

Standards and Research-Based Study of a Curricular Topic  
**NATURAL AND ARTIFICIAL SELECTION**

Section and Outcome	Selected Sources and Readings for Study and Reflection Read and examine <u>related parts</u> of:
<b>I. Identify Adult Content Knowledge</b>	<p><b>IA: <i>Science for All Americans</i></b></p> <ul style="list-style-type: none"> <li data-bbox="402 457 1474 751">▶ <i>Heredity</i>, p. 61-62. Parents pass on instructions for development in the form of segments of DNA called genes. In asexual reproduction offspring are genetically identical to the parent, while in sexual reproduction each parent contributes half of the genetic information to the offspring. Variation arises because of combinations of genes during sexual reproduction and because of mutation, which can occur spontaneously or be induced by chemicals. If mutations are present in sex cells, they may be passed to offspring. Characteristics produced by this variation may be harmful, advantageous, or neutral.</li> <li data-bbox="402 789 1474 1285">▶ <i>Evolution of Life</i>, p. 67-69. Evolution is the theory that all life has evolved from common ancestors. It explains the number of different life forms that exist, the similarities in anatomy and biochemistry between those life forms, and the fossil record. Life originated when simple molecules formed more complex molecules that became capable of self-replicating. For billions of years, life existed only as simple microorganisms until the development of multicellular organisms lead to increased rate of evolution. The central concept of evolution is natural selection which is based on three observations: (1) there is heritable variation within species, (2) some of these characteristics give individuals advantages in surviving and reproducing, and (3) those individuals are likely to produce more offspring, which will also be more likely to survive and reproduce than others. Over time, these advantageous characteristics will increase in the population. New characteristics can result from new combinations of genes or mutations. When an environment changes, the benefit of a characteristic may change, so natural selection does not always progress in one direction for a long term.</li> <li data-bbox="402 1323 1474 1558">▶ <i>Agriculture</i>, p.108-109. After thousands of years hunting and gathering, humans found a way to manipulate plants and animals to provide better food supply. People learned to control breeding by choosing which animals and plants could reproduce, and then with the development of modern genetics scientists learned how to increase variation and to directly modify genes. Pesticides were developed to increase crop yields, but they present dangers to the ecosystems in which they are used.</li> <li data-bbox="402 1591 1474 1885">▶ <i>Explaining the Diversity of Life</i>, p.157-159. Prior to Darwin's theory of evolution, people explained the diversity of life with the theory of creationism. Some ideas were proposed that organisms changed during their lifetime and passed these changes to their offspring. Darwin theorized that inherited variations among individuals increased the reproductive fitness of some individuals who had more offspring and that those offspring would too inherit those advantages. By this mechanism, these traits would become more prominent over successive generations within the population, which is known as evolution. Under certain circumstances, these traits could give rise to new species. Darwin's theory</li> </ul>

	<p>revolutionized scientific thought because it was broad, yet clear and understandable and thoroughly supported by evidence from the natural world. Though evolution is widely accepted in the scientific community, some people still reject the theory of evolution because of its implication about human evolution.</p> <p><b>IB: Science Matters</b></p> <ul style="list-style-type: none"> <li>▶ <i>Natural Selection</i>, p.248-250. In <i>On the Origin of Species</i> Darwin proposed three major conclusions of his studies: (1) every species exhibits variation, (2) many traits are passed down to offspring, and (3) the variation of these traits affect survival and reproduction and individuals with more advantageous traits will have more offspring and pass these traits to many of those offspring. This is the process of natural selection, the means by which a trait becomes widely spread in a population. Darwin's phrase "survival of the fittest" has been misused at times to rationalize political or economic actions.</li> </ul>
<p><b>II. Consider Instructional Implications</b></p>	<p><b>IIA: Benchmarks for Science Literacy</b></p> <ul style="list-style-type: none"> <li>▶ 5B, <i>Heredity 6-8</i>, 9-12 grade span essay, p.108. In middle grades, students can begin the study of genetic traits through the context of reproduction and selective breeding. In grades 9-12, students' understanding of DNA makes it possible for them to understand heredity, evolution and genetic engineering.</li> <li>▶ 5F, <i>Evolution of Life</i> general essay, p.122, grade span essay, p.123-124. Students may have difficulty understanding the broad applicability of biological explanation and may feel that it contradicts their beliefs. Students should first be familiar with evidence of evolution such as the fossil record and relatedness of species and then be offered natural selection as a mechanism of evolution. In elementary grades, students learn that organisms are diverse and adapted to their environment. In middle grades, students can be introduced to evidence for evolution and in high school students can begin to study the mechanism of evolution and understand change in populations.</li> <li>▶ 8A, <i>Agriculture</i> general essay p.183, 9-12 grade span essay, p.186. Students must be introduced to ideas about where food comes from and what is required to grow it, leading to more complex ideas such as selecting desirable features. In grades 9-12, students understanding of agricultural technology can draw on their understanding of underlying science like ecosystem interactions and inheritance of traits.</li> <li>▶ 10H, <i>Explaining the Diversity of Life</i> general essay, p. 254, grade span essay, p.254. Students can explore the history of scientific discovery by understanding that Darwin's ideas came from observations and not strict scientific experimentation. The history can be brought up to current times with the controversy of evolution with the general public.</li> </ul> <p><b>IIB: National Science Education Standards</b></p> <ul style="list-style-type: none"> <li>▶ Grades 9-12, Standard C essay, p.181, 184. In grades K-8, students should have developed a foundational understanding of life sciences, but in grades 9-12 students understanding of biology will expand to incorporate more abstract</li> </ul>

