

TEACHING EVOLUTION



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Position Summary. Evolution and the directly related concept of deep (geologic) time are essential parts of science curricula at all levels of education. The evolution of life on Earth stands as one of the central concepts of modern science that is accepted by the scientific community. Two centuries of research in geology, paleontology, and biology have produced an increasingly detailed, consistent, and robust picture of how life on Earth evolved. Creationism, whether presented as creation “science” or intelligent design, attempts to explain complicated phenomena of the natural world by invoking a supernatural creator or designer. Creationism cannot be tested using the scientific method and therefore has no place in a science curriculum.

This position statement (1) summarizes GSA’s views regarding the teaching of evolution; (2) defines evolution and discusses the physical and biological evidence for evolution; (3) describes the concepts of creation “science” and explains why they are not science; and (4) provides a communication tool for GSA members.

CONCLUSIONS AND RECOMMENDATIONS

- Evolution and the directly related concept of deep time must be included as part of science curricula from K–12 to all forms of higher education. The Next Generation Science Standards clearly set education goals for student learning regarding evolution and geologic time (<http://www.nextgenscience.org/>).
- Creationism must not be included in science curricula or taught alongside evolution in any science classroom.
- Science teachers must not advocate any religious interpretations of nature and should be nonjudgmental about the personal beliefs of students.
- GSA encourages use of this position statement in any dialogue about teaching evolution. GSA members may also want to refer to the GSA publication *The Nature of Science and the Scientific Method* (<https://www.geosociety.org/documents/gsa/geoteachers/NatureScience.pdf>).

RATIONALE

By the early 1800s, geologists understood that the fossil record showed changes in living organisms over time and used fossils and their relationships among rocks to establish the geologic time scale. In 1859, Charles Darwin’s *On the Origin of Species* described how all life on Earth is related through descent with modification and how natural selection operated on random variations in organisms to cause change over time—the process we now know as biological evolution. Although Darwin had no way of explaining how traits were transmitted from generation to generation, Gregor Mendel’s later discovery of genes paved the way for one of the most robust pillars of modern evolutionary understanding. Paleontologists have continued to uncover details of life’s history, and biologists have elucidated the genetic and molecular basis for evolution. Evolution is not a static idea; over time it has been expanded and strengthened by scientific observation, testing, and debate. New discoveries continued to sharpen our understanding of evolution, which is now established as a well-tested fact—life on Earth evolved and species share common ancestors, structures, and genes. The discovery of radioactivity in the twentieth century made it possible to measure the ages of rocks, allowing geologists to quantify Earth’s

age, estimate rates of many geologic processes (including uplift, erosion, sedimentation, etc.) and use the fossil record to understand the rate of evolutionary change.

Understanding Earth’s history and the evolution of life has implications for society. The geologic record reveals how life responded to past environmental change (by migrating, adapting, or becoming extinct), thereby providing insight into how life might respond to current environmental change. Many of the medical advances that save human lives and the agricultural breakthroughs that feed the world are based on our understanding of evolution. For example, short-term adaptations by viruses and bacteria in response to new pharmaceuticals demonstrate the fundamental processes responsible for the evolution of resistant strands.

From before the time of Darwin, some people objected to and challenged scientific findings that conflicted with traditional religious beliefs. Creationism, creation “science,” and intelligent design emerged from religious thought, and because they invoke supernatural phenomena, they cannot frame hypotheses that can be tested. Hence, all forms of creationism are not science. The immensity of geologic time and the evolutionary origin of species are concepts that pervade modern geology, biology, and other sciences that support human life and must therefore be treated as central themes in science courses. Without an adequate knowledge of geologic time and the evolutionary origin of species, students will not understand the processes that shape the natural environment and ecosystem in which they live. Without an understanding of and appreciation for rigorous scientific methods, students will not be prepared for higher education in the sciences, or to work in the many fields of science upon which our society depends for resources and technological innovation.

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ABOUT THE GEOLOGICAL SOCIETY OF AMERICA

The Geological Society of America, founded in 1888, is a scientific society with members from academia, government, and industry in more than 100 countries. Through its meetings, publications, and programs, GSA enhances the professional growth of its members and promotes the geosciences in the service of humankind. Headquartered in Boulder, Colorado, USA, GSA encourages cooperative research among earth, life, planetary, and social scientists, fosters public dialogue on geoscience issues, and supports all levels of earth science education. Inquiries about GSA or this position statement should be directed to GSA’s Director for Geoscience Policy, Kasey S. White, at +1-202-669-0466 or kwhite@geosociety.org.

OPPORTUNITIES FOR GSA AND ITS MEMBERS TO HELP IMPLEMENT RECOMMENDATIONS

To facilitate implementation of the goals of this position statement, The Geological Society of America recommends that when discussing the importance of teaching evolution and geologic time with school boards, legislative committees, and other groups likely to include individuals with strong fundamental religious convictions, it may be necessary to assert that literal interpretations of creation stories do not constitute science. Nonetheless, we must respect the differing viewpoints and interests of others.

Talking points when speaking with school boards, legislative committees, etc., could include:

- The separation of science and religion that we advocate does not mean that science and religion are incompatible. Many scientists who study evolution are religious. Several major religions accept the importance of science and the theory of evolution. Some religious scholars find evolution fertile ground for the development of theological and spiritual understanding.
- Scientists do not and cannot claim to prove or disprove the existence of God or other major tenets of religious traditions.
- The core concepts of evolution are firmly established, but our understanding of evolution is itself changing. As with any field of active scientific research, there will be debate about unresolved issues at the frontiers of evolutionary science. Our understanding of the relationships between the evolution of species and the ecological systems that sustain them is progressing. Instead of weakening the case for evolution, scientific debate on these topics reveals how science advances. As those controversies are resolved, the answers enrich our understanding of evolutionary processes.
- Some arguments used to support the notion of an intelligent design focus on issues that are not well understood and claim that some action by a creator is needed to explain gaps in our understanding of natural processes. Scientists find that it is generally wiser to admit that the gap exists and to work to understand how to fill it.
- Our present ability and that of future generations to cope with mounting environmental, agricultural, and human-health challenges will depend upon how effectively the scientific method can be mastered and how the vast body of scientific knowledge can be utilized. The science taught in our schools must be the best the scientific community can offer. Science must not be confused with religious claims, no matter how well intended the latter may be.