Grade 7
Life Science Unit 4: Biological Evolution: Unity and Diversity (45 Instructional Days)
Approved August, 2022

Content Statement: Much of evolution and natural selection research is based on finding patterns over long periods of time. Therefore, it is important to emphasize patterns in this unit. Students should practice looking for patterns in the fossil record, as well as look for patterns between the embryological development between several species to reveal how the theory of evolution was inferred by Darwin and other scientists in our more recent history.

Rationale: Students will use mathematical reasoning, models, probability, and proportional reasoning to analyze trends in populations over time, in order to analyze natural selection. In order to see the breadth of natural selection, students will need to be able to manipulate large data sets and use mathematical concepts to support explanations and arguments. This, arguably more than any unit, will emphasize mathematical thinking (which is why is also is ideal to have as the last unit so that the students can use nearly a year's worth of 7th grade mathematical concepts within their science class).

Overarching Essential Questions	Overarching Enduring Understandings
• How can fossils reveal how life has evolved over the history of the Earth? • How can genetic variations affect the survival and reproduction of species? • What is the difference between natural selection and artificial selection? • What evidence do scientists use to support the theory of evolution from a common ancestor?	• Patterns in fossils can reveal the evolution of life throughout the history of Earth. • Variations in traits can influence the probability of a species to survive and reproduce successfully. • Humans can influence the inheritance of desired traits in organisms, similar to how particular traits are naturally transferred to populations over time. • Describe different pieces of evidence that support evolution from a common ancestor (fossil record, homology and embryological development).

Student Learning Objectives	
What students should be able to do after instruction.	*Evidence Statements*
Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.[Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]	**MS-LS4-1**
Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. [Clarification Statement:	**MS-LS4-2**

Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]	
Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]	**MS-LS4-3**
Construct an explanation based on evidence that describes how genetic variations of traits in a population increasesome individuals' probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]	**MS-LS4-4**
Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]	**MS-LS4-5**
Use mathematical representations to support explanations of how natural selection may lead to increases and decreasesof specific traits in populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [*Assessment Boundary: Assessment does not include Hardy Weinberg calculations.*]	**MS-LS4-6**
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	**MS-ETS1-1**
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	**MS-ETS1-2**
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	**MS-ETS1-3**
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**MS-ETS1-4**

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and	**LS4.A: Evidence of Common Ancestry and Diversity** • 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	**Patterns** • Patterns can be used to identify cause and effect relationships. (MS-LS4-2) • Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1),(MS-LS4-3)

causation, and basic statistical techniques of data and error analysis.

- Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3)
- Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

- Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2)
- Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)

Obtaining, Evaluating, and Communicating Information

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. (MS-LS4-1)

- 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. (MS-LS4-2)
- Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)

LS4.B: Natural Selection

- Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)
- In *artificial* selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)

LS4.C: Adaptation

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the

Cause and Effect

- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4),(MS-LS4-5),(MS-LS4-6)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS4-5)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS4-1),(MS-LS4-2)

Science Addresses Questions About the Natural and Material World

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5)

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS4-5)	distribution of traits in a population changes. (MS-LS4-6)	
Connections to Nature of Science **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1)		

Interdisciplinary Connections
English Language Ars:- *RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-LS4-1),(MSLS4-2),(MS-LS4-3),(MS-LS4-4),(MS-LS4-5)* *RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS4-1),(MS-LS4-3)* *RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-LS4-3),(MS-LS4-4)* *WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS4-2),(MS-LS4-4)* *WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS4-5)* *WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-2),(MS-LS4-4)*

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS4-2),(MS-LS4-4)

SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS4-2),(MS-LS4-4)

Mathematics –

MP.4 Model with mathematics. (MS-LS4-6)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-LS4-4),(MS-LS4-6

Technology--

8.2.8.D.1 Design and create a product that addresses a real world problem using a design process under specific constraints.

8.2.8.D.3 Build a prototype that meets a STEM-based design challenge using science, engineering, and math principles that validate a solution.

8.2.8.A.3 Use and/or develop a simulation that provides an environment to solve a real world problem or theory.

8.2.8.A.2 Examine a system, consider how each part relates to other parts, and discuss a part to redesign to improve the system

Three-Dimensional Teaching and Learning

Analyzing Patterns

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Science and Engineering Practices: Using Mathematics and Computational Thinking

Students will use mathematical reasoning, models, probability, and proportional reasoning to analyze trends in populations over time, in order to analyze natural selection. In order to see the breadth of natural selection, students will need to be able to manipulate large data sets and use mathematical concepts to support explanations and arguments. This, arguably more than any unit, will emphasize mathematical thinking (which is why is also is ideal to have as the last unit so that the students can use nearly a year's worth of 7th grade mathematical concepts within their science class).

