

HISTORICAL PERSPECTIVES

EXPLAINING EVOLUTION (10H)

The dramatic effect of Darwin's *On the Origin of Species* on biology can be traced to several factors: The argument Darwin presented was sweeping, yet clear and understandable; his line of argument was supported with a wealth of biological and fossil evidence; his comparison of natural selection to the "artificial selection" used in animal breeding was persuasive; and the argument provided a unifying framework for guiding future research.

There are some people who reject the concept of evolution—not on scientific grounds but on the basis of what they take to be its unacceptable implications: that human beings and other species have common ancestors and are therefore related; that humans and other organisms might have resulted from a process that lacks direction and purpose; and that human beings, like other animals, are engaged in a struggle for survival and reproduction. And for some people, the concept of evolution violates the biblical account of the special (and separate) creation of humans and all other species.

The study of this history provides a good opportunity to emphasize the importance in science of careful observation and description and to illustrate that not all scientific advances depend on experimentation. The history of this episode should also take note of people's acceptance and rejection of ideas about evolution, in the past and in the present.

The map is organized around four strands—*scientific ideas about evolution*, *development and acceptance of scientific ideas about evolution*, *determining the age of the earth*, and *nature of science*. Two benchmarks in the elementary- and middle-school grades provide a foundation for understanding natural selection. But because of the complexity of the scientific evidence and arguments that must be examined, a thorough understanding of species evolution probably cannot be achieved earlier than high school.

Maps on **BIOLOGICAL EVOLUTION** and **NATURAL SELECTION** in *Atlas 1* are extremely relevant to this map. Other closely linked maps are in Chapter 1: THE NATURE OF SCIENCE in *Atlas 1* and in this volume.

NOTES

The *scientific ideas about evolution* strand presents just a few of the ideas needed to understand the basic mechanisms that underpin modern theory on evolution. More complete presentations of the learning progressions involving these ideas can be found on the **DIVERSITY OF LIFE** map in this volume and on the **NATURAL SELECTION** and **BIOLOGICAL EVOLUTION** maps in *Atlas 1*. The 3-5 benchmark "There are millions of different species..." is a new statement based on text from *Science for All Americans*, and the 6-8 benchmark "Most species that have lived..." is a new statement based on *National Science Education Standards*. Together, the two statements describe important prerequisite ideas that contribute to an understanding of the processes of natural selection and how Darwin discovered them.

In the *development and acceptance of scientific ideas about evolution* strand, the benchmarks have been revised to improve their clarity and accuracy.

Ideas in the *determining the age of the earth* strand are important because they explain how Darwin's arguments depended on the notion that the earth was much older than was commonly believed and that the types of processes that occurred in the past are the same as those that take place today.

Several of the benchmarks in the *nature of science* strand can also be found on **THE COPERNICAN REVOLUTION** map. Both maps focus on discoveries made through the study of phenomena as they occurred in nature rather than during controlled experiments in the laboratory. The ideas of Copernicus and Darwin challenged people's fundamental understanding of how the world works. Nevertheless, the scientific community readily accepted the new ideas because of their explanatory and predictive powers.

