

---

**Topic:** Principles of Evolution

**Reading:** Chapter 14

---

**Main concepts:**

- Evolution is, by modern definition, changes in inheritable traits of a population (and therefore changes in the gene ratios of a population) over many generations.
- Evolution in the modern sense of organic change has been discussed since the 18th century. Buffon proposed early ideas that made logical sense in Newtonian thinking but had little supporting evidence. Cuvier, an anatomist, thought that change wasn't possible because organisms were perfectly adapted and changes would be fatal. Lamarck first used the word "evolution" to describe organic change, proposed a system in which organisms strove to climb an evolutionary ladder, and change occurred by the inheritance of acquired characteristics. Darwin and Wallace independently developed the Theory of Natural Selection, the first plausible mechanism that could cause organic change, and the first supported by data. Of these ideas, the Darwin-Wallace mechanism of natural selection has held up to rigorous testing by modern science. Modern genetics explains how natural selection works. Other mechanisms of change, based on genetic research, have also been described, such as genetic drift and genetic bottlenecks.
- The fossil record demonstrates that changes occur over time: organisms live today that did not live in the past, and there are organisms in the past that do not live today.
- Comparative anatomy and comparison of embryos were used in the past as scientists tried to trace the paths of common descent. If organisms share a set of characteristics, they probably share a similar set of genes. Biochemical and genetic analysis adds new information that helps scientists understand how organisms are related to one another.
- Natural selection appears to be the strongest mechanism of change. Natural selection works like this:
  - In all populations, individuals vary from one another. The source of inheritable variation is small mutations (favorable, unfavorable, or neutral) that appear in the population spontaneously over time.
  - Most traits are controlled by genes, which are inheritable.
  - Some traits or combinations of traits have more survival value than others.
  - Those individuals with more favorable traits or combinations of traits are the most likely to survive (though their survival is never guaranteed).
  - Among those survivors, some have a better chance at reproduction, because reproductive success is not random.
  - Survivors that are able to reproduce may pass their favorable traits on to their offspring.
- Humans can use selective breeding to bring about changes in organisms in a very short time. This demonstrates that organisms can change. Natural selection is not as rapid as artificial selection, but it has been observed and measured in the natural world. Scientists hypothesize that over time, selection and other microevolutionary processes lead to speciation.

**Common misconceptions:**

- The misconceptions about evolution and natural selection are legion. Here are a few of the common ones:
    - "Evolution is a theory about the origin of life." Evolution describes what happens to organisms over time. Other theories describe how life might have first arisen.
    - "Evolution is a climb up the ladder of life. Organisms are always getting better/more complex." Natural selection may weed out the "least fit," but organisms don't have to be perfect or complex to survive.
    - "Bacteria are simple because they stopped evolving." Bacteria evolve quite rapidly. Antibiotic resistance is an example of selection in bacteria. Organisms do not strive to climb an "evolutionary ladder."
    - "Evolution means that organisms change totally at random." Chance is one factor in change over time, but selection, by definition, is not random.
    - "Natural selection means that organisms are trying or learning to adapt." Selection may allow organisms with favorable adaptations to survive, but organisms do not "try" or "learn" to develop new traits.
    - "Natural selection gives organisms what they need to survive." Nature is not that benevolent. Organisms that are adapted to an environment are likely to survive. Those that are not are likely to go extinct. A trait does not appear just because an organism "needs" it.
-

- “People are getting taller because they are evolving.” Our tallness genes have changed little in tens of thousands of years. What has changed is nutrition in Western civilization. Good nutrition allows people to grow to the full extent that their genes code for. There is no strong selective factor that allows only tall people to survive and reproduce.
- “Because of evolution, our little toes are getting smaller and smaller.” Unless little toes are a hazard, they will not be selected against. Wisdom teeth, on the other hand, can be hazardous in cultures where there is no modern medical care available to remove infected wisdom teeth and treat the infection.
- “Evolution is just a theory.” A theory is an evidence-supported explanation for a natural phenomenon. In science, the word “theory” is not used to mean “guess.”
- “Evolution has never been proven.” The evidence that genetic change happens to populations over time is overwhelming. Details of the mechanisms of change, especially at the molecular level, are still being discovered.
- “Scientists can’t prove evolution because they haven’t found the missing link.” The idea of a “missing link” is a misnomer. Fossilization is a rare process, and our understanding of fossilization actually predicts gaps in the fossil record. Fossils aren’t the only evidence used in tracing connections between groups of organisms.
- “Evolution is not science because it is not observable or testable.” For over a century, scientists have been observing and testing genetic change in organisms.
- “Evolution is a religion.” Religions are faith-based ways of understanding the world. Science is an evidence-based way of understanding the world. What we understand about evolution comes from evidence from the natural world, not faith or belief.

## Reading notes:

- Summarize some of the early ideas about fossils.
- Describe the differences between Catastrophism and Uniformitarianism.
- Describe early evolutionary ideas proposed by Buffon and Lamarck.
- Summarize the Darwin-Wallace Theory of Natural Selection.
- Define “homologous structures” and give some examples.
- Define “analogous structures” and give some examples.
- Define “vestigial structures” and give some examples.
- Define “convergent evolution” and describe how it differs from divergence.
- Describe how molecular studies contribute to today’s understanding about relationships between groups of organisms.
- Describe examples of natural selection from the natural world (several examples are in the book).
- Describe why variation is important in the process of natural selection.
- Explain why these statements are misconceptions about evolution:
  - “Nature gave the porcupine quills because it needed them for protection.”
  - “The Arctic Hare evolves when it gets white fur in the winter.”
  - “Thousands of years from now, human brains will be larger.”
  - “We hardly use our little fingers, so they’ll eventually disappear.”
  - “If a population of ducks is left in the middle of the Sahara, they’ll slowly evolve to become desert animals.”

## Useful websites:

- “[Understanding Evolution](http://evolution.berkeley.edu/evolibrary/home.php)” (<http://evolution.berkeley.edu/evolibrary/home.php>) is a huge site that is full of information about evolution and the mechanisms of evolutionary change. Click on “Attention Teachers!” for a terrific feature on the history of evolutionary theory.
-