	<p>knowledge like DNA and complex theories like evolution. It is important that information is not overemphasized at the expense of students developing conceptual understandings. Students have many misconceptions about natural selection, such as believing that it is based on need. These misconceptions need to be directly addressed for students to move forward with correct understanding.</p>
<p><b>III. Identify Concepts and Specific Ideas</b></p>	<p><b>IIIA: <i>Benchmarks for Science Literacy</i></b></p> <ul style="list-style-type: none"> <li>▶ 5B, <i>Heredity</i>, p.108-109. In asexual reproduction offspring is genetically identical to <i>the</i> parent, whereas in sexual reproduction half of offspring's genes come from each parent. Specialized sex cells merge to form one cell that grows and divides into a mature organism. Gene combinations may be advantageous, deleterious, or neutral. Sorting and recombination of genes provides endless variation. DNA carries the code of life with segments called genes. Mutations, which can be spontaneous or caused by chemicals or radiation, can alter genes. Each cell is influenced not only by its genes but also by its environment and history.</li> <li>▶ 5F, <i>Evolution of Life</i>, p. 123-125. Organisms are adapted to their environments. Variations among individuals of the same species may give them advantages for survival and reproduction. The fossil record shows organisms that are both extinct and still in existence. Changes in the environment can affect the survival of individuals and species. Natural selection explains that variation among traits of individuals in a population leads to reproductive advantages for some who pass those traits on to a greater number of offspring, who do the same, gradually increasing that trait in the population. Heritable characteristics can vary from molecular to anatomical to behavioral. Life on Earth is thought to have begun as a one-celled organism about 4 billion years ago.</li> <li>▶ 8A, <i>Agriculture</i>, p.184-186. Plants need warmth, light, water, and protection from pests to grow. The crops that can grow in an area depend on climate and soil. Pesticides are used to produce better yields, but may be harmful. People control the characteristics of plants and animals by selective breeding. New varieties of farm plants and animals have been genetically engineered.</li> <li>▶ 10H, <i>Explaining the Diversity of Life</i>, p.254-255. Natural selection provides an answer for the problem of explaining similarities within the diversity of existing organisms and the fossil record. Before Darwin, most people believed in creationism or in inheritance of acquired traits. Darwin proposed natural selection in <i>Origin of Species</i>, which made a clear and understandable argument with evidence to support it. This theory was further supported with Mendel's discovery of genes.</li> </ul> <p><b>IIIB: <i>National Science Education Standards</i></b></p> <ul style="list-style-type: none"> <li>▶ Grades 9-12, Standard C, <i>Biological Evolution</i>, p.185. Species evolve over time via the mechanism of natural selection. Life began about 3.5 billion years ago and evolution has produced a great diversity of organisms, all descended from a common ancestor. Natural selection explains the fossil record as well as the molecular similarities observed among diverse life forms. Organisms are</li> </ul>

	classified based on evolutionary relationships.
<b>IV. Examine Research on Student Learning</b>	<p><b>IVA: <i>Benchmarks for Science Literacy</i></b></p> <ul style="list-style-type: none"> <li>▶ 5F, <i>Natural Selection</i>, p.343, <i>Adaptation</i>, p.344. Students have difficulty integrating two distinct processes in evolution: the occurrence of new traits in a population and their effect on long-term survival. Students may believe that changes in environment or the need of organisms caused new traits to arise, rather than the correct explanation that chance alone causes new traits to arise. Students have difficulty understanding that a changing population results from the survival of a few individuals that preferentially reproduce rather than the gradual change of all individuals. Students have difficulty because in everyday usage, people adapt deliberately, but in science adaptation occurs inadvertently over generations. Students often think of adaptation as purposeful and as a conscious process.</li> </ul> <p><b>IVB: <i>Making Sense of Secondary Science</i></b></p> <ul style="list-style-type: none"> <li>▶ Chapter 1, <i>The Concept of Species</i>, p.25, <i>Adaptation</i>, p.26, Chapter 5, <i>Adaptation</i>, p.52-53. Students show little understanding of the basis of the grouping of species. Students frequently see adaptations as occurring in response to a need. They also confuse an individual's adaptation over its lifetime with inherited change in a population over time and believe in inheritance of acquired characteristics.</li> </ul>
<b>V. Examine Coherency and Articulation</b>	<p><b>V: <i>Atlas of Science Literacy</i></b></p> <ul style="list-style-type: none"> <li>▶ <i>Biological Evolution</i>, p.80-81. DNA is universal and cells function similarly in all organisms. Thousands of layers of sedimentary rock provide evidence for the history of changing life forms. Molecular evidence substantiates anatomical evidence.</li> <li>▶ <i>Natural Selection</i>, p.82-83. Heritable characteristics influence how likely an organism is to survive and reproduce. Offspring of advantaged individuals will be more likely than others to survive and reproduce and through successive generations, the proportion of individuals with advantageous characteristics will increase. When an environment changes, the survival value of inherited characteristics may change. The continuing operation of natural selection over time has produced many diverse species.</li> </ul>
<b>VI. Clarify State Standards and District Curriculum</b>	<p><b>VIA: <i>State Standards-</i></b></p> <p>BIO.7 The student will investigate and understand how populations change through time. Key concepts include</p> <ul style="list-style-type: none"> <li>a) evidence found in fossil records;</li> <li>b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations;</li> <li>c) how natural selection leads to adaptations;</li> <li>d) emergence of new species; and</li> <li>e) scientific evidence and explanations for biological evolution.</li> </ul>