TIMELINE

1700

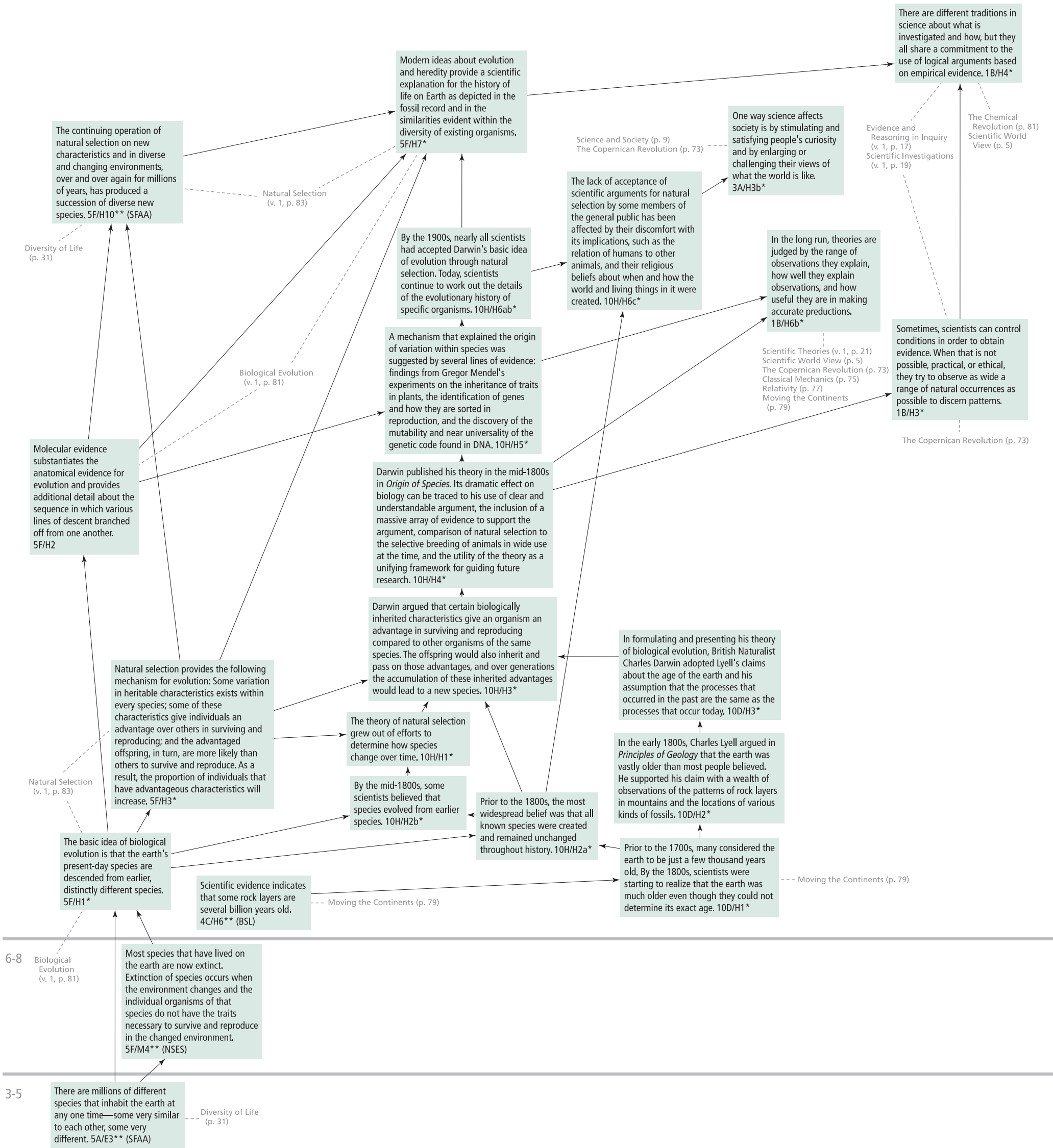
- 1744 Georges Buffon states that the earth is at least 75,000 years old.
- 1745 Pierre Maupertius proposes the idea of common descent.
- 1755 Buffon suggests that species are shaped by their environment and that these changes are heritable.

1800

- 1809 Jean Lamarck is the first important proponent of evolution, though his theory suggests that characteristics acquired during an individual's lifetime can be passed on.
- 1833 Charles Lyell publishes the third, and final, volume of *Principles of Geology*.
- 1835 Charles Darwin completes his four-year voyage on the HMS Beagle.
- 1859 Darwin publishes *On the Origin of Species by Means of Natural Selection*.
- 1866 Gregor Mendel interprets heredity in terms of discrete particles.
- 1871 Darwin publishes *The Descent of Man*, suggesting that the evolution of humans and animals differs only in degree, not in kind.
- 1883 August Weismann refutes Lamarck's theory that acquired characteristics can be inherited, arguing instead that information flows from sex cells to body cells, not the reverse.

1900

- 1900 The significance of Mendel's work is recognized in three independent accounts.
- 1902 William Bateson demonstrates that Mendel's principles, derived from studying plants, also apply to animals.
- 1904 Thomas Nuttall infers, based on similarities in their proteins, that humans are more closely related to old-world than to new-world primates, which corresponds to Darwin's conclusions based on structural similarities.
- 1944 Oswald Avery, Colin MacLeod, Maclyn McCarty, and Frederick Griffith establish that DNA is the genetic material responsible for heredity.
- 1953 James Watson and Francis Crick work out the structure of the DNA double helix and show how a molecule could carry functional genetic information.



scientific ideas about evolution

development and acceptance of scientific ideas about evolution

determining the age of the earth

nature of science