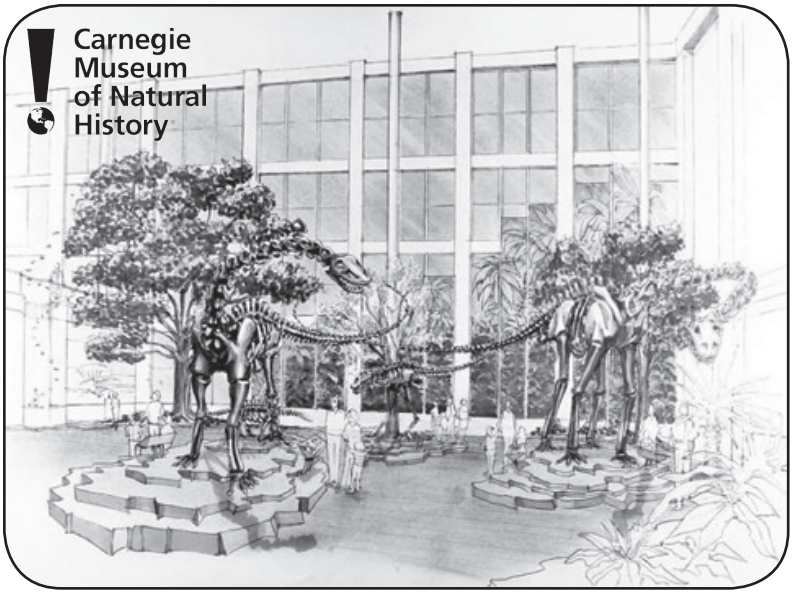


The Evolution of Life

A 1½-hour tour for Grades 7–12
Teachers' Guide

Carnegie Museum of Natural History
Division of Education

www.CarnegieMNH.org/doe

Concepts

The Earth and our solar system are approximately 4.6 billion years old.

The earliest evidence of life on Earth appears in the fossil record over 3 billion years ago.

Evolution is the change over time in populations as they adjust to changing conditions. These changing conditions may include the appearance or disappearance of a predator, new or reduced food sources, physical isolation, or change of climate.

Natural selection means that the individuals who are fitter (who survive longer and who produce more offspring) possess characteristics that appear more in succeeding generations. Eventually, the population changes so much that one species has evolved into another.

Fossils are our record of the changes in life over time. They cannot tell us the entire picture of past life, but we can make inferences from our knowledge of life on Earth today to interpret the fossil record.

State Standards

Science and Technology

3.3.7 Describe the role that fossils play in studying the past.
Identify adaptations that enable organisms to live in a particular environment.
Understand that differences in individuals can give a survival advantage.
Describe how environmental change can affect survival.

3.3.10 Explain the mechanisms of evolution.

3.3.12 Analyze evolution.

3.5.7 Identify living plants and animals that are similar to fossil forms.

3.5.10 Evaluate specific adaptations plants and animals have made that enable them to survive in different climates.

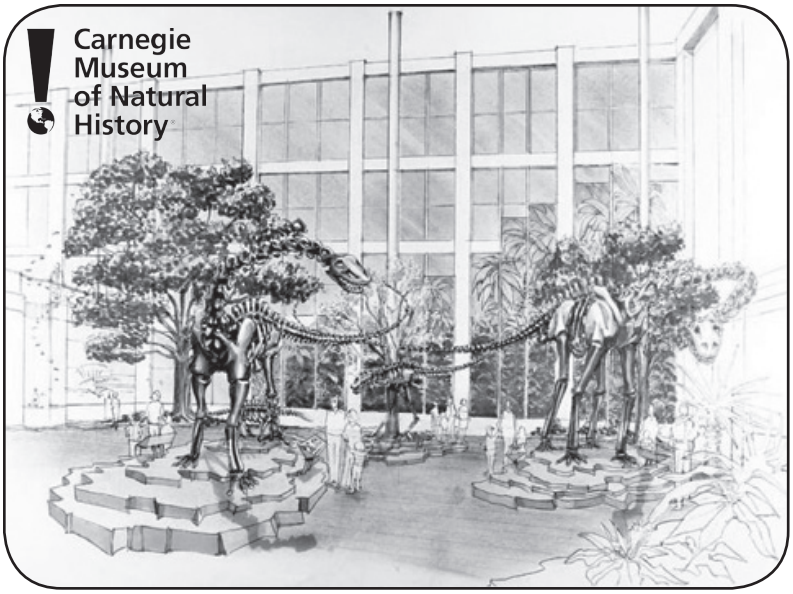
3.5.12 Interpret geological evidence supporting evolution.

