Life Science Standard **LS3D**

Content Standard:

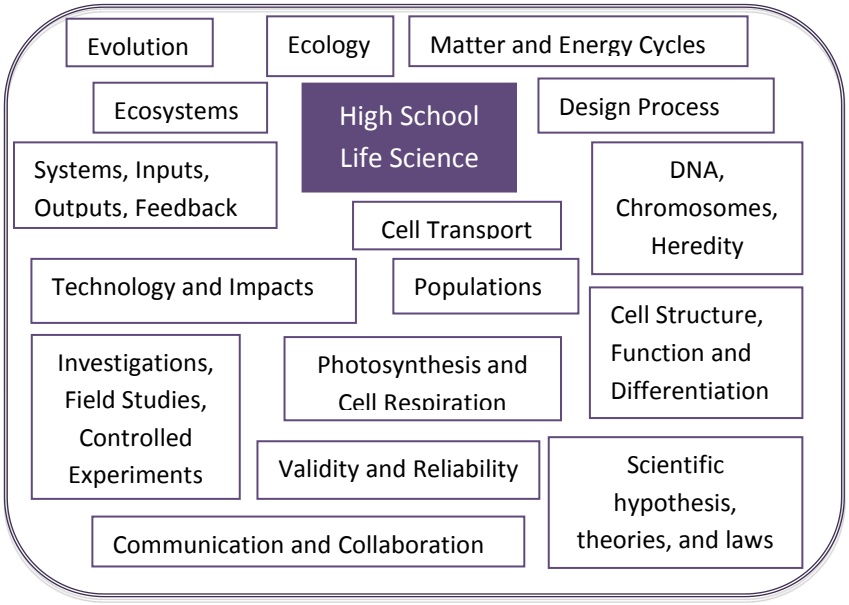
The ***fossil* record** and anatomical and molecular similarities observed among diverse *species* of living *organisms* provide *evidence* of biological *evolution*.

Performance Indicators:

Using the ***fossil* record** and anatomical and/or molecular (DNA) similarities as *evidence*, formulate a *logical argument* for biological *evolution* as an explanation for the development of a representative *species* (e.g., birds, horses, elephants, whales).

Item Specifications:

Explain how the fossil record, anatomical similarities, and/or molecular (DNA) similarities can be used as evidence for the evolutionary development of a given species (e.g., birds, horses, elephants, whales).



Reflective Questions for Students:

How do genes explain how organisms are related?

Why are scientists interested in understanding the relationships between different organisms?

Why *is biodiversity important to humans*?

Assessment Information

http://www.k12.wa.us/Science/Assessments.aspx

Quick Links for Students:

http://www.scientificamerican.com/article.cfm?id=alternative-evolution-dinosaurs-foresaw-contemporary-paleo

Paleobiology sites and related activities:

http://www.fossilmuseum.net/fossilrecord.htm

http://www.fossilmuseum.net/PaleobiologyVFM.htm

http://www.pbs.org/wgbh/nova/nature/amber-locations.html

Teacher Center
Elements of Effective Science Instruction

Disciplinary Core Ideas

Essential teaching components leading to the big ideas:

Student acquisition of the content of science involves opportunities to meet state crosscutting and domain standards and recognize how the big ideas fit within a large conceptual framework. Learning is best achieved through sequencing learning targets into learning progressions that inform the teacher's instructional decision making.

The K-12 Framework for Science Education states the following about the fossil record:

> Biological evolution, the process by which all living things have evolved over many generations from shared ancestors, explains both the unity and the diversity of species. The unity is illustrated by similarities found across all species; it can be explained from the inheritance of similar characteristics from similar ancestors. The diversity of species is also consistent with common ancestry; it is explained by the branching and diversification of lineages as populations adapted, primarily through natural selection, to local circumstances. Evidence for common ancestry can be found in the fossil record, from comparative anatomy, from comparative embryology, and from the similarities of cellular processes and structures and of DNA across all species. The understanding of evolutionary relationships has recently been greatly accelerated by molecular biology, especially as applied to developmental biology, with researchers investigating the genetic basis of some of the changes seen in the fossil record, as well as those that can be inferred to link living species (e.g., the armadillo) to their ancestors (e.g., glyptodonts, a kind of extinct gigantic armadillo). (Page 128).

The K-12 Framework for Science Education states the following what students should know about the fossil record:

> ***By the end of grade 8.*** Fossils are mineral replacements, preserved remains, or traces of organisms that lived in the past. Thousands of layers of sedimentary rock not only provide evidence of the history of Earth itself but also of changes in organisms whose fossil remains have been found in those layers. The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. Because of the conditions necessary for their preservation, not all types of organisms that existed in the past have left fossils that can be retrieved. Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy.
>
> ***By the end of grade 12.*** Genetic information, like the fossil record, also provides evidence of evolution. DNA sequences vary among species, but there are many overlaps and common features; the ongoing branching that produces multiple lines of descent can be inferred from the DNA composition of organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.

