

Life Science Standard LS3B

Content Standard:

Random changes in the *genetic* makeup of cells and *organisms* (*mutations*) can cause changes in their physical *characteristics* or behaviors. If the *genetic mutations* occur in eggs or sperm cells, the changes will be inherited by offspring. While many of these changes will be harmful, a small minority may allow the offspring to better survive and reproduce.

Performance Indicators:

Describe the molecular process by which organisms pass on physical and behavioral traits to offspring, as well as the environmental and genetic factors that cause minor differences (variations) in offspring or occasional “mistakes” in the copying of *genetic* material that can be inherited by future *generations* (*mutations*).

Explain how a *genetic mutation* may or may not allow a *species* to survive and reproduce in a given *environment*.

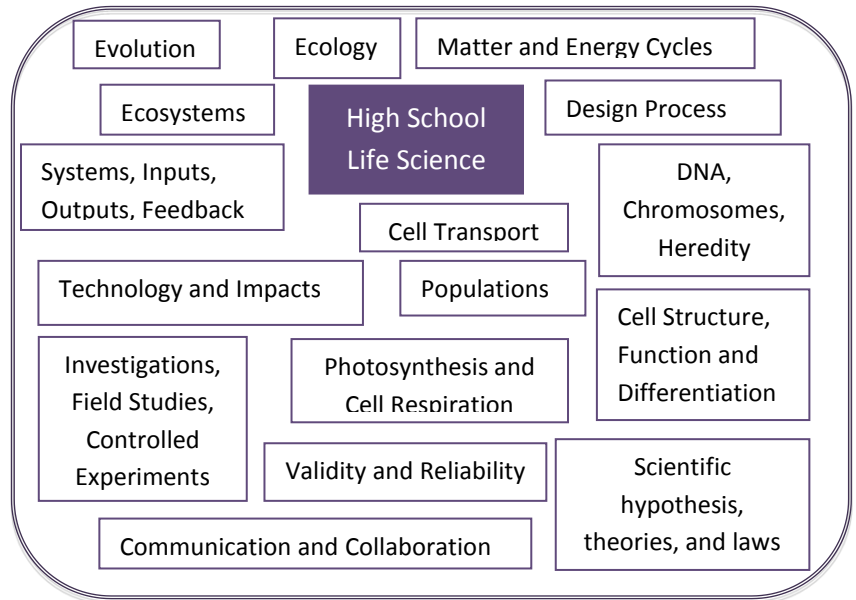
Item Specifications:

Describe mutations as random changes or occasional mistakes in the copying of genetic material that, when in egg or sperm cells, can be inherited by future generations.

Describe the molecular processes and/or environmental factors by which mutations can occur (e.g., insertion, deletion, substitution, or UV radiation in sunlight).

Describe that changes caused by mutations will often be harmful, but a small minority of mutations will cause changes that allow the offspring to survive longer and reproduce more.

Predict how a given trait or mutation will allow a species to survive and reproduce in a given environment.



Reflective Questions for Students:

How do mutations and environment drive evolution?

Why do some offspring survive and others do not in a changing ecosystem?

Assessment Information

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

Quick Links for Students:

Natural Selection Simulation

<http://phet.colorado.edu/en/simulation/natural-selection>

In this simulation you can control variables to perform simple inquiries. As you design your mini-experiments, record the variables that you are controlling and observe the results. Reset the simulation and vary the variable that you controlled. How does your population of rabbits change? What conclusions can you make and how would you further change the experiment?

Activity on variation

<http://learn.genetics.utah.edu/content/variation/sources/>

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.

Big Ideas of Random Change from A Framework for K – 12 Science Education (2011)

The information passed from parents to offspring is coded in the DNA molecules that form the chromosomes. In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can cause mutations in genes, and viable mutations are inherited. Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (Framework for K – 12 Science Education, 2011).

Natural selection is the result of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. Natural selection leads to adaptation that is to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. Adaptation also means that the distribution of traits in a population can change when conditions change.

Changes in the physical environment, whether naturally occurring or human-induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction— of some species. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or too drastic, the opportunity for the species' evolution is lost.