Environment and Ecology

4.7.7 Explain how an adaptation is an inherited structure or behavior that develops over time. (An adaptation helps an organism survive and reproduce.)
Explain how one species may survive an environmental change while another may not.

4.7.10 Explain how structure, function, and behavior of plants and animals affect their ability to survive.

4.7.12 Examine the effects of extinction on the environment.



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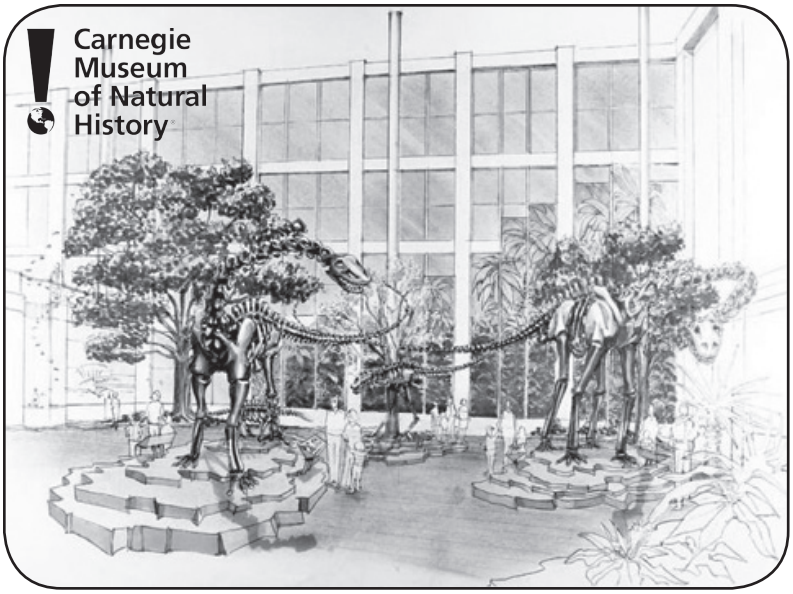
Vocabulary

- **Amniote**: an animal whose egg possesses a membrane sac that protects the embryo.
- **Amphibian**: a vertebrate that usually has an aquatic larval stage and later develops lungs that enable it to breath on land.
- **Artifact**: an object made or modified by a human being.
- **Avian**: bird.
- **Cartilage**: connective tissue made of collagen; it is rarely preserved in fossils.
- **Carnivore**: an animal that eats meat. A carnivore may be a predator and/or a scavenger.
- **Cenozoic Era**: the time period since 65 million years ago, including today. It is commonly called the Age of Mammals.
- **Dinosaur**: a reptile with particular skeletal features that define the group. Birds are now considered to be a group within the dinosaurs. Because of the birds, we cannot say that dinosaurs are extinct. We can say that non-avian dinosaurs are extinct. All non-avian dinosaurs lived on land, 225–65 million years ago.
- **Evolution**: change over time of the inherited traits of a population.
- **Extinct**: no longer existing on Earth.
- **Fossil**: any trace of life, not produced by a human, from more than 10,000 years ago.
- **Herbivore**: an animal that eats plants.
- **Invertebrate**: an animal without a backbone.
- **Mammal**: a type of animal that produces mother's milk and has fur.
- **Mass Extinction**: an extinction event that is spread throughout the world.
- **Mesozoic Era**: the time period between 248 and 65 million years ago. This era is split into the Triassic, Jurassic, and Cretaceous Periods. The Mesozoic is commonly called the Age of Reptiles.
- **Mutation**: the process producing a change in the genetic makeup of an organism.
- **Natural Selection**: a process in nature where one set of individuals produce more offspring than another set.
- **Paleontologist**: a scientist that studies fossils.
- **Paleozoic Era**: the time period between 543 and 248 million years ago.
- **Reptile**: a type of animal that lays eggs on land, but does not produce milk or have fur.
- **Vertebrate**: an animal with a backbone (vertebral column).



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Suggested Reading

Barrett, Paul. *National Geographic Dinosaurs*. Washington, DC: National Geographic Society, 2001. Illustrated by Raul Martin.

DeSalle, Rob. *The Science of Jurassic Park and the Lost World, or, How to Build a Dinosaur*. New York: Basic Books, 1997.

Fastovsky, David E., and David B. Weishampel. *The Evolution and Extinction of the Dinosaurs*. Cambridge, New York: Cambridge UP, 1996.

Fiffer, Steve. *Tyrannosaurus Sue: The Extraordinary Saga of the Largest, Most Fought Over T. Rex Ever Found*. New York: W. H. Freeman, 2000.

Holtz, Thomas R., Jr., and Michael Brett-Surman. *Jurassic Park Institute Dinosaur Field Guide*. New York: Random House, 2001.