Prior Learning
Life Science- (3rd & 6th grade) • Species differ in their likelihood of survival and reproduction. • Organisms have unique life cycles, but all have common birth, growth, reproduction, and death. • Plants and animals have traits inherited from parents. • Traits can be influenced by the environment. • Variations in traits may provide advantages in reproduction, survival, and finding mates. ***Mathematics-*** • Understanding of probability, ratios and rates. • Solid foundation of fractions, decimals, and percentages. • Analyzing tables and graphs of data and information.

Part A: How can fossils reveal how life has evolved over the history of the Earth?	
Concepts	**Formative Assessment**
• Patterns in fossils can reveal the existence, diversity, extinction, and change of life through the history of life on Earth. • Chronological order of fossils show the complexity of organisms change over time. • Speciation is the formation of a new species over the course of biological evolution.	*Students who understand the concepts are able to:* • Analyze fossil data and construct a argument about the increase in complexity of life forms over time. Identify any patterns within the fossils over several eras in the fossil record. Students can practice chronologically lining up different pictures of fossils based on their relative complexity (emphasis on ordering fossils by complexity and not on true age) to show the basic trend over time. • Use scientific argumentation and evidence to determine if a fossilized tooth came from a prehistoric lion or a prehistoric shark. Students should be able to make their arguments *in writing*, using appropriate claims, support/evidence, and argumentative language and phrases. Using an Argument Card Sort: Fossils

Part B: How can genetic variations affect the survival and reproduction of species?	
Concepts	**Formative Assessment**
• Natural selection is the increase in probability of a species to survive or reproduce based on a variation of traits.	*Students who understand the concepts are able to:*

• Similarities exist between embryos of different species, which may suggest a common ancestral structure. • Homologies can show species that arose from common ancestry.	• Use proportional reasoning to construct arguments and explanations of how genetic variations increase the probability of survival and reproduction. • Compare two similar species and make a claim supported with evidence that a particular variation in traits allowed it to survive and reproduce more readily than the other OR that a particular environmental change increased the likelihood of a particular trait to be passed on to offspring. • Compare the embryological development of several species to identify homologies that may not be present in the fully formed adult species, such as gills in both fish and human embryos (Evidence-Embryos). Construct an argument that there is a general relatedness between the different species suggesting similar ancestral structure.

Part C: What is the difference between natural selection and artificial selection?

Concepts	Formative Assessment
• Humans can influence genetic outcomes in artificial selection, such as with genetic modification, animal husbandry, and gene therapy. • Artificial selection technologies have impacted society and vice versa. • Biomimicry is the idea that humans can learn from the patterns of survival and success of other animals and imitate them in innovative ways.	*Students who understand the concepts are able to:* • Construct explanations of technologies that have greatly impacted the artificial selection field of study. Students should synthesize this information from multiple sources, being sure to assess their credibility and accuracy. • Analyze the line of events involved in a particular type of artificial selection, such as genetically modified food or the domestication of animals. Students may also analyze the affect these human-controlled changes have made on the natural environment or population. • STEM: Design, redesign or analyze a design for a method of aritificial selection. • STEM: Use the idea of biomimicry to design a product for humans inspired by adaptations by nature. (Design rubric)

Modifications: *Teachers identify the modifications that they will use in the unit. The unneeded modifications can then be deleted from the list.(See NGSS Appendix D)*

- *Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)*
- *Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.*

- *Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).*
- *Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).*
- *Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).*
- *Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.*
- *Use project-based science learning to connect science with observable phenomena.*
- *Structure the learning around explaining or solving a social or community-based issue.*
- *Provide ELL students with multiple literacy strategies.*
- *Collaborate with after-school programs or clubs to extend learning opportunities.*

Resources and Samples of Open Education Resources for this unit:

HMH Dimensions Science Program

PhET Simulator is a resource of simulations of hundreds of concepts. (Natural Selection simulation)

NSTA Classroom Resources is a website of sample lessons aligned directly with each 6th grade space and Earth science unit.

Brainpop is a website of short mini-lesson videos.

CK-12 is a resource where you can create supplemental content in online "flexbooks" for students aligned with NGSS.

M&M Survival Challenge is a lab that students can perform to show microevolution.

Evolutionary Embryology is a resource for teachers to more deeply understand homologies and embryological structures.

An Origin of Species: Pollenpeepers is a web simulation that follows the 5 million year history of a fictitious bird, the pollenpeeper.

Catch Up on Tomato History is a lesson plan for following the history of natural and artificial selection on our modern-day tomato plant.