Additional supports and extensions for understanding how students grasp the concept:

- Structure of DNA
http://rpd.net/sciencetips_v2/L12D2.htm
- Mutations and evolution
http://rpd.net/sciencetips_v2/L12D5.htm

Supporting Websites:

- Basic Evolution content
<http://evolution.berkeley.edu/evosite/evo101/index.shtml>
- Evolution animation shorts

<http://www.hhmi.org/biointeractive/evolution/animations.html>

Extension(s):

- Extensive website on genetics and evolution <http://learn.genetics.utah.edu/content/variation/>
- Teachers Resource Lounge <http://evolution.berkeley.edu/evolibrary/teach/912lounge.php>

**Cross Cutting Ideas:
Designing for Learning**

Strategies to reveal student understanding:

- Website of common misconception regarding DNA
http://rpd.net/sciencetips_v2/L12D2.htm#misconcept
- Science Assessment Probes by Paige Keeley at NSTA Press
- Misconceptions regarding mutations
http://rpd.net/sciencetips_v2/L12D5.htm#misconcept.

Prerequisite knowledge required:

- Nature of science
- Traits are coded for in DNA
- Mutations are changes in DNA
- Environments are where and organism lives
- Basic products and process of mitosis and meiosis

Student learning progressions can include:

- Progression and misconception document <http://www.doe.mass.edu/omste/ste/default.html>
- *Will need to scroll down and select the Life science document and then scroll to evolution.*
- AAAS Atlas of Science Literacy.

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

- How does genetics and the environment work together for the survival of a species?
- What is the effect of a changing climate on organisms and their evolution?

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

• **SYSTEMS (EALR 1):**

In evolutionary change, the present arises from the materials and forms of the past, more or less gradually, and in ways that can be explained. Most systems above the molecular level involve so many parts and forces and are so sensitive to tiny differences in conditions that their precise behavior is unpredictable, even if all the rules for change are known. Benchmarks, p. 275.

- The following activity at Concord Consortium, *Conflicting Selection Pressures*, allows students to observe how heredity and natural selection allow a population to adapt to a changing environment by making favorable mutations more common and unfavorable mutations less common (from Concord Consortium). If structured carefully, the students will be able to use EALRs 1-3. Refer to the Washington Standards documents for more detailed information on these EALRs.

<http://www.concord.org/activities/conflicting-selection-pressures>

• **INQUIRY (EALR 2):**

- <http://www.concord.org/activities/conflicting-selection-pressures>

• **APPLICATION (EALR 3):**

- <http://www.concord.org/activities/conflicting-selection-pressures>

- **LIFE SCIENCE (EALR 4):**

- Random Mutation activity
http://www.accessexcellence.org/AE/AEC/AEF/1995/westerling_selection.php
- Article and discussion
- http://evolution.berkeley.edu/evolibrary/news/101201_panthers

<p align="center">Cross Cutting Ideas: <i>Sense Making</i></p>	<p align="center">Cross Cutting Ideas: <i>Classroom Culture and Environment</i></p>
<p>Planning time in the lessons to support time for students to make sense of what they are learning include:</p> <ul style="list-style-type: none"> ● Pair-share on mutations and evolution. ● Reflective learning log entries on new learning about random selection. 	<p>Activities that show how this content standard relates to students' everyday lives include:</p> <ul style="list-style-type: none"> ● Activity on an evolutionary biologist and antibiotic resistant bacteria. http://evolution.berkeley.edu/evolibrary/article/0_0_0/bergstrom_01
<p>Strategies to focus on student conversations, interactive notebook prompts, model-building include:</p> <ul style="list-style-type: none"> ● http://www.ncosp.wvu.edu/ North Cascades and Olympics Science Partnership has many ideas and strategies for use in your classroom. ● http://nsta.org/publications/article.aspx?id=Z349URi8cV6bBbX1vjDQMEI3BOcgfN!plus!suJNn!plus!JMjBQ= NSTA journal article (The Science Teacher) written by a high school teacher about using interactive notebooks in the science classroom. ● Simulation of bunny breeding. http://www.pbs.org/wgbh/evolution/educators/lessons/lesson4/act1notes.html 	<p>Activities that show how scientists think and do science in relationship to this content standards include:</p> <ul style="list-style-type: none"> ● Web activity on an evolutionary biologist http://evolution.berkeley.edu/evolibrary/article/happyface_01 ● A similar activity can be found at Teachers Domain ● http://www.teachersdomain.org/resource/tdc02.science.life.gen.variation/