Supporting Websites:

- http://rpdp.net/sciencetips_v2/L12D3.htm is a site that provides the students with a summary of evolution and how the fossil record provides evidence of earlier life forms.
- http://www.ucmp.berkeley.edu/fosrec/Learning.html is a site that provides teacher activities.
- http://www.pbs.org/wgbh/nova/teachers/resources/subj_09_03.html

Extension(s):

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Cross Cutting Ideas:
Designing for Learning

Strategies to reveal student understanding:

- http://undsci.berkeley.edu/teaching/misconceptions.php This site has lots of resources for teachers, especially student misconceptions in general.
- http://rpdp.net/sciencetips_v2/L12D3.htm#misconcept. This site describes some common student misconceptions and evolution.
- http://www.doe.mass.edu/omste/ste/LifeScience.doc Scroll to page 38 to see the scientific ideas, skills and misconceptions associated with evolution and the fossil record.
  Paige Keeley's Formative Assessments available through NSTA.

Prerequisite knowledge required:

- Students should understand how genes can change or remain the same over time.
- The fossil record and DNA analysis provide evidence of evolution.

Student learning progressions can include:

- Classify organisms, using similarities and differences in physical and functional characteristics.
- Explain similarities and differences among closely related organisms in terms of biological evolution (e.g., "Darwin's finches" had different beaks due to food sources on the islands where they evolved).
- Biodiversity is the wide range of existing life forms that have adapted to the variety of conditions on Earth, from terrestrial to marine ecosystems recycling (K-12 Framework for Science Education, p. 129).
- Biodiversity includes genetic variation within a species, in addition to species variation in different habitats and ecosystem types recycling (K-12 Framework for Science Education, p. 129).

Scientifically oriented questions focused on clarifying and extending student understanding include:

- How does the fossil record reveal information and evidence of evolution?
- What can fossils tell us about diversity of organisms in the past and the future?

Activities supporting opportunities for students to make claims, use evidence and communicate reasonings include:

- **SYSTEMS (EALR 1):**
  - http://www.pbs.org/wgbh/evolution/darwin/origin/index.html This activity allows students to follow a species as it responds to changes in habitat over time.

- **APPLICATION (EALR 2):**
  - http://www.teachersdomain.org/resource/evol07.sci.life.evo.lptiktaalik/ This series of lessons with video and individual activities, focuses on change over time from fish to amphibian. It shows how scientists use a prediction to seek a transitional fossil.
  - http://www.pbs.org/teachers/connect/resources/7793/preview/ Bones of Contention is an interactive website that allows students to classify mystery fossils of hominids by comparing them to an actual data base of fossils.

- **INQUIRY (EALR 3):**
  - http://www.nhptv.org/natureworks/nwep1.htm, this site has information and a lab on adaptation of a species, specifically how birds' beaks are adapted to their food.

- **LIFE SCIENCE (EALR 4):**
  - http://sciencecases.lib.buffalo.edu/cs/collection/results.asp?search=&subject_headings=Evolutionary+Biology&educational_level=High+school&type_methods=&topical_areas=&x=36&y=10

○ Case studies of various cases involving evolutionary biology.

Cross Cutting Ideas: ***Sense Making***	**Cross Cutting Ideas:** ***Classroom Culture and Environment***
Planning time in the lessons to support time for students to make sense of what they are learning include: ● The following website offers a variety of activities that can help students understand evolution and the fossil record. http://rpdp.net/sciencetips_v2/L12D3.htm#intervention http://www.pbs.org/wgbh/nova/nature/amber-locations.html	**Activities that show how this content standard relates to students' everyday lives include:** ● http://www.pbs.org/wgbh/nova/teachers/activities/2408_trex.html This site provides an activity that allows students to consider reasons for participating in a fossil dig. The following site offers short essays for students to analyze. ● http://www.ucmp.berkeley.edu/fosrec/
Strategies to focus on student conversations, interactive notebook prompts, model-building include: There are many compare and contrast activities within this site that can be used to generate conversations and notebook prompts for students. http://www.ucmp.berkeley.edu/education/explorations/reslab/flight/main.htm	**Activities that show how scientists think and do science in relationship to this content standards include:** ● http://www.pbs.org/wgbh/nova/teachers/activities/2408_trex.html This site provides an activity that allows students to consider reasons for participating in a fossil dig.