Norell, Mark, Eugene S. Gaffney, and Lowell Dingus. *Discovering Dinosaurs in the American Museum of Natural History*. New York: Knopf, 1995.

Novacek, Michael J. *Time Traveler: In Search of Dinosaurs and Ancient Mammals from Montana to Mongolia*. New York: Farrar, Straus, and Giroux, 2002.

Ottavianni, Jim. *Bone Sharps, Cowboys, and Thunder Lizards: A Tale of Edwin Drinker Cope, Othniel Charles Marsh, and the Gilded Age of Paleontology*. Ann Arbor, MI: GT Labs, 2005. *(Well-researched and historically accurate graphic novel.)*

Rea, Tom. *Bone Wars: The Excavation and Celebrity of Andrew Carnegie's Dinosaur*. Pittsburgh: University of Pittsburgh Press, 2001.

Richardson, Hazel. *Smithsonian Handbook of Dinosaurs and Prehistoric Life*. New York: Dorling Kindersley, 2003.

Scothchmoor, Judith et al. *Dinosaurs: The Science Behind the Stories*. Alexandria, VA: American Geological Institute, 2002.

Scott, Eugenie. *Evolution vs. Creationism: An Introduction*. Berkeley: University of California Press, 2005.

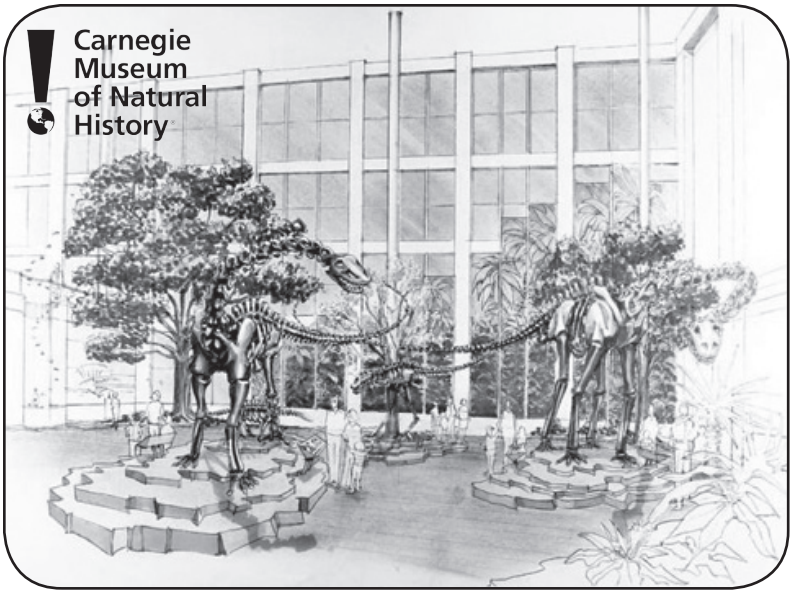
Online Resources

Discovery Education Lesson Plan for grades 9–12
school.discovery.com/lessonplans/programs/greatbooks-originofspecies

National Academy of Sciences / Online book / *Science and Creationism*
books.nap.edu/html/creationism

National Center for Science Education / Evolution in Schools
www.natcenscied.org

PBS Evolution Teachers and Students resources
www.pbs.org/wgbh/evolution/educators



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Online library of evolution resources
www.pbs.org/wgbh/evolution/library/08
Strange Science / Evolution
www.strangescience.net/evolution.htm
Mistakes made in interpreting fossil evidence
www.strangescience.net/goof.htm
University of California Museum of Paleontology / Berkeley / Dinosaur Pages
www.ucmp.berkeley.edu/diapsids/dinosaur.html
Teacher resources
www.ucmp.berkeley.edu/education/teachers.php

Museum Resources

Educational Loan Collection

Teachers at registered schools may borrow material for two weeks for a fee of $50. The entire faculty at a school may borrow indefinitely for the school year when the school pays a fee, based on the size of the school, from $150–200. For more information or to reserve a loan, call (412) 622-3292.

These thematic kits are available to supplement this tour:
Dinosaurs
Fossils

Online Exhibits

Carnegie Museum of Natural History's Web site is a great source of educational content. Visit our online exhibits page for a complete list of all educational online content:
www.CarnegieMNH.org/exhibits

These online exhibits compliment this tour:
Paleolab
www.CarnegieMNH.org/ditw/paleolab.htm
Carnegie's Dinosaurs
www.CarnegieMNH.org/carnegiesdinosaurs
This is Your Life, Diplodocus carnegii
www.CarnegieMNH.org/carnegiesdinosaurs/dippy