Early Ideas About Evolution 11.3

Eighteenth-century scientists were starting to understand pieces of the evolution puzzle by drawing on early physical evidence from the fossil record. Geology offered the foundation for new and tentative, but scientific, hypotheses of the age of Earth and the origins of life. In 1795, Scottish geologist James Hutton proposed a theory he called **actualism** to contrast with Cuvier's catastrophism. Hutton explained the geological formation of landforms as the result of slow processes, such as erosion, that were ongoing and observable in his day (**Figure 1**). Building on Hutton's ideas, Sir Charles Lyell revolutionized geology with his principles of **uniformitarianism**. In his now-famous *Principles of Geology*, published in 1830, Lyell made the following arguments:

- Earth has been changed by the same processes in the past as can be observed occurring in the present.
- Geological change is slow and gradual rather than sudden and catastrophic.
- Natural laws and processes are constant and eternal, and they operated with the same kind of intensity in the past as they do in the present.

Lyell had based his theories on extensive examination of fossil deposits and such processes as erosion and sedimentation. He championed the need for direct and systematic observation of nature. While travelling through North America in 1841, he estimated the age of Niagara Falls at 35 000 years. In a later trip, he discovered important fossils at Joggins, Nova Scotia.

The work of Hutton and Lyell led to two significant conclusions: that Earth must be unimaginably ancient and that dramatic change could result over such extremes of time through slow, seemingly slight processes. These conclusions provided the foundation on which other scientists could build theories about the history of life forms on Earth.

During the second half of the 18th century, scholarly interest in observable changes to species intensified. A leading naturalist, Georges Buffon, proposed that species could change over time and that these changes could lead to new organisms. Carl Linnaeus, the founder of biological nomenclature, and Erasmus Darwin, a well-respected physician and poet who was the grandfather of Charles Darwin, both proposed views similar to those of Buffon. Linnaeus proposed that a relatively few species had formed many new species through hybridization and interbreeding. Erasmus Darwin wrote the first detailed treatise on evolution, in which he asserted strong evidence for the idea that all life had developed from a single source. Along with others, he believed that humans may be closely related to primates. But scientists of this time could offer no mechanisms to explain how evolution might occur.

Adaptation and Inheritance

A student of Buffon made significant contributions to the 19th-century debate on evolution. Jean Baptiste Pierre Antoine de Monet, Chevalier de Lamarck was the first prominent biologist to recognize the key role played by the environment in evolution. Lamarck reasoned that for species to survive over long periods of time, they must be able to adapt to changing environmental conditions. Unlike Buffon and his contemporaries, Lamarck did not believe that a single species could give rise to additional species; instead, he argued that each species gradually became more complex and that new very simple species were continually being created by **spontaneous generation**. Lamarck believed in the evolutionary change and improvement of individual species.

actualism the theory that the same geological processes occurring in the present also occurred in the past

uniformitarianism the theory that Earth's surface has always changed and continues to change through similar, uniform, and very gradual processes

spontaneous generation the idea that living organisms arise from non-living matter

DID YOU KNOW?

Lyell in Nova Scotia

Nova Scotia became a famous place for fossils when, in 1851, Sir Charles Lyell and the principal of McGill University, Sir William Dawson, visited the Joggins cliffs. There, they found many fossils, including the remains of large plant trunks, some tiny bones, and shells. The Joggins fossils are 280 million years old and are among the earliest of all reptiles, land snails, and millipedes.

Figure 1
Close observation and study of changes to such landforms as the cliffs of Dover in England sparked the theoretical developments credited to James Hutton, Sir Charles Lyell, and others.

acquired traits those changes in an individual resulting from interaction with the environment

Building on others' ideas, he postulated the inheritance of **acquired traits**. By this hypothesis, changes acquired by an organism as a result of adaptation to environmental conditions during that organism's lifetime could be inherited by future generations. One generation of giraffes, for example, might have had to strive to obtain food higher in trees, so that, over their lifetime, continual stretching might have led to a slight elongation of the neck. For Lamarck, this slightly longer neck became an acquired trait to be inherited by offspring. Since then, it has been established that such acquired traits cannot be inherited. Ridiculed by contemporaries—including the influential Cuvier who rejected evolution outright—Lamarck deserves credit for his recognition of the role of the environment in driving evolutionary change. His attempt to formulate a mechanism for evolution smoothed the way for succeeding theories.

SUMMARY Early Ideas About Evolution

Table 1

Scientist	Contribution to development of theory of evolution
Sir Charles Lyell (1797–1875)	suggested Earth had undergone and continues to undergo slow, steady, and very gradual changes
Comte Georges Louis Leclerc de Buffon (1707–1788)	suggested that similar organisms may have a common ancestor
Erasmus Darwin (1731–1802)	proposed that all life may have a single source
Jean Baptiste Pierre Antoine de Monet, Chevalier de Lamarck (1744–1829)	was the first scientist to recognize that the environment plays a key role in the evolution of species. He further postulated the theory of inheritance of acquired traits

Section 11.3 Questions

Understanding Concepts

1. How did evidence about the age of Earth support thinking about the origin of life forms?
2. Give an example of the kind of evolutionary change that Buffon thought might occur.
3. Describe the theory of the inheritance of acquired traits, including an example.
4. Lamarck postulated the adaptation of species to a changing environment, spontaneous generation, and the inheritance of acquired traits. How did his thinking contrast with that of his contemporary Cuvier?
5. In your notebook, make a list of inherited and acquired traits.
   (a) Write examples of your own traits (physical or mental).
   (b) Which, if any, of your inherited traits could be altered during your life? How?
   (c) Which, if any, of your acquired traits can be passed on to your offspring? How?

Applying Inquiry Skills

6. Lyell estimated that Niagara Falls was about 35 000 years old. Find out the current scientific estimate. How close was Lyell?
7. How might you investigate scientific evidence to support your response to question 5(c)?

Making Connections

8. Much scientific investigation and debate preceded Lyell's principles in support of an ancient history for Earth. Explain why the conceptual leap in support of a lengthy history for organisms—and especially for humanity—sparked even greater investigation and debate in 19th-century Europe.
9. Some medical conditions, such as viral infections, are acquired while others such as Huntington's disease are inherited. An acquired disease results from environmental factors, which can be monitored and, possibly, altered or eliminated. An inherited disease results in fundamental physiological changes within the body that require very different medical treatment. Research one of the following diseases using electronic and print sources. Determine whether it is acquired, inherited, or a combination.
   (a) breast cancer
   (b) diabetes
   (c) cystic fibrosis
   (d) multiple sclerosis
   (e) Duchenne's muscular dystrophy

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