

Browne, Janet. *Charles Darwin: Voyaging.* Princeton, NJ: Princeton University Press, 1995.

Burkhardt, Frederick, ed. *Charles Darwin's Letters: A Selection 1825–1859.* Cambridge, UK: Cambridge University Press, 1998.

Darwin, Charles. *Voyage of the Beagle.* New York: Penguin Putnam Inc., 1839 (reprint 1989).

Darwin, Charles. *The Origin of Species.* New York: The Modern Library, 1993.

Darwin, Charles. *The Autobiography of Charles Darwin.* New York: W.W. Norton and Company, Inc., 1958.

Desmond, Adrian, and James Moore. *Darwin: The Life of a Tormented Evolutionist.* New York: W.W. Norton and Company, Inc., 1994.

Jones, Steve. *Darwin's Ghost: The Origin of Species Updated.* New York: Random House, 2000.

Mayr, Ernst. *The Growth of Biological Thought: Diversity, Evolution, and Inheritance.* Cambridge, MA: Harvard University Press, 1982.

Ridley, Mark, ed. *The Darwin Reader.* New York: W.W. Norton and Company, Inc., 1996.

White, Michael, and John Gribbin. *Darwin: A Life in Science.* New York: Penguin Books USA, 1997.

pbs.org/evolution

SCILINKS www.scilinks.org

Topic	Keyword
Charles Darwin	EG11A

Activities

Online Student Lesson 2: *Who Was Charles Darwin?*
Students meet the man behind the theory, chart his voyage, and learn how his observations led to his theory of natural selection.

Darwin Makes the Front Page

Teacher's Guide Web Resources

Video Resources
"Darwin: Reluctant Rebel"

Reading Resources
"Depart Indefinitely from the Original Type" by Alfred Russel Wallace

Introduction to *On the Origin of Species*

Audio Resources
"James Moore: Darwin and Victorian Culture"

Books

The Autobiography of Charles Darwin

Charles Darwin's Letters: A Selection 1825–1859

The Collected Papers of Charles Darwin

1. Explain that students will work in teams to produce a newspaper describing the times in which Darwin introduced his theory of natural selection, reporting the public reaction to his theory, and comparing Darwin and Wallace's theories.

2. Ask students to bring copies of different newspapers to class to use as models. Within each team, assign roles for different parts of the paper. Sections might include feature articles, editorials, letters to the editor, lifestyles, editorial cartoons, a religion page, and book review. Help them identify the unique characteristics of each part of the paper.

3. Have students use resources in the *Evolution* Library, books, and Web sites to determine the subject and angle of their stories, editorials, and cartoons.

4. Have students combine their work to create a newspaper for their team.

Darwin Goes to the Dogs...

Teacher's Guide Web Resources

Image Resource
"Dog Evolution"

1. Read the following excerpt to students and discuss the questions below:

It is wonderful what the principle of Selection by Man, that is the picking out of individuals with any desired quality, and breeding from them, and again picking out, can do. Even Breeders have been astonished at their own results....Man by this power of accumulating variations adapts living beings to his wants—he may be said to make the wool of one sheep good for carpets and another for cloth....

– Charles Darwin in a letter to Asa Gray (Botanist at Harvard University), September 5, 1857 (From *Charles Darwin's Letters: A Selection* 1825–1859, p. 178.)

What kinds of animals have been domestically bred?

What characteristics have been selected in different animals?

2. Using the *Evolution* Library, the school library, and the Web as resources, have students work in teams of two to three to research different dog varieties. Have each team identify which characteristics were selected for and what the genealogy (family tree) is for their breed. Have one team research the domestication of dogs from wolves.

3. Now discuss these questions:
What are the differences/similarities between artificial selection and natural selection?

Why do you think Darwin started *On the Origin of Species* with a chapter called "Variation under Domestication"?

How did Darwin's knowledge about artificial selection influence his theory of natural selection?

Video 2 for Students

Who Was Charles Darwin?
In this brief portrait, students will discover how Charles Darwin's upbringing, curiosity and passion for natural history, voyage on the *Beagle,* and his reliance on scientific process led to the publication of his groundbreaking book, *On the Origin of Species by Means of Natural Selection.*

Discussion questions:
What characteristics made Darwin especially well-suited for science?

What did Darwin see and do on his five-year voyage on the *Beagle?*

Why was the publication of *On the Origin of Species* a courageous act?

Why was it simply good science?

Take It Further

Online Course for Teachers
Session 2: "How Does Darwin's Theory of Evolution Illustrate the Process of Science?"

Evolution Web Features
"Darwin's Diary"
"Evolution Revolution"

Evolution Library
Charles Darwin's Letters–excerpts
Charles Darwin's Journal of Researches –excerpts

In-depth Investigation

Seeds at Sea 🕘🕘 to 🕘🕘🕘

Darwin puzzled for a long time over how plant species from the mainland could colonize islands. He wondered whether seeds could survive being carried by ocean currents. To test that assumption he experimented enthusiastically, filling his home with soaked seeds and germinating plants and regularly asking for advice from readers of *Gardener's Chronicle* journal.
In this activity, students recreate Darwin's experiments.

Objective:
Students test Darwin's hypothesis that seeds could be immersed in sea water and still germinate.

Materials:
- Copy of Darwin's article "Does Sea-Water Kill Seeds?" *Gardener's Chronicle,* May 26, 1855 (see **Teacher's Guide Web Resources**)
- A selection of fast-growing seeds, including different varieties of the same species (radish, lettuce, cabbage, beans, mustard, carrot); note germination time on package
- Tap water
- Sea water (if sea water is not available, make a solution of 35 g table salt (NaCl) per liter of water; instant ocean mix may be available in aquarium/pet supply stores)
- Glass containers for soaking seeds (beakers, jars, etc.)
- Containers for growing seeds (pots, trays, paper cups, etc.)
- Sterile potting soil

Procedures
Preparation: Gather enough materials for teams and make copies of Darwin's article.

1. Introduce this activity by reading Charles Darwin's letter to the *Gardener's Chronicle* and *Agricultural Gazette,* April 14, 1855.

> *I have begun making some experiments on the effects of immersion in sea-water on the germinating powers of seeds, in the hope of being able to throw a very little light on the distribution of plants, more especially in regard to the same species being found in many cases in far outlying islands and on the mainland. Will any of your readers be so kind as to inform me whether such experiments have already been tried? And, secondly, what class of seeds, or particular species, they have any reason to suppose would be eminently liable to be killed by sea-water?*

2. Have students work in teams to design and conduct a controlled experiment that tests the effect of saltwater immersion on seed germination. Some factors that teams should consider are types of seeds; number of days seeds will be immersed; a control group of seeds; planting and growing of seeds/watering; water temperature; and so forth.

3. After waiting for the required germination time, have teams analyze their data and draw conclusions, create a visual display explaining their experiment, and present their experimental research to the class. Have students compare data and interpret any differences by considering the following:
- Which plant species survived saltwater immersion the best? Did the length of time immersed affect seeds? If so, how? If you used different varieties of the same species, did all seeds respond the same?
- Does the class data help explain the colonization of islands by plant species? Why or why not?
- Is there any evidence that refutes the hypothesis that seeds are carried by ocean currents to islands?
- What other ways might seeds be dispersed to islands besides being carried by ocean currents? How might you test those hypotheses?

4. Finally, give students a copy of "Does Sea-Water Kill Seeds?" and have them compare their results with Darwin's. Ask them to identify and discuss other questions Darwin raises in his article.

See Assessment Rubric on p. 34.